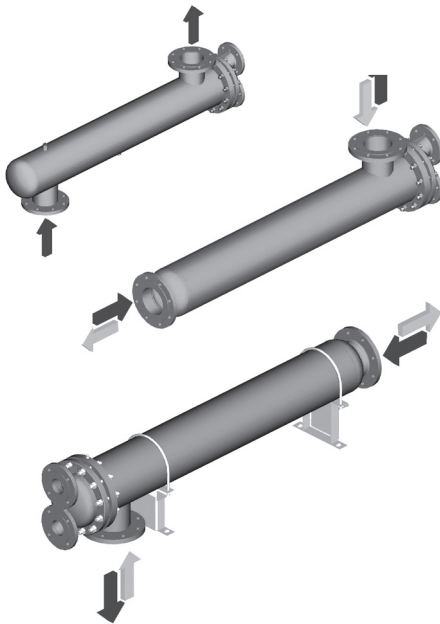


U-tube bundle type shell and tube heat exchangers UPI, UPC and UPF

Installation and Maintenance Instructions



1. Safety information
2. Storage
3. General product information
4. Installation
5. Commissioning
6. Maintenance
7. Inspection
8. Troubleshooting
9. Spare parts

1. Safety information

Safe operation of these products can only be guaranteed if they are properly installed, commissioned, used and maintained by qualified personnel in compliance with the operating instructions.

General installation and safety instructions for pipeline and plant construction, as well as the proper use of tools and safety equipment must also be complied.

1.1 Intended use

Reference these Installation and Maintenance Instructions, the nameplate and the Technical Information sheet or relevant documentation to ensure that the product is suitable for the intended use or application.

The products listed in the below table comply with the requirements of the European Pressure Equipment Directive 2014/68/EU and carry the  mark when required. The products fall within the specified Pressure Equipment Directive categories within below table:

- i) The products have been specifically designed for use on steam, air or water which are in Group 2 of the above mentioned Pressure Equipment Directive. Spirax-Sarco should be contacted to confirm the suitability of the product for use on alternative fluids and applications.
- ii) Check material suitability, pressure and temperature and their maximum and minimum values. If the maximum operating limits of the product are lower than those of the system in which it is being fitted, or if malfunction of the product could result in a dangerous overpressure or overtemperature occurrence, ensure a safety device is included in the system to prevent such over-limit situations.
- iii) Determine the correct installation situation and direction of fluid flow.
- iv) Spirax Sarco products are not intended to withstand external stresses that may be induced by any system to which they are fitted. It is the responsibility of the installer to consider these stresses and take adequate precautions to minimise them.
- v) Remove protective covers from all connections and protective film from all name-plates, where appropriate, before installation on steam or other high temperature applications.

Table 1 Standard series PED categorisation

Shell Ø"	Heat exchanger (diathermic oil or hot water as primary fluid)					Heat exchanger (steam or superheated water as primary fluid)					Generator (steam, diathermic oil or superheated water as primary fluid)								
	Nominal length					Nominal length					Nominal length								
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5				
5"	No CE marking Art. 3 comma 3 2014/68/UE Directive					SEP	Cat. I	Cat. II				Cat. II	Cat. III	Cat. III					
6"							Cat. I	Cat. I							Cat. III	Cat. III			
8"							Cat. II	Cat. II							Cat. III	Cat. III			
10"							Cat. II	Cat. II	Cat. II						Cat. III	Cat. III	Cat. III		
12"								Cat. II	Cat. II	Cat. II						Cat. III	Cat. III		

Generators = pressure equipment suitable for producing steam or superheated steam at $T > 110\text{ }^{\circ}\text{C}$ in both circuits.

Hot water = liquid in Group 2 (non-hazardous) with steam saturation pressure $\leq 0.5\text{ bar g}$ at maximum temperature.

Superheated water = fluid in Group 2 (gases, liquified gases, dissolved gases, liquids) with steam saturation pressure $> 0.5\text{ bar g}$ at maximum temperature.

