Atlas Copco

Energy Recovery Stand Alone Kit

Instruction book

Instruction manual

1. General Information

Energy Recovery Stand Alone Kit

Document Number	:	9845 0512 02
Concerning	:	GA 11-315 kW
Preliminary Operations	:	–
Safety Instructions	:	General
Persons Required	:	1
Special Tools	:	–
Consumables	:	–

2. Document Overview

This document covers the following subjects:

3. Preface

This manual details and illustrates the main components and the functional working principle of the energy recovery unit stand alone version for use on 11 to 315 kW oil injected compressors.

For the sake of convenience, the terms “energy recovery” and “energy recovery unit” may be abbreviated as “ER” and “ER unit”.

4. Safety precautions

These precautions apply to machinery processing or consuming air or inert gas. Processing of any other gas requires additional safety precautions typical to the application which are not included herein.

Some precautions are general and cover several machine types and equipment; hence some statements may not apply to your machine.

All responsibility for any damage or injury resulting from neglecting these precautions, or non-observance of the normal caution and care required for installation, operation, maintenance and repair, even if not expressly stated, will be disclaimed by the manufacturer.

4.1. Safety precautions during installation

General precautions

1. The operator must employ safe working practices and observe all related work safety requirements and regulations.
2. If any of the following statements does not comply with the applicable legislation, the stricter of the two shall apply.
3. Installation, operation, maintenance and repair work must only be performed by authorised, trained, specialised personnel.
4. The compressor is not considered capable of producing air of breathing quality. For air of breathing quality, the compressed air must be adequately purified according to the applicable legislation and standards.
5. Before any maintenance, repair work, adjustment or any other non-routine checks, stop the compressor, press the emergency stop button, switch off the voltage and depressurise the compressor. In addition, the power isolating switch must be opened and locked.
6. Never play with compressed air. Do not apply the air to your skin or direct an air stream at people. Never use the air to clean dirt from your clothes. When using the air to clean equipment, do so with extreme caution and wear eye protection.
7. The owner is responsible for maintaining the unit in safe operating condition. Parts and accessories shall be replaced if unsuitable for safe operation.

Precautions during installation

1. The machine must only be lifted using suitable equipment in accordance with the applicable safety regulations. Loose or pivoting parts must be securely fastened before lifting. It is strictly forbidden to dwell or stay in the risk zone under a lifted load. Lifting acceleration and deceleration must be kept within safe limits. Wear a safety helmet when working in the area of overhead or lifting equipment.
2. Place the machine where the ambient air is as cool and clean as possible. If necessary, install a suction duct. Never obstruct the air inlet. Care must be taken to minimise the entry of moisture at the inlet air.
3. Any blanking flanges, plugs, caps and desiccant bags must be removed before connecting the pipes.
4. Air hoses must be of correct size and suitable for the working pressure. Never use frayed, damaged or worn hoses. Distribution pipes and connections must be of the correct size and suitable for the working pressure.
5. The aspirated air must be free of flammable fumes, vapours and particles, e.g. paint solvents, that can lead to internal fire or explosion.
6. Arrange the air intake so that loose clothing worn by people cannot be sucked in.
7. Ensure that the discharge pipe from the compressor to the aftercooler or air net is free to expand under heat and that it is not in contact with or close to flammable materials.
8. No external force may be exerted on the air outlet valve; the connected pipe must be free of strain.
9. If remote control is installed, the machine must bear a clear sign stating: DANGER: This machine is remotely controlled and may start without warning.

The operator has to make sure that the machine is stopped and that the isolating switch is open and locked before any maintenance or repair. As a further safeguard, persons switching on remotely controlled machines shall take adequate precautions to ensure that there is no one checking or working on the machine. To this end, a suitable notice shall be affixed to the start equipment.

10. Air-cooled machines must be installed in such a way that an adequate flow of cooling air is available and that the exhausted air does not re-circulate to the compressor air inlet or cooling air inlet.
11. The electrical connections must correspond to the applicable codes. The machines must be earthed and protected against short circuits by fuses in all phases. A lockable power isolating switch must be installed near the compressor.
12. On machines with automatic start-stop system or if the automatic restart function after voltage failure is activated, a sign stating "This machine may start without warning" must be affixed near the instrument panel.
13. In multiple compressor systems, manual valves must be installed to isolate each compressor. Non-return valves (check valves) must not be relied upon for isolating pressure systems.
14. Never remove or tamper with the safety devices, guards or insulation fitted on the machine. Every pressure vessel or auxiliary installed outside the machine to contain air above atmospheric pressure must be protected by a pressure-relieving device or devices as required.
15. Pipework or other parts with a temperature in excess of 80°C (176°F) and which may be accidentally touched by personnel in normal operation must be guarded or insulated. Other high-temperature pipework must be clearly marked.
16. For water-cooled machines, the cooling water system installed outside the machine has to be protected by a safety device with set pressure according to the maximum cooling water inlet pressure.
17. If the ground is not level or can be subject to variable inclination, consult the manufacturer.

4.2. Safety precautions during operation

General precautions

1. The operator must employ safe working practices and observe all related work safety requirements and regulations.
2. If any of the following statements does not comply with the applicable legislation, the stricter of the two shall apply.
3. Installation, operation, maintenance and repair work must only be performed by authorised, trained, specialised personnel.
4. The compressor is not considered capable of producing air of breathing quality. For air of breathing quality, the compressed air must be adequately purified according to the applicable legislation and standards.
5. Before any maintenance, repair work, adjustment or any other non-routine checks, stop the compressor, press the emergency stop button, switch off the voltage and depressurise the compressor. In addition, the power isolating switch must be opened and locked.
6. Never play with compressed air. Do not apply the air to your skin or direct an air stream at people. Never use the air to clean dirt from your clothes. When using the air to clean equipment, do so with extreme caution and wear eye protection.

Precautions during operation

1. Use only the correct type and size of hose end fittings and connections. When blowing through a hose or air line, ensure that the open end is held securely. A free end will whip and may cause injury. Make sure that a hose is fully depressurized before disconnecting it.
2. Persons switching on remotely controlled machines shall take adequate precautions to ensure that there is no one checking or working on the machine. To this end, a suitable notice shall be affixed to the remote start equipment.
3. Never operate the machine when there is a possibility of taking in flammable or toxic fumes, vapours or particles.
4. Never operate the machine below or in excess of its limit ratings.
5. Keep all bodywork doors shut during operation. The doors may be opened for short periods only, e.g. to carry out routine checks. Wear ear protectors when opening a door.
6. People staying in environments or rooms where the sound pressure level reaches or exceeds 90 dB(A) shall wear ear protectors.
7. Periodically check that:
    - All guards are in place and securely fastened
    - All hoses and/or pipes inside the machine are in good condition, secure and not rubbing
    - There are no leaks
    - All fasteners are tight

- All electrical leads are secure and in good order
- Safety valves and other pressure-relief devices are not obstructed by dirt or paint
- Air outlet valve and air net, i.e. pipes, couplings, manifolds, valves, hoses, etc. are in good repair, free of wear or abuse

8. If warm cooling air from compressors is used in air heating systems, e.g. to warm up a workroom, take precautions against air pollution and possible contamination of the breathing air.
9. Do not remove any of, or tamper with, the sound-damping material.
10. Never remove or tamper with the safety devices, guards or insulations fitted on the machine. Every pressure vessel or auxiliary installed outside the machine to contain air above atmospheric pressure shall be protected by a pressure-relieving device or devices as required.

4.3. Safety precautions during maintenance or repair

General precautions

1. The operator must employ safe working practices and observe all related local work safety requirements and regulations.
2. If any of the following statements does not comply with the applicable legislation, the stricter of the two shall apply.
3. Installation, operation, maintenance and repair work must only be performed by authorised, trained, specialised personnel.
4. The compressor is not considered capable of producing air of breathing quality. For air of breathing quality, the compressed air must be adequately purified according to local legislation and standards.
5. Before any maintenance, repair work, adjustment or any other non-routine checks, stop the compressor, press the emergency stop button, switch off the voltage and depressurise the compressor. In addition, the power isolating switch must be opened and locked.
6. Never play with compressed air. Do not apply the air to your skin or direct an air stream at people. Never use the air to clean dirt from your clothes. When using the air to clean equipment, do so with extreme caution and wear eye protection.

Precautions during maintenance or repair

1. Always wear safety glasses.
2. Use only the correct tools for maintenance and repair work.
3. Use only genuine spare parts.
4. All maintenance work shall only be undertaken when the machine has cooled down.
5. A warning sign bearing a legend such as "work in progress; do not start" shall be attached to the starting equipment.
6. Persons switching on remotely controlled machines shall take adequate precautions to ensure that there is no one checking or working on the machine. To this end, a suitable notice shall be affixed to the remote start equipment.
7. Close the compressor air outlet valve before connecting or disconnecting a pipe.
8. Before removing any pressurized component, effectively isolate the machine from all sources of pressure and relieve the entire system of pressure.
9. Never use flammable solvents or carbon tetrachloride for cleaning parts. Take safety precautions against toxic vapours of cleaning liquids.
10. Scrupulously observe cleanliness during maintenance and repair. Keep dirt away by covering the parts and exposed openings with a clean cloth, paper or tape.
11. Never weld or perform any operation involving heat near the oil system. Oil tanks must be completely purged, e.g. by steam-cleaning, before carrying out such operations. Never weld on, or in any way modify, pressure vessels.
12. Whenever there is an indication or any suspicion that an internal part of a machine is overheated, the machine shall be stopped but no inspection covers shall be opened before sufficient cooling time has elapsed; this to avoid the risk of spontaneous ignition of the oil vapour when air is admitted.
13. Never use a light source with open flame for inspecting the interior of a machine, pressure vessel, etc
14. Make sure that no tools, loose parts or rags are left in or on the machine.
15. All regulating and safety devices shall be maintained with due care to ensure that they function properly. They may not be put out of action.

16. Before clearing the machine for use after maintenance or overhaul, check that operating pressures, temperatures and time settings are correct. Check that all control and shut-down devices are fitted and that they function correctly. If removed, check that the coupling guard of the compressor drive shaft has been reinstalled.

17. Every time the separator element is renewed, examine the discharge pipe and the inside of the oil separator vessel for carbon deposits; if excessive, the deposits should be removed.

18. Protect the motor, air filter, electrical and regulating components, etc. to prevent moisture from entering them, e.g. when steam-cleaning.

19. Make sure that all sound-damping material and vibration dampers, e.g. damping material on the bodywork and in the air inlet and outlet systems of the compressor, is in good condition. If damaged, replace it by genuine material from the manufacturer to prevent the sound pressure level from increasing.

20. Never use caustic solvents which can damage materials of the air net, e.g. polycarbonate bowls.

21. The following safety precautions are stressed when handling refrigerant:

    - Never inhale refrigerant vapours. Check that the working area is adequately ventilated; if required, use breathing protection.
    - Always wear special gloves. In case of refrigerant contact with the skin, rinse the skin with water. If liquid refrigerant contacts the skin through clothing, never tear off or remove the latter; flush abundantly with fresh water over the clothing until all refrigerant is flushed away; then seek medical first aid.

22. Protect hands to avoid injury from hot machine parts, e.g. during draining of oil.

5. Energy Recovery (ER)

5.1. Description

The energy required in any compression process is mainly transformed into heat. In oil-injected screw compressors, most of this compression heat is dissipated through the oil system. The Energy Recovery stand alone kit is designed to recover most of this heat by transforming it into warm/hot water without adversely affecting compressor performance. The water can be used for various applications.