1.2 Hazards to be considered when installing/using/maintaining

1.2.1 Access

Ensure safe access and if necessary a safe working platform before attempting to work on the product. Arrange suitable lifting gear if required.

1.2.2 Lighting

Ensure adequate lighting, particularly where detailed or intricate work is required. (e.g. electrical wiring)

1.2.3 Hazardous liquids or gases in the pipeline

Consider what is in the pipeline or what may have been in the pipeline at some previous time. Consider flammable materials, substances hazardous to health, extremes of temperature.

1.2.4 Hazardous environment around the product

Consider explosion risk areas, lack of oxygen (e.g. tanks, pits) dangerous gases, extremes of temperature, hot surfaces, fire hazard (e.g. during welding), excessive noise, moving machinery.

1.2.5 The system

Consider the effect on the complete system of the work proposed. Will any proposed action (e.g. closing isolating valves, electrical isolation) put any other part of the system or any other workers at risk? Dangers might include isolation of vents or protective devices or the rendering ineffective of controls or alarms. Ensure isolation valves are turned on and off in a gradual way to avoid system shocks.

1.2.6 Pressure systems

Ensure that any pressure is isolated and safety vented to atmospheric pressure. Consider double isolation (double block and bleed) and the locking and/or labelling of valve shut. Do not assume the system is de-pressurized even when the pressure gauge indicates zero.

1.2.7 Temperature

Allow time for temperature to normalise after isolation to avoid the danger of burns.

1.2.8 Tools and consumables

Before starting work ensure that you have suitable tools and/ or consumables available. Use only genuine Spirax-Sarco replacement parts.

1.2.9 Protective clothing

Consider whether any protective clothing is required, to protect against the hazards of, for example, chemicals, high/low temperature, noise, falling objects, dangers to eyes/face.

1.2.10 Permits to work

All works must be carried out or be supervised by a suitable competent person. Where a formal permit to work system is requested, it must be complied. Where not required, it is recommended that a responsible person knows what work is going on and, where necessary, arrange to have an assistant whose primary responsibility is safety. Post warning notices if necessary.

1.2.11 Electrical connections

Before starting any operation, study the wiring diagram and wiring instructions and note any special requirements. Consider particularly: mains supply voltage and phase, local mains isolation, fuse requirements, grounding, special cables, cable entries/cable glands, electrical screening.

1.2.12 Commissioning

After installation or maintenance, ensure that the system is properly operating. Carry out tests on any alarms or protective devices.

1.2.13 Disposal

Unwanted equipment should be disposed of in a safe manner.

1.2.14 Freezing

Provision must be made to protect products which are not self-draining against frost damage in environments where they may be exposed to temperatures below freezing point.

1.3 Returning products

Customers and stockists are reminded that under EC Health, Safety and Environment Law, when returning products to Spirax-Sarco they must provide information on any hazards and the precautions to be taken due to contamination residues or mechanical damage which may present a health, safety or environmental risk. This information must be provided in writing including Health and Safety data sheets relating to any substances identified as hazardous or potentially hazardous.

△ Safety instruction

This safety alert symbol will be used in this manual to draw attention to safety related instructions. When used, the safety alert symbol means that procedures must be followed; failure to follow these instructions may result in a safety hazard.

1.4 Standards

Spirax-Sarco heat exchangers are calculated, constructed and marked in accordance with the Pressure Equipment Directive 2014/68/EU. The heat exchangers can be constructed, on request, according to ASME code.

For Marine industry applications, the heat exchangers can be manufactured in compliance with several standards, such as:

- LLRR
- RINA
- BV
- DNV
- ETC

1.5 Handling and installation

Manual handling of large and/or heavy products may present a risk of injury. Lifting, pushing, pulling, carrying or supporting a load by bodily force can cause injury particularly to the back. You are advised to assess the risks taking into account the task, the individual, the load and the working environment and use the appropriate handling method depending on the circumstances of the work being done.