5.2. Components

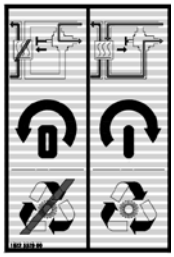
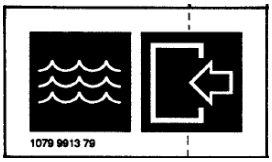
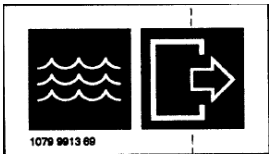
The stand alone energy recovery system comprises:

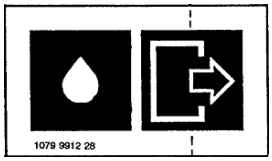
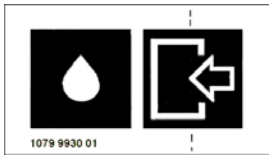
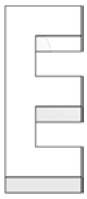
- Completely **stainless steel** oil/water heat exchanger.
- Thermostatic bypass valve with on/off lever.
- Temperature sensors for water inlet and outlet control.
- Necessary bolts, pipes, hose assemblies, etc.
- The Energy Recovery system also includes thermostats for both the bypass valve of the Energy Recovery unit and the main bypass valve of the oil filter pipe.
- Flexibles to connect the kit to the main compressor
- Tap flange (except for GA 11-30 kW range)

5 versions are available:

- 2230 0060 90 for 11^{+} - 30 kW
- 2230 0060 91 for 30^{+} - 55 kW
- 2230 0060 92 for 55^{+} - 90 kW
- 2230 0060 93 for 90^{+} - 180 (VSD) kW
- 2230 0060 94 for 180^{+} - 315 kW

5.3. Labels

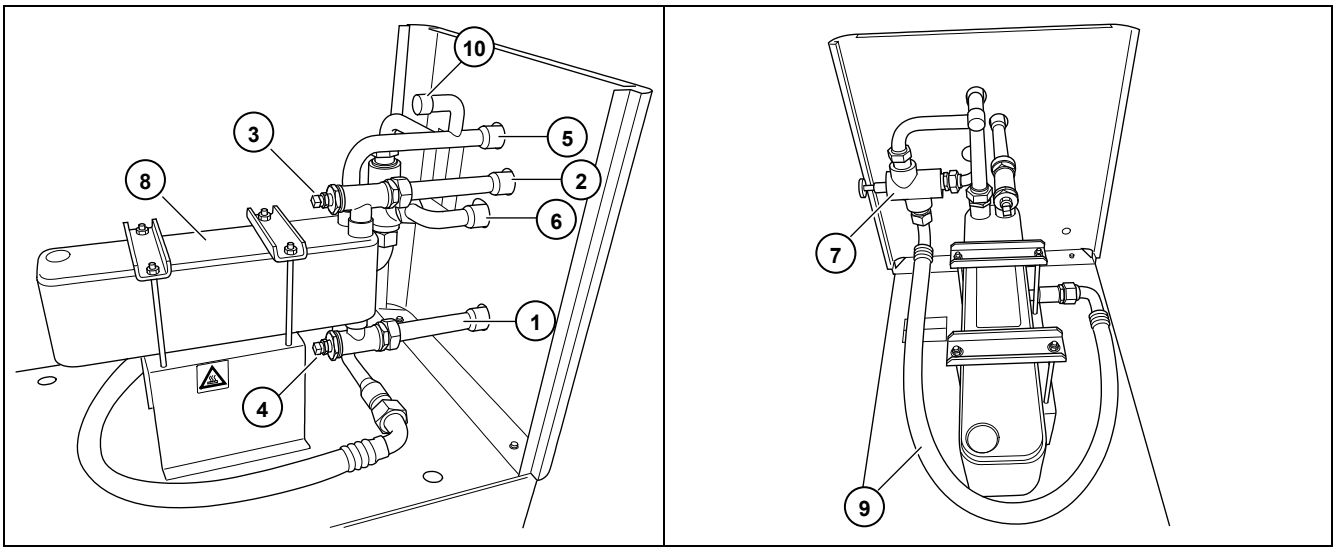
Part Number	Picture	Description
1079 9902 55		Warning label – hot surface
1622 5529 00		System operation remark
1079 9913 79		Water in
1079 9913 69		Water out

1079 9912 28		Oil out
1079 9930 01		Oil in
1630 0267 00		System remark
0690 1116 01		Atlas Copco logo
1630 0264 00		ER S-1 logo
1630 0265 00		ER S-2 logo
1630 0266 00		ER S-3 logo
1630 0349 00		ER S-4 logo
1630 0350 00		ER S-5 logo

5.4. Main parts of the Energy Recovery unit

11-315 kW range (& VSD)

Figure 1



1. Water inlet connection	**5.** Oil inlet connection	**8.** Heat exchanger (or ER unit)
2. Water outlet connection	**6.** Oil outlet connection	**9.** Oil flexible (oil outlet)
3. Temperature sensor, water out	**7.** 1st bypass valve with thermostat and lever for manual on/off control of the ER unit	**10.** Venting nipple
4. Temperature sensor, water in		

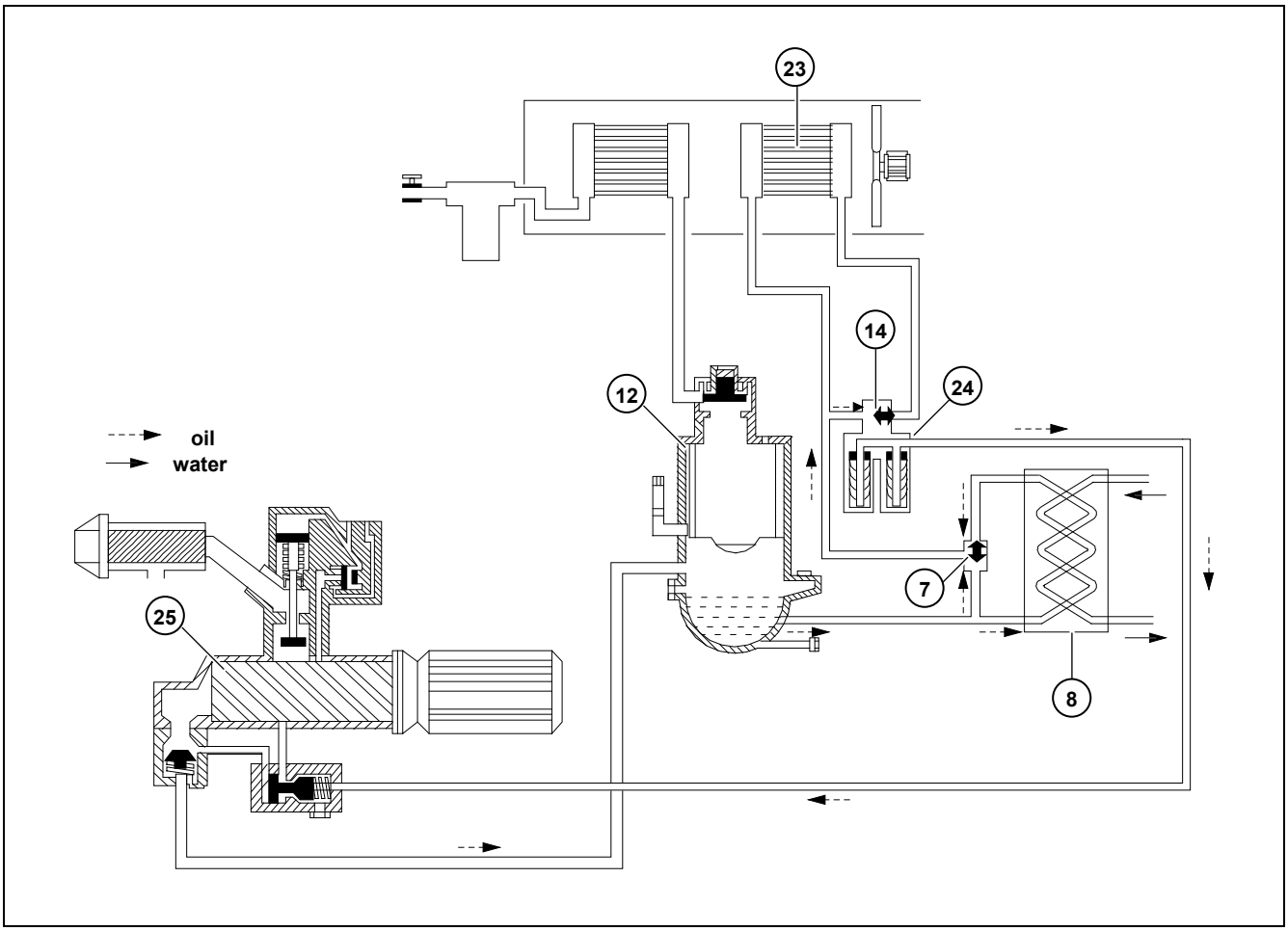
The functions of the main components are detailed below in this manual.

The size of the heat exchanger varies according to its range. The 55-90 kW range heat exchanger is shown in the figure above. The set up is similar for other ER kits.

5.5. Typical flow

The compressor oil flow is controlled by two thermostatic bypass valves, ensuring reliable compressor operation and optimum energy recovery.

Figure 2: Example of air cooled oil injected screw compressor



7. 1st bypass valve of ER (BV1)	**14.** 2nd bypass valve (BV2) of oil filter pipe	**24.** Oil filter of oil filter pipe
8. Heat exchanger of ER	**23.** Main oil cooler	**25.** Compressor element
12. Oil separator		

The 1st bypass valve (Figure 2-7) is integrated in the ER unit and controls the operation of the oil heat exchanger (Figure 2-8) of the ER unit. The 2nd bypass valve (Figure 2-14) is integrated in the oil filter pipe and controls the operation of the main oil cooler (Figure 2-23) of the compressor. Both bypass valves consist of an insert (thermostat) mounted in a housing. In the 1st bypass valve of the ER unit, this is a single housing. In the 2nd bypass valve of the compressor, this housing is integrated in the oil filter pipe (Figure 2-14).

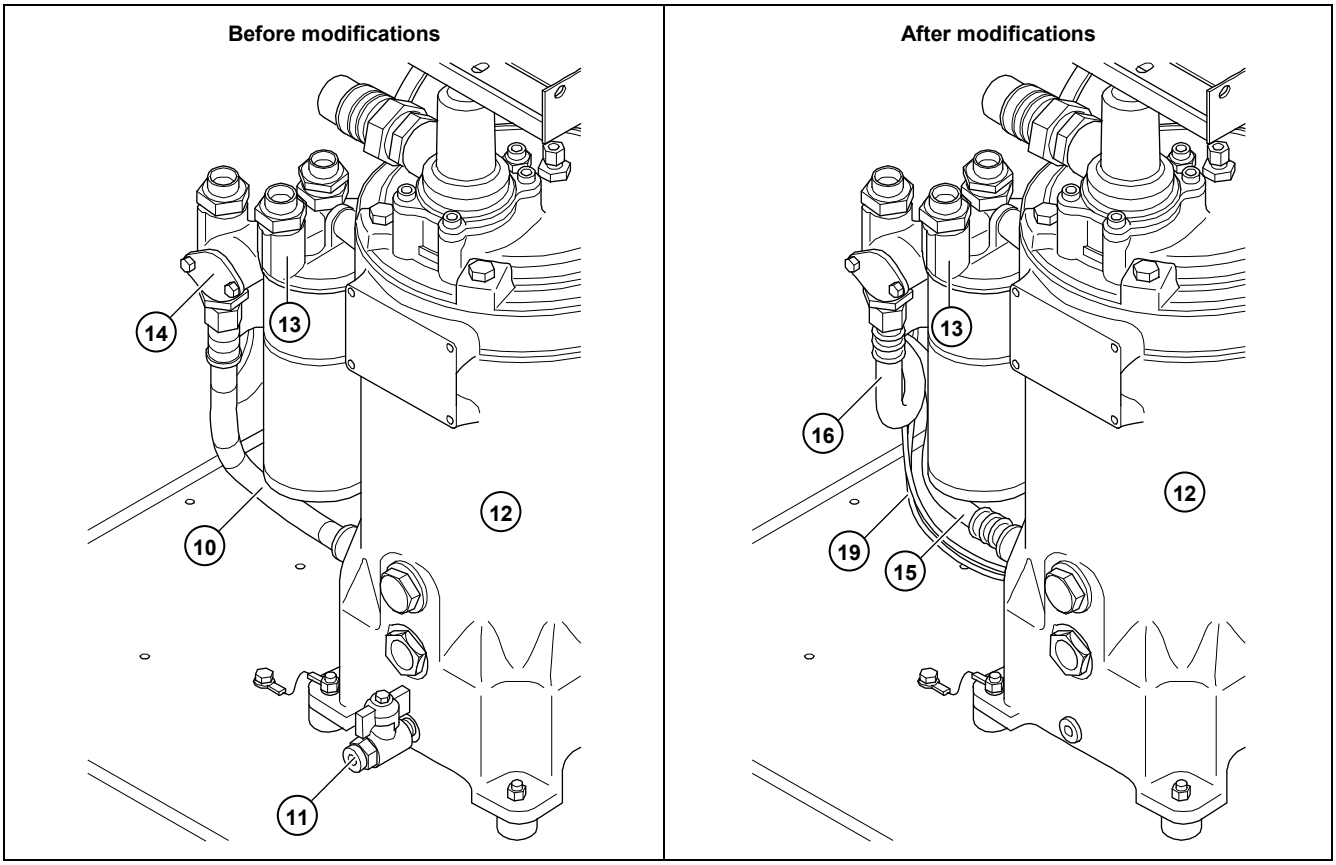
5.6. Mechanical modifications & installation

When servicing the unit, please follow the safety precautions as described in the instruction manual of the compressor.