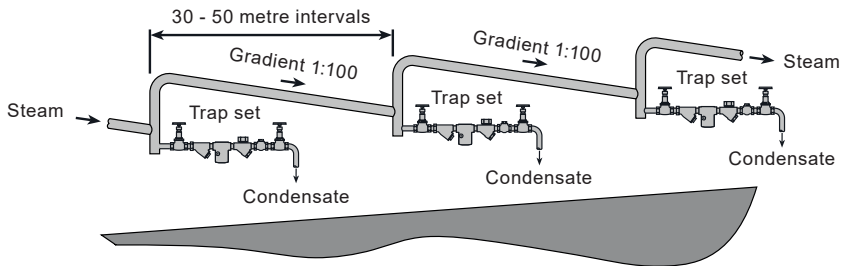
1.5.1 Working safely with cast iron products on steam

Cast Iron is a brittle material. If the product is dropped during installation and there is any risk of damage the product should not be used unless it is fully inspected and pressure tested by the manufacturer.

Please remove label before commissioning cast iron products are commonly found on steam and condensate systems. If installed correctly using good steam engineering practices, they pose no risk. However, because of its mechanical properties, it is less malleable compared to other materials such as SG iron or carbon steel. The following are the good engineering practices required to prevent water hammer and ensure safe working conditions on a steam system.

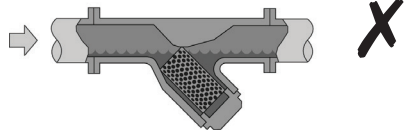
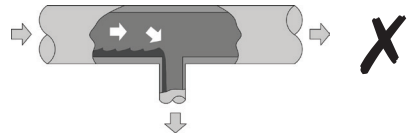
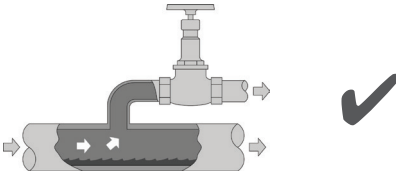
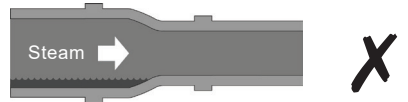
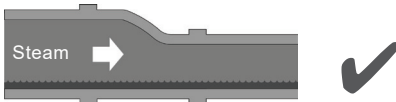
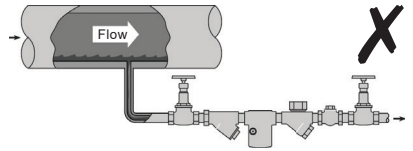
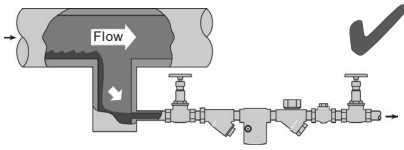
1.5.2 Prevention of waterhammer

Steam trapping on steam mains:



U-tube bundle type shell and tube heat exchangers UPI, UPC and UPF

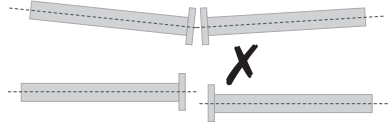
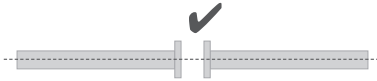
1.5.3 Steam Mains - Do's and Don'ts:



△ Procedure detailed in this manual are valid for all Spirax Sarco U-tube bundle type heat exchangers. See the design specifications of each unit, as well as the nameplate attached to the heat exchangers for design specifications and maximum operating conditions of each unit.

1.5.4 Prevention of tensile stressing

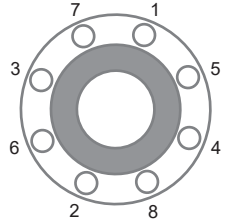
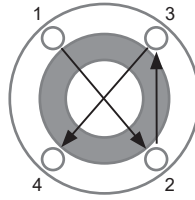
Pipe misalignment:



Installing products or re-assembling after maintenance:

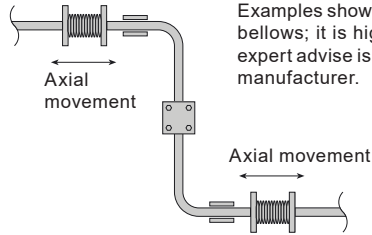
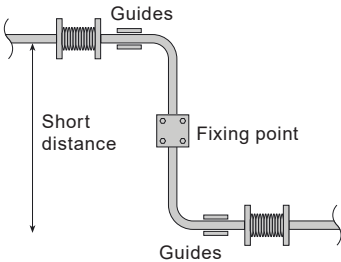


Do not over tighten.
Use correct torque figures.

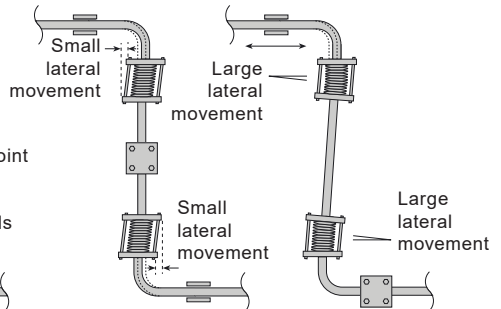
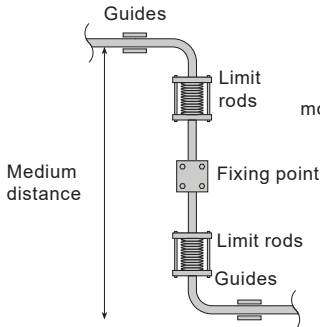


Flange bolts should be gradually tightened across diameters to ensure even load and alignment.

1.5.5 Thermal expansion:



Examples showing the use of expansion bellows; it is highly recommended that expert advice is sought from the bellows manufacturer.



U-tube bundle type shell and tube heat exchangers UPI, UPC and UPF

2. Storage

If the heat exchanger can not be commissioned immediately upon receipt at the job site, certain precautions are necessary to prevent deterioration during storage. Responsibility for integrity of the heat exchangers must be assumed by the user.

Spirax-Sarco will not be responsible for damage, corrosion or other deterioration of heat exchanger equipment during transit and storage.

Good storage practices are important, considering the high costs of repair or replacement, and the possible delays for items which require long lead times for manufacture. The followings suggested practices are provided solely as a convenience to the user, who shall make his own decision on whether to use all or any of them.

- 2.1** On receipt of the heat exchanger, inspect for shipping damage to all protective covers. If damage is evident, inspect for possible contamination and replace protective covers as required. If damage is extensive, notify the carrier immediately and Spirax-Sarco.
- 2.2** The Heat Exchangers made of carbon steel, may be pressure tested with oil at the factory. However, the residual oil coating on the inside surfaces of the exchangers does not preclude the possibility of rust formation.
- 2.3** If the heat exchanger is not to be placed in immediate service, take precautions to prevent rusting or contamination. If the heat exchanger will be installed after two weeks from delivery it is recommended to follow this procedure:
 - Remove humidity either tubes side either shell side by circulating hot hair.
 - Close with blind flanges drains and air vent connections.
 - Install a manometer.
 - Fill the tube and shell side with nitrogen up to 0,5 bar.
- 2.4** The choice of preservation of interior surfaces during storage depends upon customer system requirements and economics. Only when included in the original purchase order specifications will specific preservation be incorporated prior to shipment from the factory.
- 2.5** Remove any accumulations of dirt, water, ice or snow and wipe dry before moving exchangers into indoor storage. If unit was not filled with oil or other preservative, open drain plugs to remove any accumulated moisture, then reseal. Accumulation of moisture usually indicates rusting has already started and remedial action should be taken.
- 2.6** Store under cover in a heated area, if possible. The ideal storage environment for heat exchangers and accessories is indoor, above grade, in a dry, low humidity atmosphere which is sealed to prevent entry of blowing dust, rain or snow. Maintain temperatures between 20°C and 60°C and humidity at 40% relative humidity or lower.