Internal modifications

11+-30 kW range (& VSD)

Figure 3: Modifications to vessel and oil filter pipe/housing to install the ER unit on 11+-30 kW and 15-30 kW (VSD)



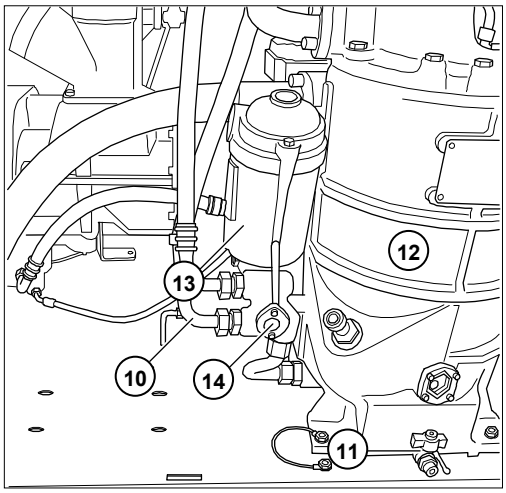
10. Oil pipe (from vessel to oil inlet oil filter pipe / oil filter housing)	**14.** 2nd bypass valve (BV2) of filter pipe	**16.** Oil flexible (from oil outlet connection of ER unit to oil filter pipe)
11. Oil drain	**15.** Oil flexible (from vessel to oil inlet connection of ER unit)	**19.** Wiring for oil temperature sensors (2 off)
12. Oil separator vessel		
13. Oil filter pipe with 2nd bypass valve and oil filter housing		

To enable the energy recovery unit to be inserted into the compressor oil circuit, the oil pipe (Figure 3-10) between the oil separator vessel (Figure 3-12) and the oil filter housing (Figure 3-13) must be removed. This pipe will NOT be reused and may be discarded.

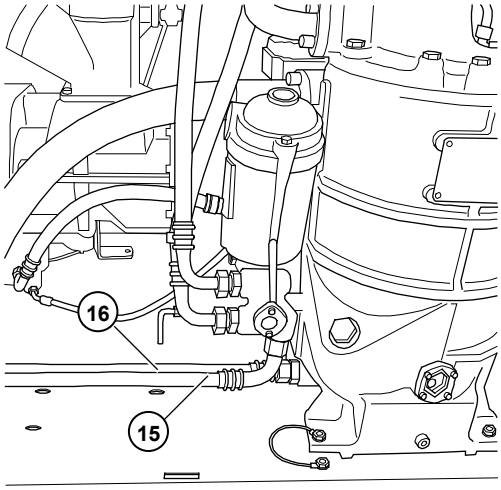
30+-45 kW range (& VSD)

Figure 4: Modifications to vessel & oil filter pipe/housing to install the ER unit on 30+-45 kW (& VSD)

Before modifications



After modifications



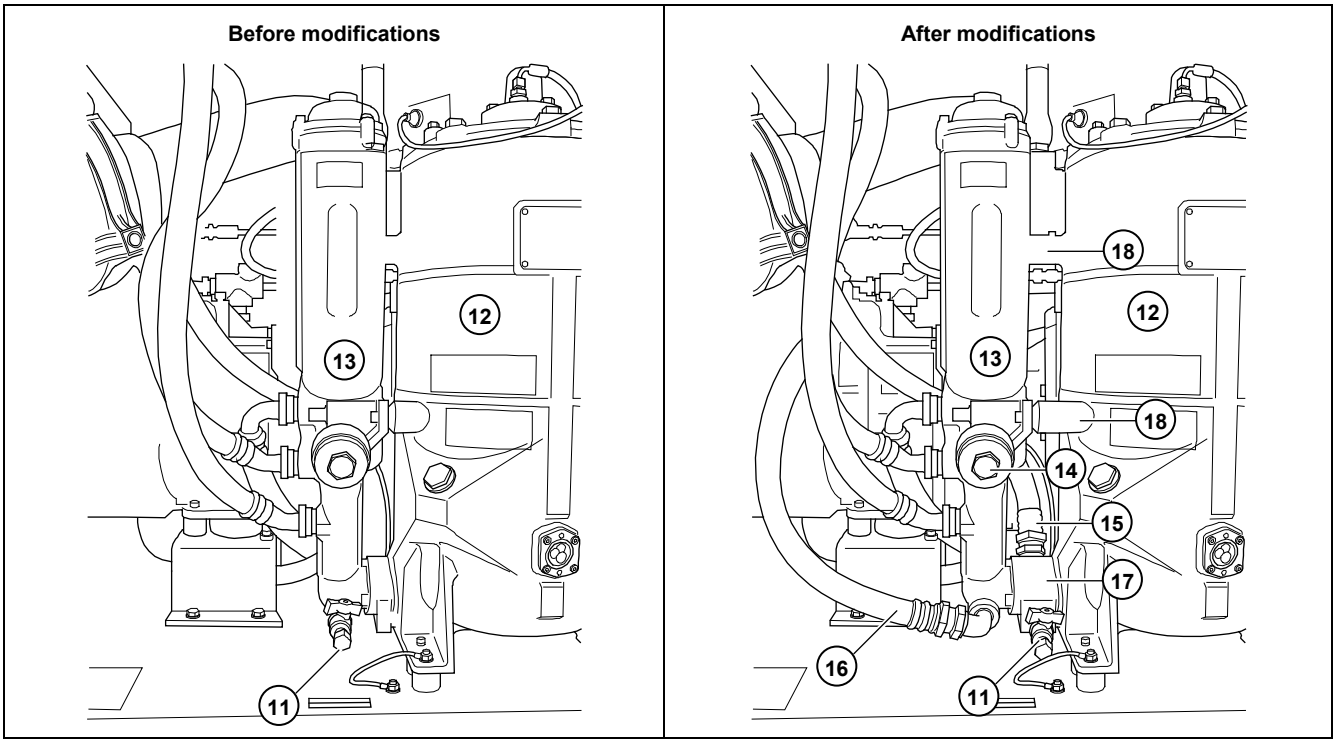
10. Oil pipe (from vessel to oil inlet oil filter pipe)	**13.** Oil filter pipe with 2nd bypass valve and oil filter housing	**15.** Oil flexible (from vessel to oil inlet connection of ER unit)
11. Oil drain	**14.** 2nd bypass valve (BV2) of filter pipe	**16.** Oil flexible (from oil outlet connection of ER unit to oil filter pipe)
12. Oil separator vessel		

To allow the energy recovery unit to be inserted into the compressor oil circuit, the oil pipe (Figure 4-10) between the oil separator vessel (Figure 4-12) and the oil filter housing (Figure 4-13) must be removed. This pipe will NOT be reused and may be discarded.

The oil inlet and outlet pipes of the ER unit are provided with a hose nipple to connect the oil hose assemblies.

37+-315 kW range (typical installation)

Figure 5: Modifications to vessel & oil filter pipe to install the ER unit on 37+-315 kW (& VSD)



11. Oil drain	**14.** 2nd bypass valve (BV2) of filter pipe	**16.** Oil flexible (from oil outlet connection of ER unit to oil filter pipe)
12. Oil separator vessel	**15.** Oil flexible (from tap flange to oil inlet connection of ER unit)	**17.** Tap flange
13. Oil filter pipe with 2nd bypass valve and oil filter housing		**18.** Spacer (up to GA 90 kW)

To enable the energy recovery unit to be inserted into the compressor oil circuit, a special tap flange (Figure 5-17) and 2 spacers (Figure 5-18) must be installed between the oil separator vessel (Figure 5-12) and the oil filter pipe (Figure 5-13). This flange allows the oil to be drained out of the oil separator vessel (Figure 5-12) and directly into the oil inlet connection (Figure 7-5) of the ER unit using a flexible (Figure 5-15).

Connect the other flexible (Figure 5-16) coming from the oil outlet connection (Figure 5-6) of the energy recovery unit to a connection at the bottom of the oil filter pipe (Figure 5-13). In standard compressors without energy recovery, this connection serves as an oil drain.

In compressors with an ER unit built in, the special tap flange (Figure 5-17) takes over this oil drain (Figure 5-11) function.

External modifications

To define connection kit, please refer to document 9845 0132 00 on GBP or contact your official Atlas Copco Service Specialist.

Make sure to install insulation on all exposed hot surfaces of external flexibles and metal parts of the compressor and ER kit, to avoid injury. The insulation can be optionally ordered, see Part list for correct order numbers.

The oil inlet and outlet pipes of the ER unit are provided with a hose nipple to connect the oil hose assemblies.

Figure 6: ER Kit - overview

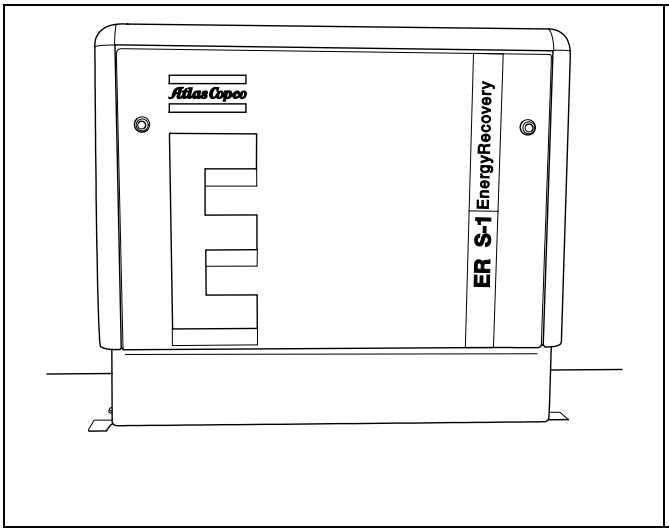
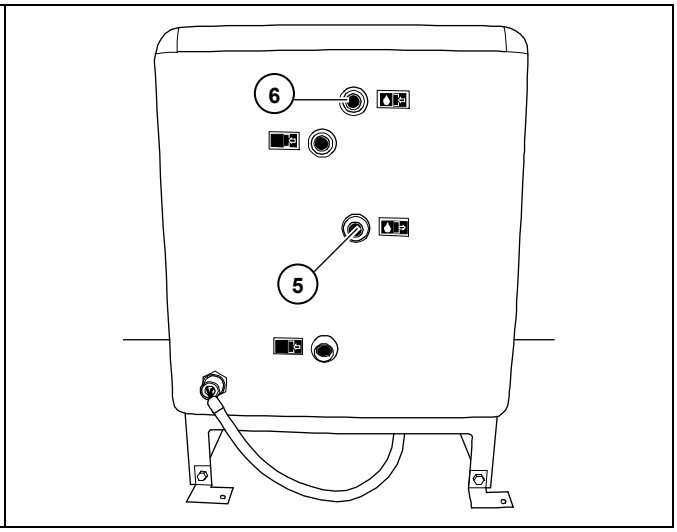


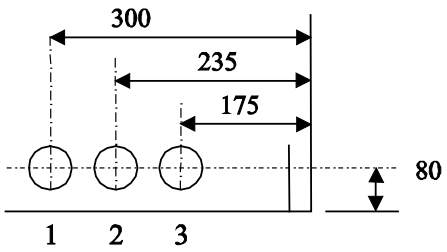
Figure 7: Connection panel



A flexible (Figure 3/4/5-15) connects the outlet of the oil separator vessel (Figure 3/4/5-12) and the oil inlet connection (Figure 7-5). The oil outlet connection (Figure 7-6) is connected to the bottom of the oil filter housing (Figure 3/4/5-13) through a second flexible hose (Figure 3/4/5-16). This is the original connection of the oil pipe (Figure 3/4-10).

The ER unit should be placed as near as possible to the compressor. The water shut-off valves (2 off) are NOT supplied with the kit.

Figure 8: Example of a hole pattern to connect the ER kit and the compressor

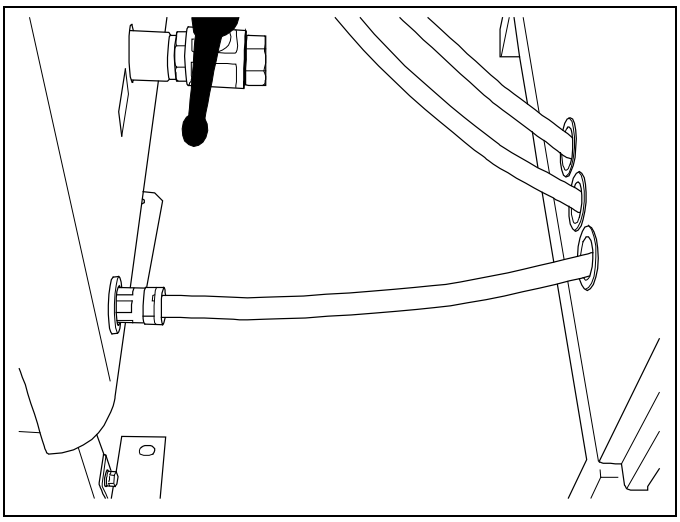


1. Oil inlet ER
2. Oil outlet ER
3. Temperature sensor cables

To connect the ER unit to the compressor, make 3 holes in the side panel of the canopy (see Figure 8):

- ø 55 mm (up to 90 kW)
- ø 70 mm (from 90^{+} kW on)

Figure 9: View on rubber grommets in side panel



Install 3 split grommets in the drilled holes to prevent the flexible hoses (2x) and the conduit gland (1x) from getting damaged by burrs in the holes (see Figure 9).

5.7. Electrical modifications & installation

11+-30 kW & 15-30 kW (VSD)

Please refer to the service diagram supplied with the main compressor and the additional service diagram 9845 1800 00 for details about the electrical installation of the temperature sensors on the energy recovery unit.

The use of expansion module 1900 xxxx yy with connection cables varies for Mk 4 and Mk 5 and must be determined on site.

30+-315 kW (& VSD)

NOTE: 90-315 kW is only available with Mk 4 controller.

Figure 10: Electrical modifications to install the ER unit with Mk 4

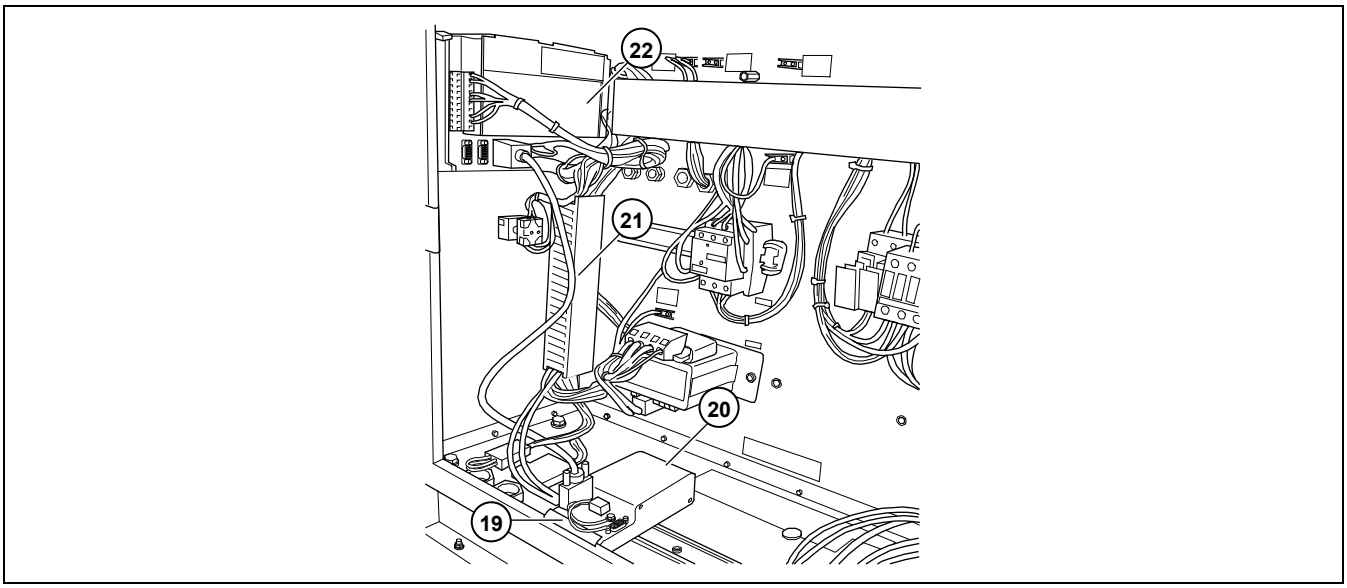
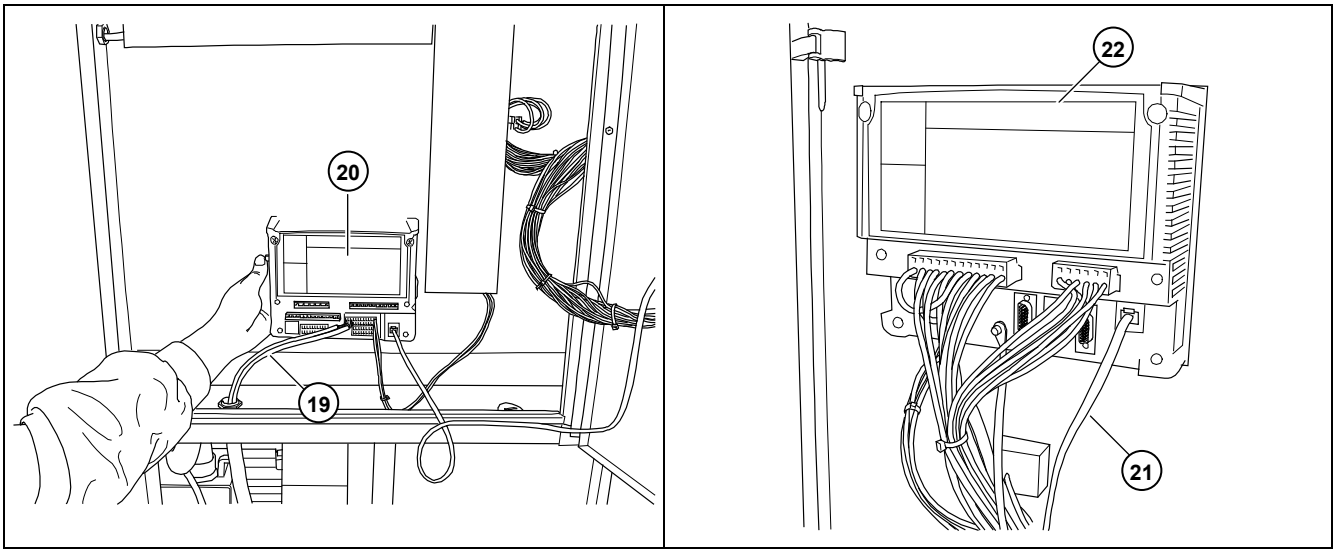


Figure 11: Electrical modifications to install the ER unit with Mk 5

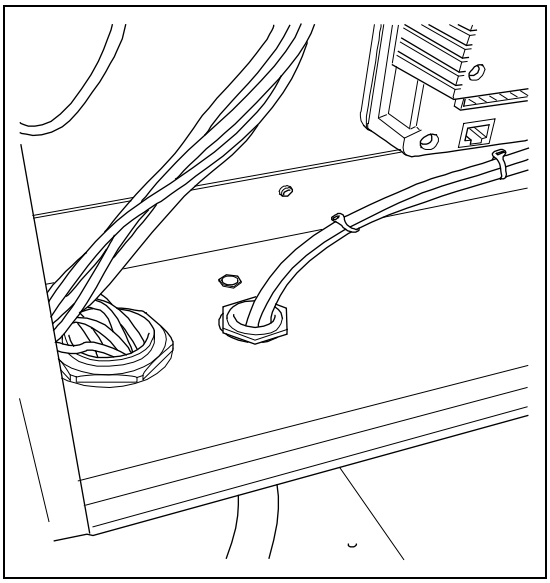


4. Temperature sensor cables	**6.** Link cable
5. Expansion module	**7.** Main controller module (Elektronikon)

The two temperature sensors (Figure 1-3&4) are connected using sensor cables (Figure 11-19) to an expansion module (Figure 11-20) in the compressor cubicle. This expansion module is connected using a link cable (Figure 11-21) to the main controller module (Elektronikon) (Figure 11-22).

Provide 1 hole of ø 26 mm in the bottom of the cubicle for the conduit with conduit gland (temperature sensor cables).

Figure 12



Make sure that all metal debris caused by drilling is removed with a vacuum cleaner as this may damage the electronic parts in the cubicle!
It is recommended to make a hole of ø 26 mm with a special punch tool (no drilling is required).

For details about the electrical installation of this expansion module, please refer to the service diagram supplied with the main compressor.

5.8. Remarks

The ER unit is delivered as a complete kit.

The said mechanical and electrical modifications must be completed to be able to use the ER unit to recover energy.

6. Applications for the energy recovery system

6.1. General

The energy recovery system can be applied as a low temperature rise/high water flow system or as a high temperature rise/low water flow system.

6.2. Low temperature rise/High water flow

For this type of application, the temperature difference between the water in the energy recovery system and the compressor oil is low. Therefore, a high water flow is needed for maximum energy recovery.

Example: The heated water is used to keep another medium at a moderately high temperature in a closed circuit, e.g. central heating.

Calculation: see chapter: 9.6

6.3. High temperature rise/low water flow

NOTE: The decrease in water flow to obtain higher water outlet temperatures will result in higher oil injection temperatures up to maximum 75°C. At this temperature, the 2nd bypass valve (Figure 3/4/5-14) will ensure that the oil injection temperature does not rise above 75°C. (See chapter 7 for operation). The higher oil injection temperature will adversely affect the performance of the compressor. The AML of the tropical thermostat option should therefore be applied when using the energy recovery in 'high temperature rise/low water flow' type of applications.

This type of application generates a high water temperature rise in the energy recovery system, resulting in a low flow rate.

Example: An open circuit with cold water from a main supply being heated by the energy recovery system for use in a factory, e.g. preheating boiler feed water.

Calculation: see chapter: 9.6

6.4. Recovery water flow

The recovery water enters the ER unit at the water inlet connection (Figure 1-1). In the heat exchanger (Figure 1-8) the compression heat is transferred from the compressor oil to the water. The water leaves the heat exchanger (Figure 1-8) through the water outlet connection (Figure 1-2).

6.5. Recovery water requirements for closed water circuits

When the Energy Recovery system is integrated in a closed recirculation water circuit, the use of soft or even demineralised water is economically beneficial and eliminates problems with scale deposits. Although the heat exchanger of the ER unit is entirely made of stainless steel, the water circuit connected to the compressor may require corrosion inhibitors. Please refer to the table below to minimize problems due to poor water quality. Please contact Atlas Copco in case of doubt.