⚠ Caution: Ambient temperature of the place where the unit will be installed must be between -10°C and 50°C if no differently required during engineering phase.
- 2.7** In tropical climates, it may be necessary to use trays of renewable desiccant (such as silica gel), or portable dehumidifiers, to remove moisture from the air in the storage enclosure. Thermostatically controlled portable heaters (vented to outdoors) may be required to maintain even air temperatures inside the enclosure.
- 2.8** Inspect heat exchangers and accessories frequently while they are in storage.
- 2.9** If paint deterioration begins, as evidences by discoloration or light rusting, consider touch-up or repainting. Units painted with special paintings (when specified on customers' orders) may require special techniques for touch-up or repair.
Obtain specific information from Spirax Sarco. Painted steel units should never be permitted to rust or deteriorate to a point where their strength will be impaired.

3. General product information

3.1 Description

The range of U-tube shell and tube heat exchangers is configured according to the "Shell & Tube" type, where the heat exchanger surface is a tube-bundle placed inside the shell.

The specific design of the series includes a U-shaped tube bundle with tubes expanded into a single carbon steel tubesheet. The bundle can be removed once the distribution head, made of cast iron or carbon steel, is removed; baffles are installed in the shell to maximize the thermal output of the exchanger. The shell, made of carbon steel, has the vent and exhaust connections integrated in the coupling flange, while the bottom connection can be lateral or axial.



3.2 Design conditions

TMA – Maximum Operating Temperature

Shell side	110 °C
Tube side	204.4 °C (300 °C*)

PMA – Maximum Operating Pressure

Shell side	16 bar g
Tube side	16 bar g (6 bar g*)

Cold hydraulic test pressure

Shell side	23 bar g
Tube side	23 bar g

* Available on request for diathermic oil as primary fluid

Notes:

1. The above conditions (ref. par. 3.1 and 3.2) are valid for standard configuration units, see Technical Specification 5A.110 for further product information.
2. Specific documentation will be issued and delivered for special-order units.
Warning! Bespoke units can be designed according to different criteria than standard units, always refer to the data on the nameplate for the ultimate design limits.

U-tube bundle type shell and tube heat exchangers UPI, UPC and UPF

3.3 Nameplate

The systems are in compliance with the requirements of the European Pressure Equipment Directive 2014/68/EU and present markings, when required.

A nameplate is attached to the heat exchanger shell and contains the following information:

- Model, factory number, year of fabrication
- System classification according to PED 2014/68/EU - Group of fluids fed on the shell side and on the tube side, according to PED 2014/68/EU
- Empty weight of the unit
- Volumes on the shell side and the tube side
- Design conditions for shell side and tube side
- Test pressure in accordance with PED 2014/68/EU

spirax		sarco		CE _____	CAT. _____
SCAMBIATORE DI CALORE A FASCIO TUBIERO AD U					
"U" tube bundle heat exchanger					
MODELLO model			N° FABBRICA serial nr.		
ANNO year					
TEMPERATURA MINIMA Minimum temperature			MANTELLO Shell side		TUBI Tube side
°C					
PESO Weight	Kg	Gruppo fluido Fluid group			
VOLUME Volume		LITRI Liters			
CONDIZIONI DI PROGETTO Design condition			bar @ °C		bar @ °C
PRESSIONE DI PROVA Test pressure			bar		
Spirax-Sarco s.r.l. - Via per Cinisello,18 - 20834 - Nova Milanese (MB) Tel +39-0362-49171 - Fax +39-0362-4917310					

Fig. 2 Unit's nameplate

Note: A different kind of approval with certification from a notified body may be possible for bespoke units

4. Installation

4.1 Transport

Each unit is individually packed in a special carton box with suitable legs for lifting with fork truck. Suitable spacers are provided in the box to avoid damages during transportation.

The total weight is indicated outside of the box.

For length out of standard special pallets are used to allow fork lifting or the units are fitted with lifting legs attached to the heat exchanger to provide a means for lifting and moving the units.

4.2 Operating conditions

Before every live run, check that the specified operating conditions are within the limits indicated on the nameplate.

Procedures detailed in this manual are valid for all Spirax Sarco U-tube bundle type heat exchangers. See the design specifications of each unit as well as the nameplate attached to the heat exchanger for design specification and maximum operating conditions of each unit.