Add an anti-freeze product, such as ethylene glycol, to the water as needed according to the expected temperature to avoid freezing. Remember that adding ethylene glycol to the cooling water reduces the heat capacity of the coolant. The heat capacity of ethylene glycol is only 61.2% of that of water. To obtain an equivalent cooling performance the coolant flow rate must therefore be increased.

Example: if the coolant contains x% glycol in 100-x% water, the coolant flow rate should be increased by $38.8 \cdot x\ (100 - 0.388 \cdot x)\%$ versus 100% water.

6.6. Recovery water requirements for open water circuits

In open, non-recirculation water circuits, the main problems that are usually encountered relate to deposit control, corrosion control and microbiological growth control. To minimize these problems, the water should meet a number of requirements. Please contact Atlas Copco in case of doubt.

Recommended maxima (mg/l)	Closed water circuit	Open water circuit
Chloride (Cl^-)	< 600	< 150
Sulphate ($SO4^-$)	< 400	< 250
Total solids	< 3000	< 750
Suspended solids (as SiO_2)	< 10	< 10
Free chlorine (Cl_2)	< 4	< 2
Ammonia ($NH4^+$)	< 0.5	< 0.5
Copper	< 0.5	< 0.5
Iron	< 0.2	< 0.2
Manganese	< 0.1	<0.1
Oxygen	< 3	< 3
Carbonate hardness (as $CaCO_3$)	50-1000	50-500
Organics ($KMnO_4$ Consumption)	< 25	< 10

7. Operation

7.1. Thermostatic bypass valve

Heat exchanger bypass valve (of ER unit) with lever

Figure 13: ER label

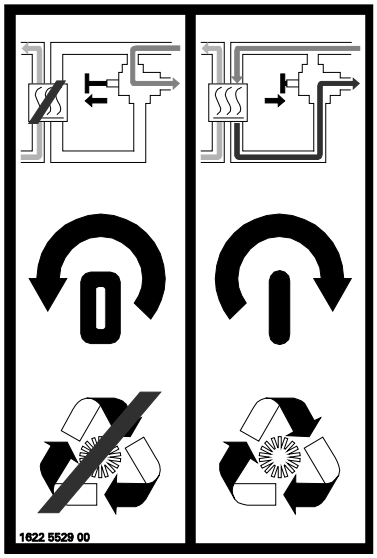
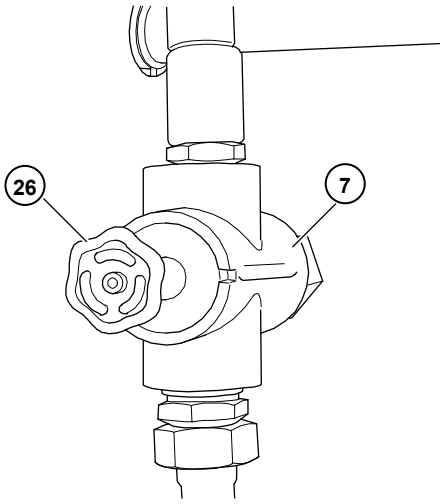


Figure 14: Thermostatic valve housing ER kit



The 1st bypass valve of the ER (Figure 14-7) is provided with a special lever (Figure 14-26). This lever controls the operation of the energy recovery system.
As can be seen on the ER label (Figure 13), the ER unit is integrated in the oil circuit and recovers energy when the lever is turned in fully clockwise.
When the lever is turned out fully counter clockwise, the ER unit is bypassed in the oil circuit and does not recover energy.

Always turn the lever (Figure 14-26) all the way in or out. Do not position it anywhere in between both ends.

Main oil cooler bypass valve of oil filter pipe

The 2nd bypass valve (Figure 2-14) starts closing the bypass line and opening the oil supply line from the main oil cooler (Figure 2-23) at the lower limit of its temperature range; at the upper limit of its temperature range, the bypass line is completely closed and all the oil flows through the main oil cooler.

On all compressors (fixed speed and VSD compressors), a thermostat with a higher temperature range (compared to the standard thermostat) is required in the 2nd bypass valve of the oil filter pipe when using the compression heat as its source for energy recovery.

Thermostatic valve instructions

The thermostatic valve of the compressor must always open at least 10°C later than the one in the ER unit to prevent tripping of the valves. See table for actions:

Valve of Compressor	Action on Compressor	Action on ER unit
40 °C	Replace valve with 60 °C	Place valve 40 °C
60 °C	Replace valve with 75 °C	Place valve 60 °C

In case thermostatic valve in compressor is 75°C (tropical thermostat), please contact your official Service Contact.

The thermostatic valve installed in the ER kit must always have a lower temperature range than the thermostatic valve installed in the compressor.

For ER installation on GA tropical variants, please contact Atlas Copco.

7.2. Energy recovery system is turned on

In this case, the lever (Figure 14-26) of the 1st bypass valve (Figure 14-7) of the ER unit should be turned in fully clockwise.

Always turn the lever (Figure 14-26) all the way in or out. Do not position it anywhere in between both ends.

Compressor start-up

When the compressor is started in cold conditions, the oil temperature will be low. The 1st bypass valve (Figure 2-7) of the ER unit shuts off the oil supply from the heat exchanger (Figure 2-8) and the 2nd bypass valve (Figure 2-14) shuts off the oil supply from the main oil cooler (Figure 2-23) to prevent the compressor oil from being cooled. The oil flows from the separator (Figure 2-12) through the oil filter (Figure 2-24) to the compressor element (Figure 2-25).

The entire energy input is used to rapidly warm up the compressor oil. No energy is recovered.

Maximum energy recovery

When the oil temperature reaches approx. 40°C, the 1st bypass valve (Figure 2-7) of the ER unit starts opening the oil supply line from the heat exchanger (Figure 2-8). When the oil temperature rises to approx. 55°C, all the oil passes through the heat exchanger. The oil from the heat exchanger outlet flows via the oil filter (Figure 2-24), the compressor element (Figure 2-25) and the separator (Figure 2-12) back to the inlet of the heat exchanger. The 2nd bypass valve (Figure 2-14) continues to bypass the main oil cooler (Figure 2-23) as long as the oil temperature after the heat exchanger (Figure 2-8) remains below 75°C.

The heat exchange between the compressor oil and the heat recovery water is at its maximum.

NOTES:

- *The opening temperature depends on which insert is placed in the 1st bypass valve of ER unit.*
- *The amount of recovered energy depends on the load cycle of the compressor (particularly in VSD applications).*

Low consumption of recovered energy

In this case, the temperature of the oil leaving the heat exchanger (Figure 2-8) may be too high for the oil to be injected into the compressor element (Figure 2-25). Therefore, the 2nd bypass valve (Figure 2-14) will open the oil supply line from the main oil cooler (Figure 2-23) to allow the hot oil to be cooled in this cooler.

The amount of energy supplied to the water is adjusted to the energy demand.

Recovery water flow too high or water inlet temperature too low

In this case, the temperature of the oil leaving the heat exchanger (Figure 2-8) may be too high for the oil to be injected into the compressor element (Figure 2-25). Therefore, the 1st bypass valve (Figure 2-7) of the ER unit will partly shut off the oil supply from the heat exchanger (Figure 2-8) to allow the cold oil from the heat exchanger to be mixed with the hot oil from the separator (Figure 2-12).

Energy is transferred from the compressor oil to the water, but at a relatively low temperature level.

7.3. Energy recovery system is turned off

In this case, turn out the lever (Figure 14-26) of the 1st bypass valve (Figure 14-7) of the ER unit fully counter clockwise.

Always turn the lever (Figure 14-26) all the way in or out. Do not position it anywhere in between both ends!

Except for the opening temperature of the 2nd bypass valve (Figure 2-14) of the oil filter pipe (Figures 3/4/5-13), the oil system is the same as without an energy recovery unit installed.

No energy is recovered.

This situation should be exceptional, e.g. in case of maintenance of the water circuit of the energy recovery unit or if no energy is required for a longer period.

7.4. Commissioning the energy recovery system

For fixed speed compressors

Run the unit unloaded for a few minutes before switching on/off the energy recovery unit by turning the lever fully in/out (Figure 14-26).

For VSD compressors

Close the air outlet valve and run the unit at minimum speed for a few minutes before switching on/off the energy recovery unit by turning the lever fully in/out (Figure 14-26).

7.5. Stopping the ER unit for a longer period

In case of an open water system, and if freezing temperatures are expected, isolate the water system of the ER unit and blow it through with compressed air.

8. Maintenance

8.1. Compressor oil

Always use RXD oil if the Energy Recovery Unit is installed, DO NOT USE RIF.

Before installation

1. Drain the compressor according to the instructions in the section “Oil and filter change” of the instruction manual of the main compressor.

Oil filling instructions

1. Check if the lever (Figure 14-26) on the bypass valve housing (Figure 14-7) is turned out fully counter clockwise (Energy Recovery Unit is turned off). Check if venting nipple of the Energy Recovery Unit is closed.
2. Top up the compressor oil level according to the instructions in the section “Oil and filter change” of the instruction manual of the main compressor.
3. When the compressor oil level has been topped up, turn in the lever (Figure 14-26) on the bypass valve housing (Figure 14-7) fully clockwise (Energy Recovery Unit is turned on). Check if the drain valve of the Energy Recovery Unit is closed.
4. Repeat the instructions in the section “Oil and filter change” of the instruction manual of the main compressor.

Do not run the compressor on warm too long. Installation of Energy recovery Unit increases the minimum oil volume. Running on warm for long time will damage your compressor.

When using Food Grade oil, decrease the oil exchange interval to 3000 working hours.

Oil drain instructions

1. Tools:
   - Set of spanners
   - Recipient, large enough to drain complete ER unit (refer to table with volumes below).
2. Check if the lever (Figure 14-26) on the bypass valve housing (Figure 14-7) is turned in fully clockwise (Energy Recovery Unit is turned on). Check if the drain valve and the venting nipple on the oil inlet of the Energy Recovery Unit are closed before draining the compressor.
3. Drain the compressor according to the instructions in the section “Oil and filter change” of the instruction manual of the main compressor.
4. Remove the roof and door panels of the Energy Recovery Unit.
5. Remove the cap from drain flexible before opening the drain valve.
6. Open the venting nipple (Figure 1-10).

Volumes

ER unit	# l oil	# l oil / m hose
ER S-1	4	1
ER S-2	6	1
ER S-3	12	1
ER S-4	20	1
ER S-5	20	1

Length flexibles

Standard 2 flexible hoses of 1.4 m length will be delivered.

Extended hoses of 3 m length are available. To order those or hoses of longer length, please contact your official Service contact.

8.2. Thermostatic bypass valves

The inserts (thermostats) should only be replaced with new ones according to the maintenance schedule below or if abnormal operation is observed.

Examples: insert is blocked and/or broken, regulating temperature is not within normal range.

8.3. Heat exchanger

If the temperature rise over the energy recovery system declines over a period of time with the same basic working conditions, the heat exchanger (Figure 1-8) should be inspected. To clean the oil side, soak the heat exchanger in a degreasing solution. To remove scale formation in the water compartment, a proper de-scaling process should be applied. Please contact Atlas Copco.

8.4. Maintenance schedule

		INSPECTION VISIT	A VISIT	B VISIT	D VISIT OVERHAUL	F VISIT
		3 months	6 months	1 year	4 years	3 years
		2000 h	4000 h	8000 h	40000 h	24000 h
Activities		**Visit I**	**Visit A**	**Visit B**	**Visit D**	**Visit F**
1	Take service reading (air, oil, water T +P)	x	x	x	x	x
2	Check for air- water- & oil leakage	x	x	x	x	x
3	Check oil & cooler, clean extern	x	x	x	x	x
4	Change oil (with the GA)		x	x	x	x
5	Check sensitive bolt/coupling connections		x	x	x	x
6	Overhaul valve			x	x	x
7	Clean cooler block (int./ext.)				x	

9. Energy recovery data

9.1. Reference conditions

- Air inlet temperature ..... °C 20
- Absolute air inlet pressure ..... bar 1

9.2. Effective operating pressure

- 7.5 bar units ..... bar 7
- 10 bar units ..... bar 9.5
- 13 bar units ..... bar 12.5
- 100 psi units ..... psi 100
- 125 psi units ..... psi 125
- 150 psi units ..... psi 150
- 175 psi units ..... psi 175

9.3. Maximum operating pressure

- Oil side ..... bar 15
- Water side..... bar 10

9.4. Reading settings

To read a setting, please refer to the section Elektronikon in the instruction manual of the compressor. In addition to other data, the following temperatures can be read by pressing the scroll key:

- The water inlet temperature of the ER unit.
- The water outlet temperature of the ER unit.