4.3 Positioning and foundation

4.3.1 Provide sufficient clearance at the head of the unit to allow removal of tube bundle from shell. When connecting, follow the in-out connections of fluids as per project.

4.3.2 Foundations must be adequate so that exchangers will not settle and cause piping strains during full load operation.

Foundation bolts should be set to allow for setting inaccuracies. In concrete footings, pipe sleeves at least one size larger than bolt diameter slipped over the bolt and cast in place are best for this purpose, as they allow the bolt centre to be adjusted after the foundation has set.

4.3.3 Loosen foundation bolts at one end of unit to allow free expansion of shells.

Oval holes in saddles, when not provided with the heat exchanger, shall be provided for this purpose (Fig. 3).

⚠ Caution: Provision must be made to isolate the heat exchanger from any external vibrations that cause tube failures within the heat exchanger.

Result is internal leakage and mixing of the hot and cold media.

4.3.4 Set exchangers level and square so that pipe connections may be made without forcing (Fig. 4).

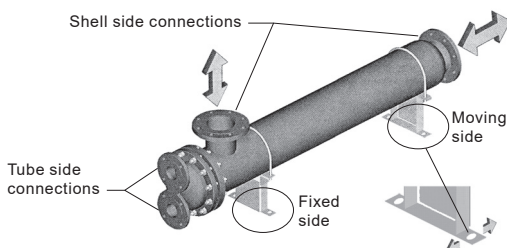


Fig. 3

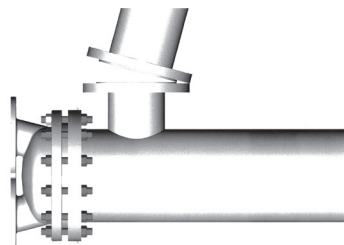


Fig. 4

4.4 External loads

None of the existing standard code (EN, ASME...etc.) give rules to define limits on the external loads or on operating conditions.

External loads can be due to wind, earthquake or supports due to piping.

The connecting piping, if incorrectly installed, generates the most common external forces and moments on the nozzles of heat exchanger. These loads are rarely known and depends on the piping system.

The piping layout must be engineered and installed in order to avoid these loads.

⚠ Caution: All system piping to the heat exchanger must be adequately supported. Failure to do so will result in excessive loads on the heat exchanger connections causing damage and/or leakage and potential injury to personnel.

When pipe loads are unavoidable, they must be calculated defining entity and direction of the possible three forces and three moments applied to each nozzle. It is almost impossible for Spirax Sarco to predefine these forces because there are infinite combinations of loading and as a consequence an infinite number of possible stress levels on the heat exchanger (Fig. 5). If there is any doubt during the installation Spirax Sarco Engineer will be happy to verify the loads and give the necessary support to correctly install the heat exchanger.

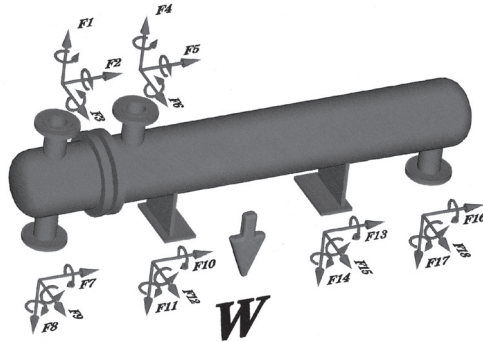


Fig. 5 Forces and torques

⚠ Caution: All system piping on the heat exchanger moving side (guided) must allow the axial movements of the shell.

Failure to do so will result in heat exchanger leakage mixing the two fluids.

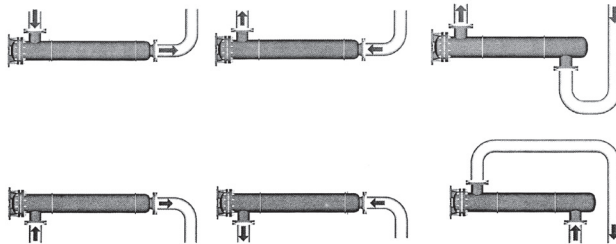


Fig. 6 Examples of installation

4.5 Other precautions

- 4.5.1 Connect the Heat Exchanger to an “electric ground” to eliminate wondering currents.
- 4.5.2 Inspect all openings of the heat exchanger for foreign material.