9.5. Modifying settings

If the pre-programmed warning settings for the water temperatures are exceeded, a warning indication is shown on the compressor control module:

Temperature input	Unit	Min. setting	Nom. setting	Max. setting
Energy recovery water inlet	°C	0	50	99
Delay at warning signal	sec	0	Please contact Atlas Copco	255
Delay at start should be less than delay at warning signal	sec	0	Please contact Atlas Copco	255
Energy recovery water outlet	°C	0	Please contact Atlas Copco	99
Delay at signal	sec	0	Please contact Atlas Copco	255
Delay at start should be less than delay at warning signal	sec	0	Please contact Atlas Copco	255

To modify a setting, please refer to the section Modifying parameters in the instruction manual of the compressor.

9.6. Recoverable energy

The recoverable energy is calculated using the following formula:

RECOVERED ENERGY (kW) = 4.2 x water flow (l/s) x water temperature rise (°C)

The maximum recoverable energy is approx. 70-80% of the shaft power of the compressor.

Compared to the electrical input power the percentage will be lower for air cooled compressors, because the fan also requires some power that is not recoverable.

In VSD compressors the recoverable energy is also a little lower because the drive also requires some power that is not recoverable.

Formula:

$$Q\ [l/s] = \frac{\text{Recovered energy [kW]}}{4{,}2 * T[°C]}$$

9.7. Data for low temperature rise/high water flow systems

In the tables below, typical values are provided for the above mentioned type of water flow system.

11^{+}-30 kW range & VSD (ER S-1)

Parameters	Units	11+ kW	15+ kW	18+ kW	22+ kW	26+ kW	30 kW
Recoverable energy	kW	8.3	11.3	13.5	16.5	19.5	22.5
Water flow	l/min	11.8	16.1	19.3	23.6	27.9	32.2
Temperature at inlet	ºC	50	50	50	50	50	50
Temperature at outlet	ºC	60	60	60	60	60	60
Pressure drop	bar	0.008	0.014	0.019	0.027	0.037	0.048

30^{+}-45 kW range (ER S-2)

Parameters	Units	30+ kW	37 kW	45 kW
Recoverable energy	kW	22.5	27.8	33.8
Water flow	l/Min	32.2	39.7	48.3
Temperature at inlet	°C	50	50	50
Temperature at outlet	°C	60	60	60
Pressure drop	bar	0.129	0.192	0.278

37^{+}-75 kW & VSD range (ER S-2)

Parameters	Units	37+ kW (VSD)	45+ kW (VSD)	55 kW (VSD)	75 kW
Recoverable energy	kW	27.8	33.8	41.3	56.3
Water flow	l/Min	39.7	48.3	59.0	80.4
Temperature at inlet	°C	50	50	50	50
Temperature at outlet	°C	60	60	60	60
Pressure drop	bar	0.192	0.278	0.405	0.727

55+-90 kW & VSD range (ER S-3)

Parameters	Units	55+ kW	75+ kW (VSD)	90 kW (VSD)
Recoverable energy	kW	41.3	56.3	67.5
Water flow	l/Min	59.0	80.4	96.5
Temperature at inlet	°C	50	50	50
Temperature at outlet	°C	60	60	60
Pressure drop	bar	0.146	0.259	0.364

90+-180 kW & VSD range (ER S-4)

Parameters	Units	90+ kW	110(+) kW (VSD)	132(+) kW (VSD)	160(+) kW (VSD)	180 kW (VSD)
Recoverable energy	kW	67.5	82.5	99.0	120.0	135.0
Water flow	l/min	96.5	117.9	141.5	171.5	192.9
Temperature at inlet	ºC	50	50	50	50	50
Temperature at outlet	ºC	60	60	60	60	60
Pressure drop	bar	0.245	0.355	0.497	0.708	0.879

180+-315 kW range (ER S-5)

Parameters	Units	200 kW	250 kW	315 kW
Recoverable energy	kW	150.0	187.5	236.3
Water flow	l/Min	214.3	267.9	337.5
Temperature at inlet	°C	50	50	50
Temperature at outlet	°C	60	60	60
Pressure drop	bar	0.680	1.021	1.554

9.8. Data for high temperature rise/low water flow systems

NOTE: Please remember that this type of application can adversely affect compressor performance. Please refer to section 6.4. for details.

In the tables below, typical values are provided for the above mentioned type of water flow system.

11+-30 kW range & VSD (ER S-1)

Parameters	Units	11+ kW	15+ kW	18+ kW	22+ kW	26+ kW	30 kW
Recoverable energy	kW	8.3	11.3	13.5	16.5	19.5	22.5
Water flow	l/min	2.0	2.7	3.2	3.9	4.3	4.6
Temperature at inlet	ºC	23	23	23	23	23	23
Temperature at outlet	ºC	83	84	84	85	89	93
Pressure drop	bar	0.001	0.001	0.001	0.001	0.002	0.002

30+-45 kW range (ER S-2)

parameters	units	30+ kW	37 kW	45 kW
Recoverable energy	kW	22.5	27.8	33.8
Water flow	l/Min	4.5	5.6	6.7
Temperature at inlet	°C	20	20	20
Temperature at outlet	°C	92	92	92
Pressure drop	bar	0.004	0.005	0.007

37+-75 kW & VSD range (ER S-2)

parameters	units	37+ kW (VSD)	45+ kW (VSD)	55 kW (VSD)	75 kW
Recoverable energy	kW	27.8	33.8	41.3	56.3
Water flow	l/Min	5.6	6.7	8.3	11.4
Temperature at inlet	°C	20	20	20	20
Temperature at outlet	°C	92	92	91	91
Pressure drop	bar	0.005	0.007	0.010	0.019

55+-90 kW & VSD range (ER S-3)

parameters	units	55+ kW	75+ kW (VSD)	90 kW (VSD)
Recoverable energy	kW	41.3	56.3	67.5
Water flow	l/Min	8.3	11.4	13.6
Temperature at inlet	°C	20	20	20
Temperature at outlet	°C	91	91	91
Pressure drop	bar	0.004	0.007	0.010

90+-180 kW & VSD range (ER S-4)

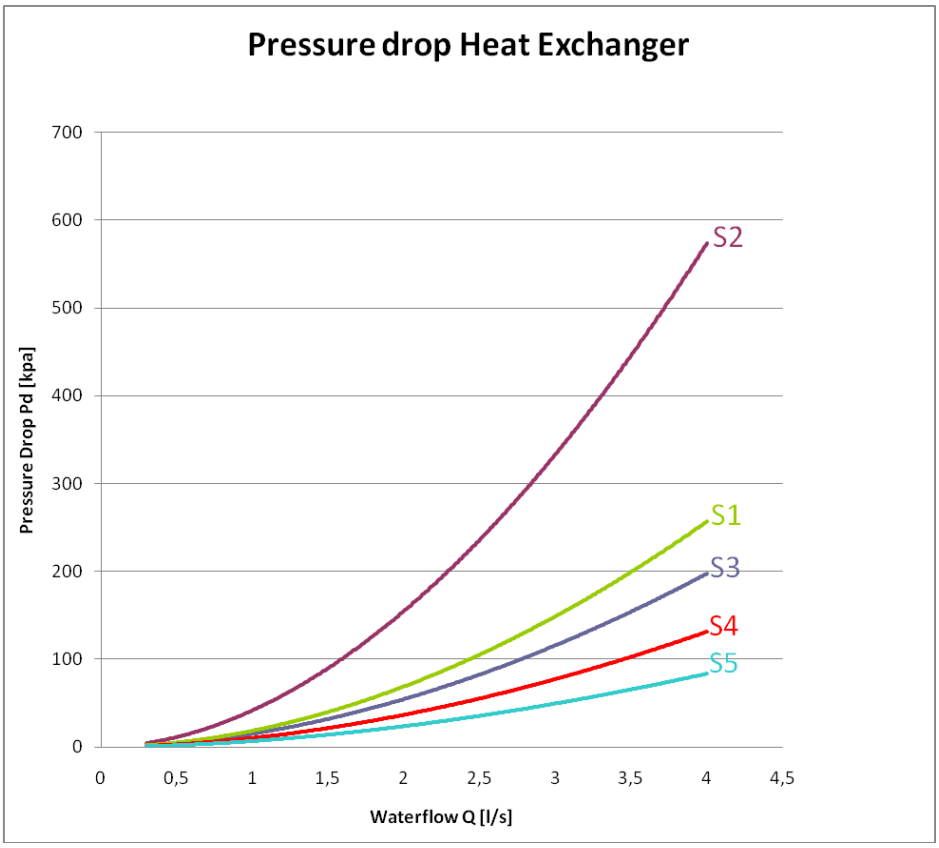
Parameters	Units	90+ kW	110(+) kW (VSD)	132(+) kW (VSD)	160(+) kW (VSD)	180 kW (VSD)
Recoverable energy	kW	67.5	82.5	99.0	120.0	135.0
Water flow	l/min	13.5	16.6	20.0	24.2	27.2
Temperature at inlet	ºC	20	20	20	20	20
Temperature at outlet	ºC	91	91	91	91	91
Pressure drop	bar	0.007	0.010	0.014	0.020	0.024

180+-315 kW range (ER S-5)

Parameters	Units	200 kW	250 kW	315 kW
Recoverable energy	kW	150.0	187.5	236.3
Water flow	l/Min	30.2	37.8	47.6
Temperature at inlet	°C	20	20	20
Temperature at outlet	°C	91	91	91
Pressure drop	bar	0.020	0.029	0.044

9.9. Pressure drop heat exchangers

Figure 15: graph



Formulas

ER S-1:
$Pd = 0.15034 * Q^{1,8581}$

ER S-2:
$Pd = 0.41764 * Q^{1,8906}$

ER S-3:
$Pd = 0.08487 * Q^{1,8983}$

ER S-4:
$Pd = 0.10198 * Q^{1,8437}$

ER S-5:
$Pd = 0.06673 * Q^{1,8225}$

9.10. Dimension drawings

- 9845 0069 00: 11-30 kW
- 9845 0070 00: 30^{+}-45 kW
- 9845 0071 00: 55-90 kW
- 9845 0124 00: 90^{+}-180 kW
- 9845 0125 00: 180^{+}-315 kW