Remove all wooden plugs and shipping pads just before installing. Do not expose the heat exchanger to the elements with pads or other covers removed from nozzles or other openings since rain water or other may enter the unit and cause severe damage.
- 4.5.3 Be sure that the entire system is clean before starting operation to prevent plugging of tubes with sand or refuse. The use of strainers upstream primary and secondary side of the heat exchanger is recommended.
- 4.5.4 Drain connections should not be piped to a common closed manifold.
- 4.5.5 Provide valves in the piping to permit isolation of the unit for inspection or repairing activities.
- 4.5.6 Provide a thermometer and pressure gauge on piping upstream and downstream the heat exchanger.
- 4.5.7 Provide convenient means for frequently cleaning the unit as suggested under “Maintenance”.

4.6 Vent and drain

- 4.6.1 Provide necessary air vents on piping for the heat exchanges so they can be purged to prevent or relieve vapour binding of either the tube bundle or the shell.
- 4.6.2 Steam hammer can cause serious damage to the tubes of any heat exchanger. A careful consideration of this point before the installation can prevent costly repairs which may be caused by steam hammer.
- 4.6.3 On smaller heat exchangers with draining to atmosphere, a simple remedy is to install a vacuum breaker on the steam inlet to the heat exchanger. It is also necessary to adequately size the condensate removal system and the steam trap in order to prevent heat exchanger flooding. The trap must be placed at a certain distance below the exchanger outlet, and must be adequately sized for a pressure equal to the static head between the heat exchanger outlet and the trap inlet. The condensate pipe from the trap should slope down so that no further back pressure is added on the trap (Fig. 7).

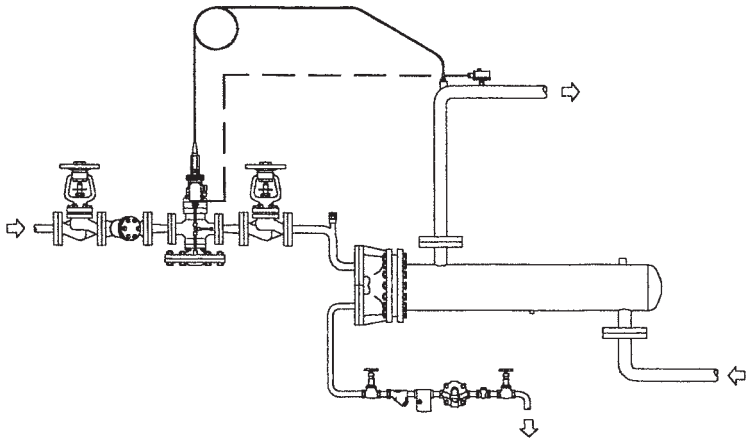


Fig. 7

4.6.4 Often, especially on larger plants, it is usually preferred not to introduce air into the steam space, and the use of a vacuum breaker may not be tolerated.

Also, if the condensate lifts after the steam trap up to a higher level, a vacuum breaker cannot assist drainage. In these situations, a pumping trap or pump/trap combination should be used. A pumping trap performs as a steam trap if there is sufficient steam pressure in the steam space to overcome the back pressure. If there is not, it acts as a pump (Fig. 8).

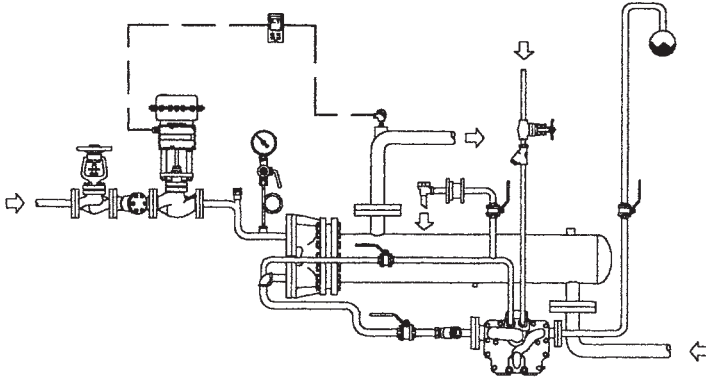


Fig. 8

When a pumping trap arrangement is used, condensate will always be removed under all pressure conditions (in particular under vacuum condition), ensuring maximum system efficiency at all times.