Figure 16: 9845 0069 00

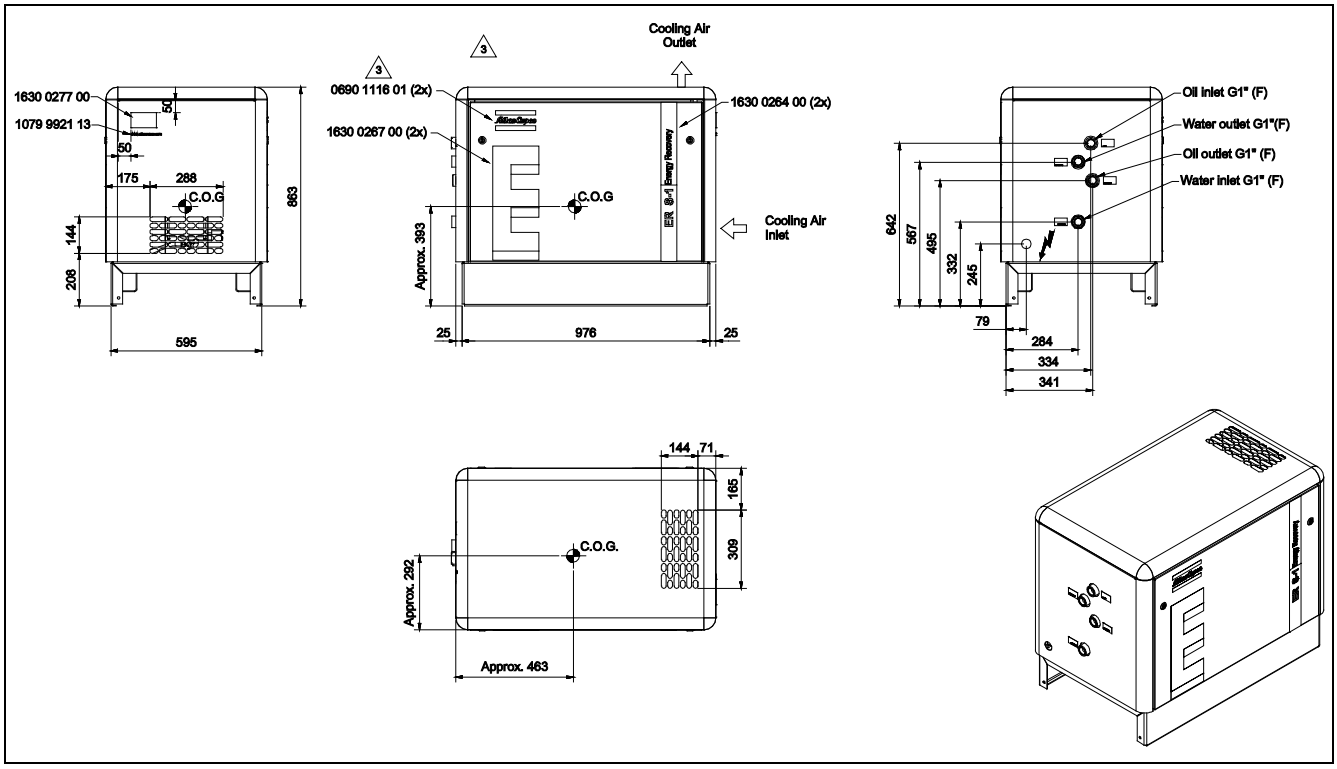


Figure 17: 9845 0070 00

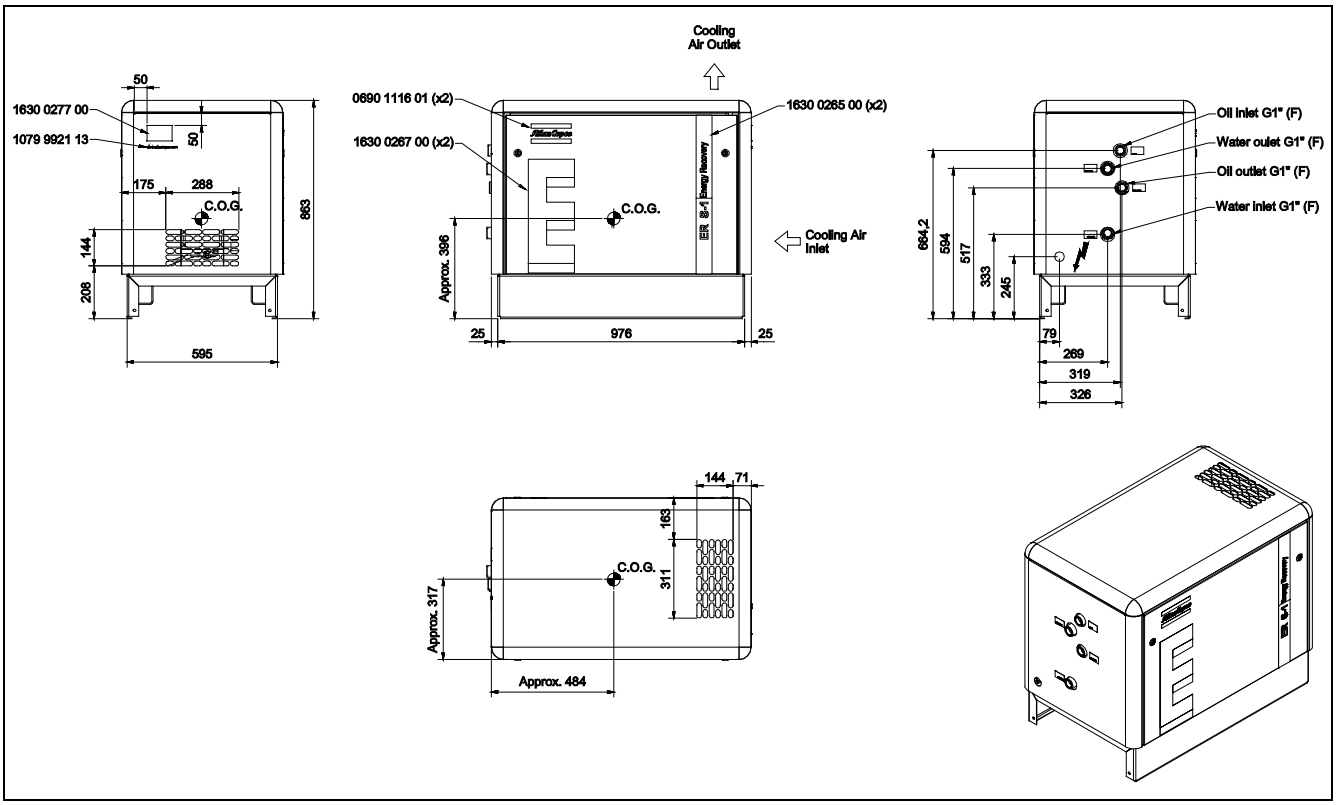


Figure 18: 9845 0071 00

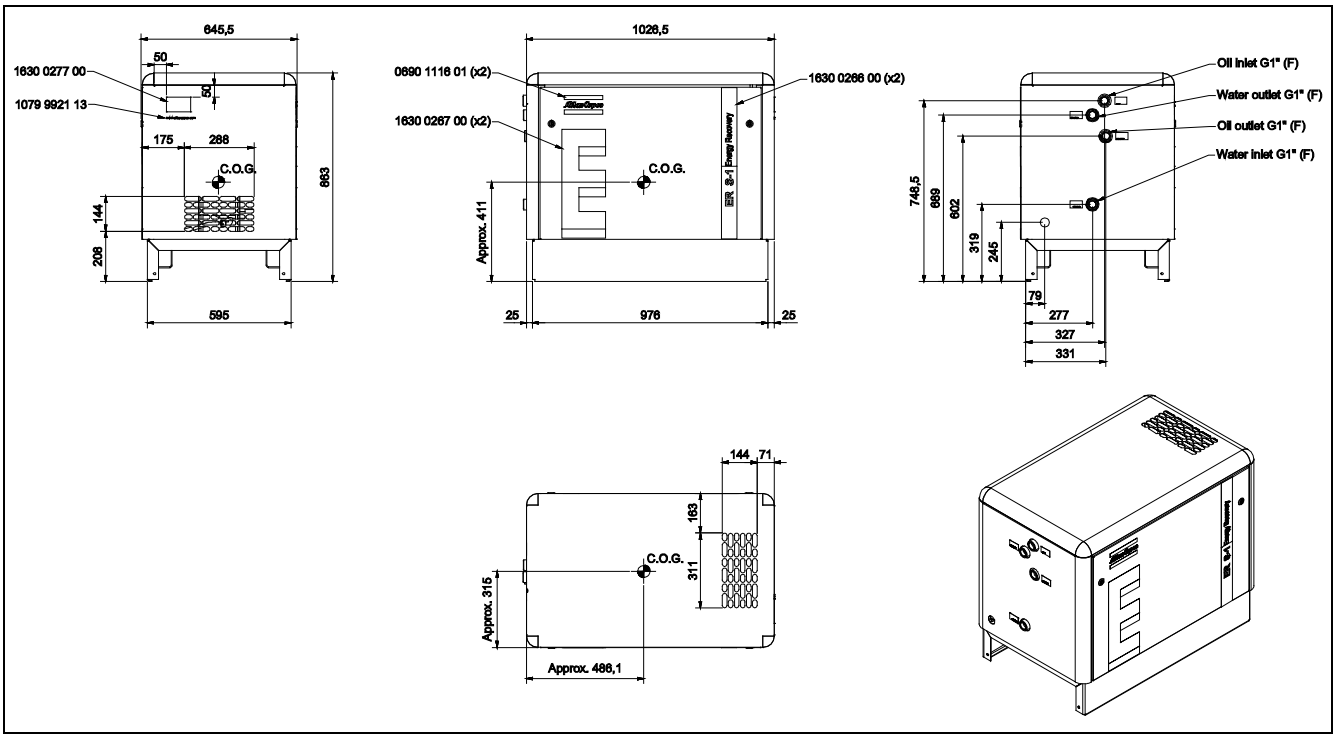


Figure 19: 9845 0124 00

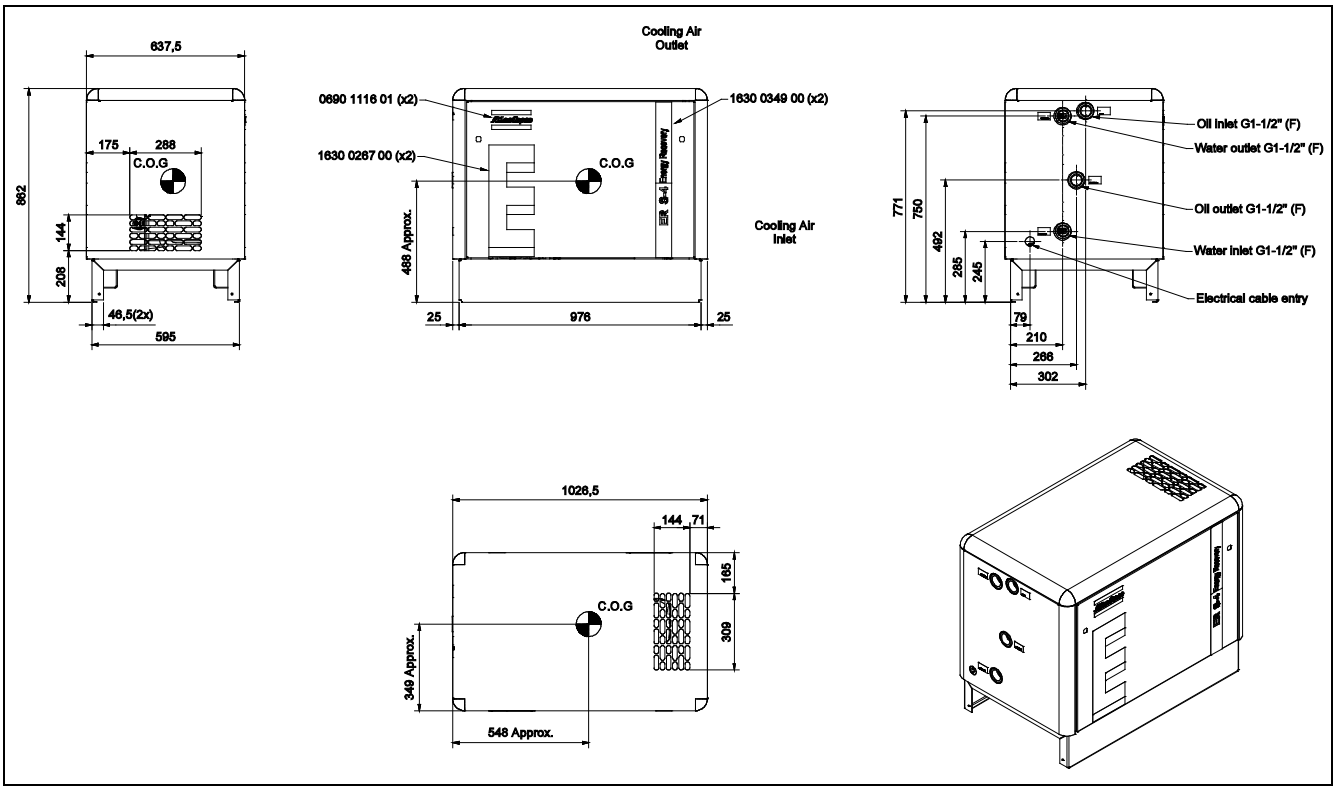
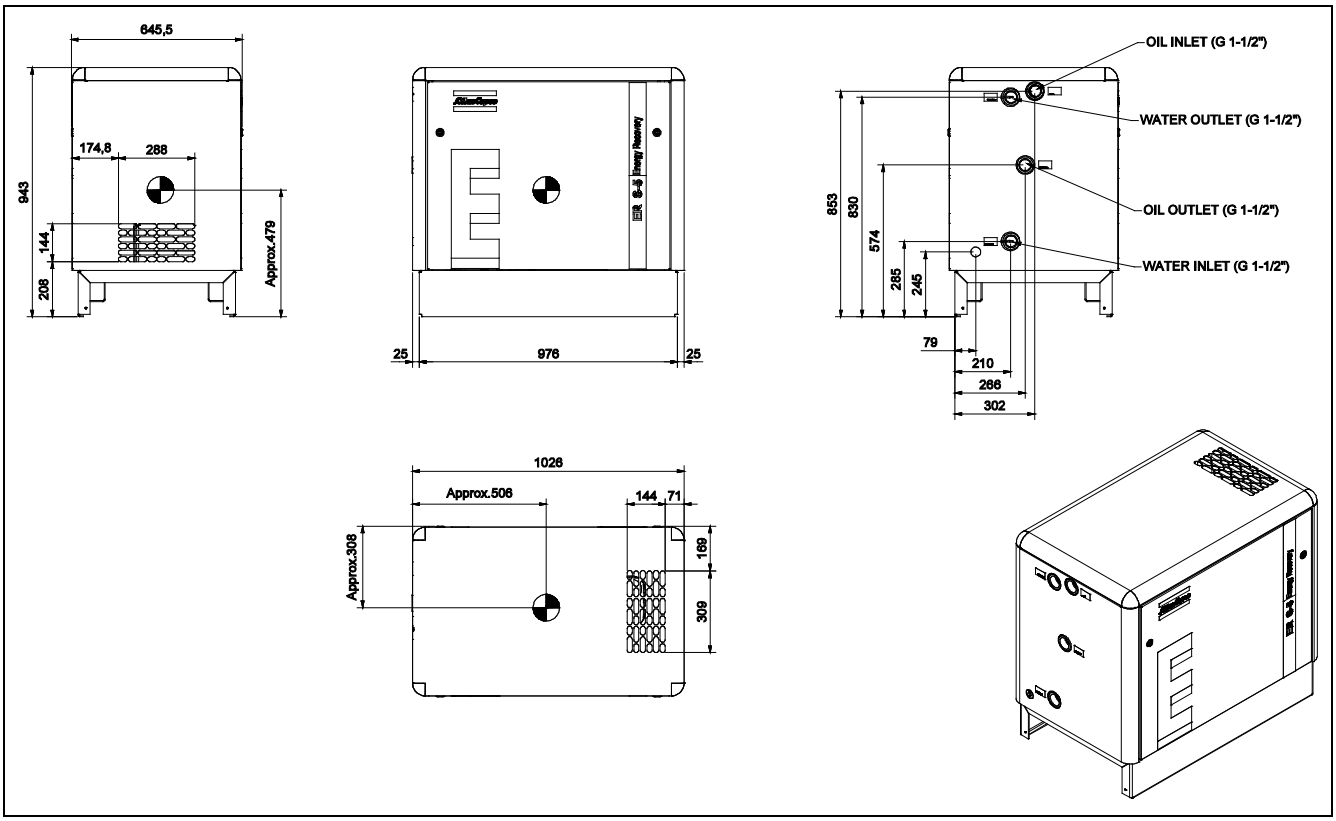


Figure 20: 9845 0125 00



9.11. Installation proposal

Installation Proposal, please refer to document 9845 0133 00 on GBP or contact your official Atlas Copco Service Specialist.

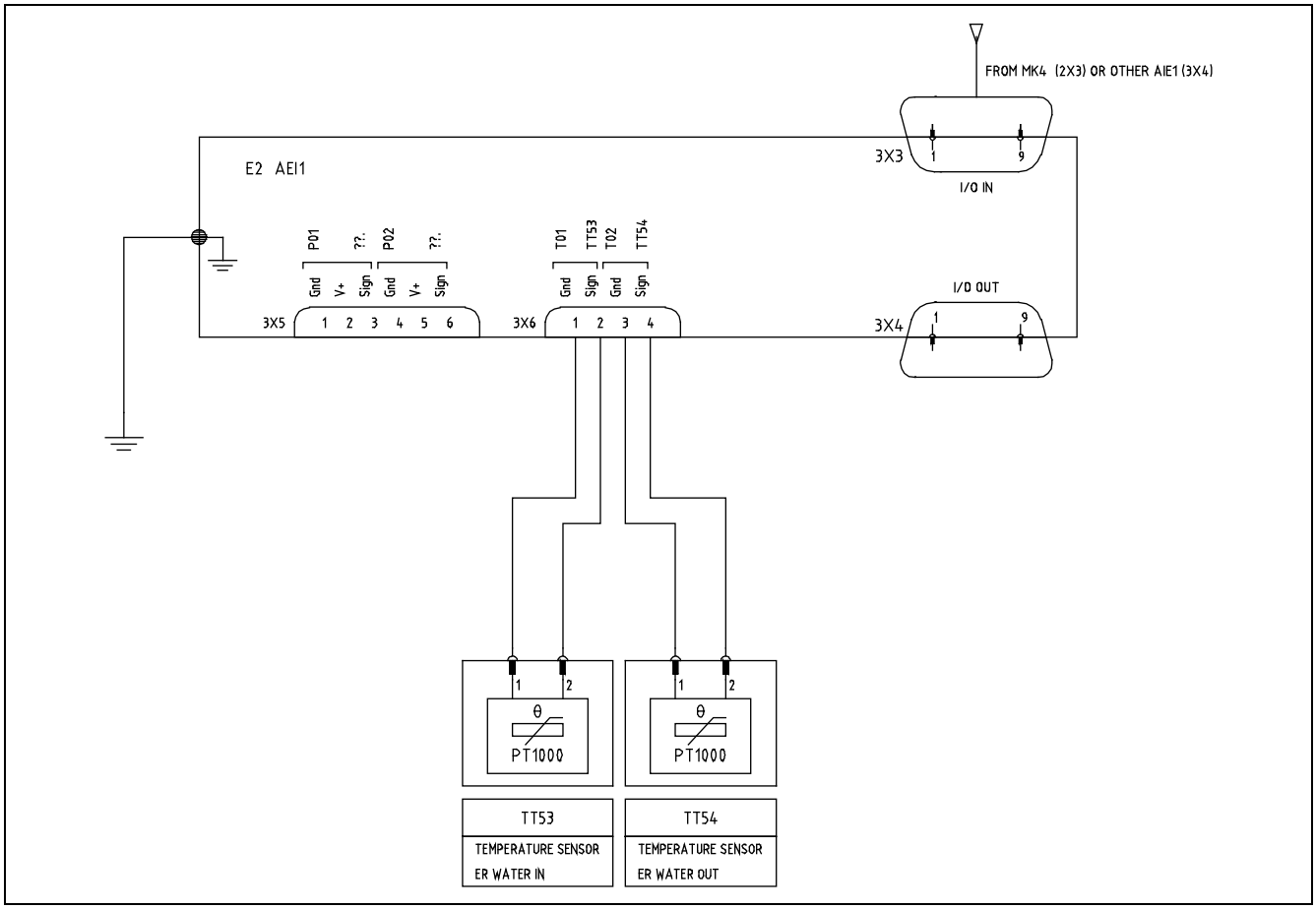
9.12. Conversion list of metric units into imperial units

1 bar	=	14.504 psi
1 l/min	=	0.035 cfm
1 kW	=	1.341 hp
x °C	=	(32 + 1.8x) °F

10. Circuit diagrams (9845 1800 00)

10.1. ER + Mk 4 Elektronikon

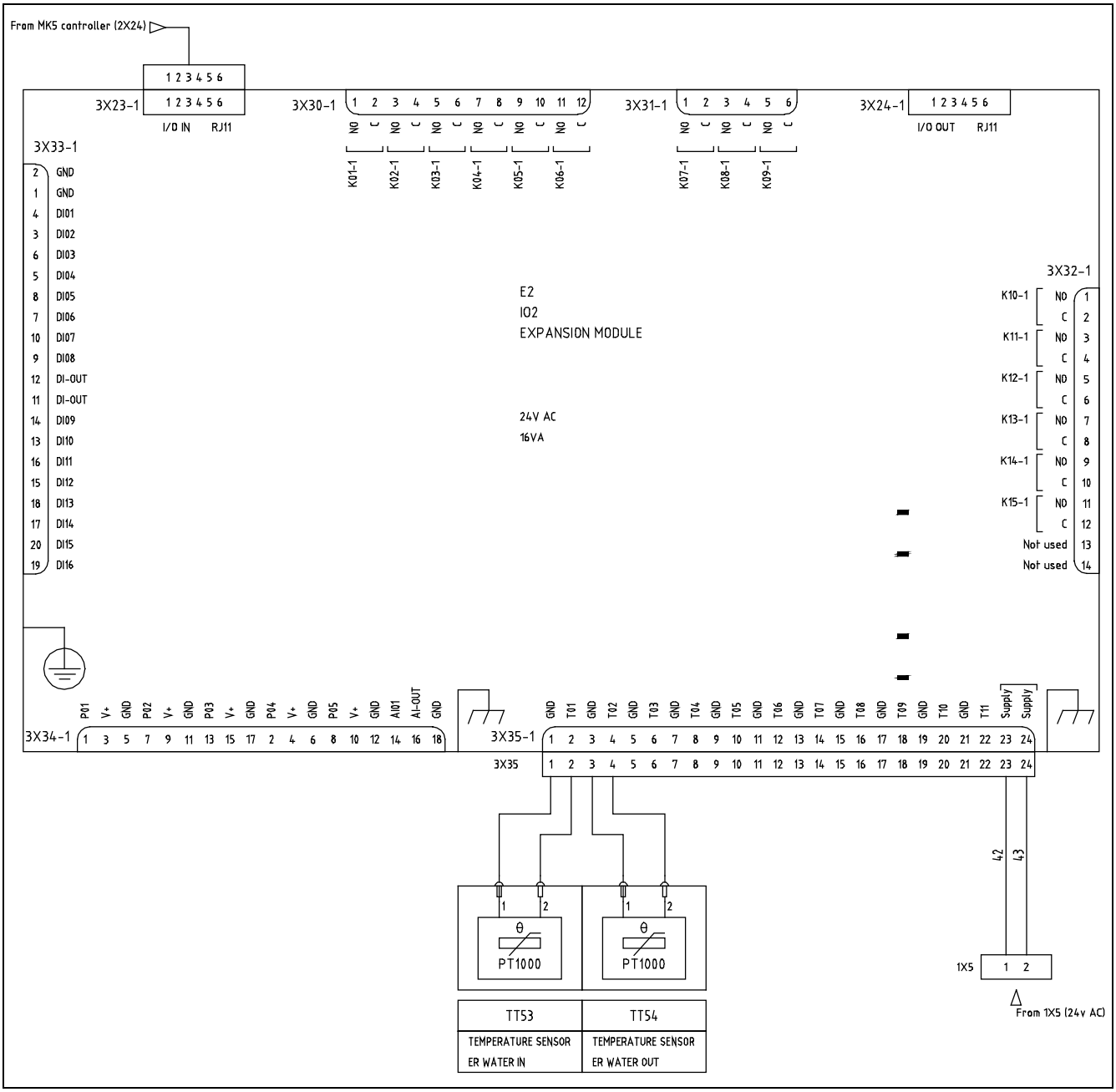
Figure 21



Reference	Designation
E2	Expansion module
TT53	ER water in
TT54	ER water out

10.2. ER + Mk 5 Elektronikon

Figure 22



Reference	Designation
E2	Expansion module
TT53	ER water in
TT54	ER water out

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