Where capacity is too large for the pumping trap, it can be replaced by a separate pump and steam trap in combination, as shown in Fig. 9.

Δ Caution: During times of shutdown, volumetric expansion can occur. We recommend the installation of a properly sized safety valve on both sides of the heat exchanger.

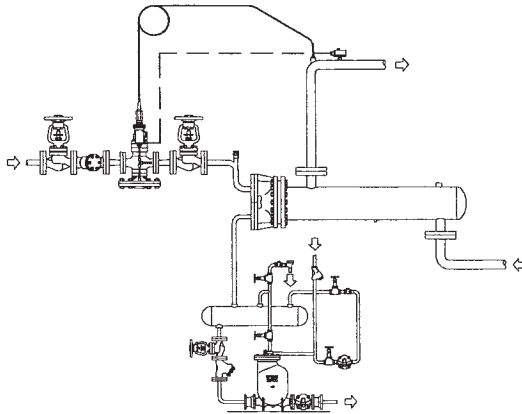


Fig. 9

5. Commissioning

5.1 Operating and design conditions

Do not operate equipment under conditions higher than those specified on nameplate.

⚠ Warning: Failure to operate the heat exchanger within the design pressure and temperature on the nameplate may result in damage to the heat exchanger and potential injury to personnel.

Fluids and steam velocities in excess of design operating conditions on either the shell or tube side of the heat exchanger can cause damaging tube erosion and/or vibrations. Result is internal leakage and mixing of the hot and cold media. Proper setting of system controls is required.

5.2 Working fluids loading

5.2.1 When placing a unit in operation, open the vent connections in order to discharge into the atmosphere the air in the heat exchanger. Start to circulate the cold medium only. Make sure that the cold fluid is present in all flow passages of the heat exchanger before closing the vents. After this operation, the hot fluid can be slowly introduced until the unit is warmed up. Make sure that there is hot fluid in all flow passages while keeping the vents open. When operation is complete, close the vents.

The fluids should be gradually introduced into the unit and the system should be slowly brought to operating temperatures. If this procedure is not attended, the heat exchanger could be damaged due to thermal shock. Do not admit hot fluid to the unit suddenly when empty or cold and do not shock the unit with cold fluid when the unit is hot.

5.2.2 Avoid pulsation of fluids that could cause vibrations and strains which ultimately could result in leaks.

5.2.3 Retighten bolting on all gasketed joints after the heat exchanger has reached operation temperatures to prevent leaks and gasket failures. Retightening should be done uniformly and in a diametrically staggered pattern as illustrated in "Maintenance". On high pressure and high temperature applications it is recommended to retight the gasketed joints of the heat exchanger to the required torque (see "Maintenance") after 24 hours at operating pressures and temperatures to compensate for relaxation or creep that may have occurred.

5.3 Unit shutdown and storage

5.3.1 In shutting down, flow of hot medium should be shut off first. If it is necessary to stop circulation of cooling medium the circulation of hot medium should also be stopped by bypassing or otherwise.

5.3.2 Drain all fluids when shutting down to eliminate the possibility of freezing and oxidation. To guard against water hammer, condensate should be drained both when starting up and when shutting down.

5.3.3 A heat exchanger that has, or will be, out of service for an extended period of time should comply with that described in "Storage" section of this document.

For heat exchangers that are out of service for short periods and use water as the flowing medium should be thoroughly drained and blown dry with warm air, if possible. If this is not practical, the water should be circulated through the heat exchanger on a daily basis to prevent stagnant water conditions that can ultimately cause oxidation.

6. Maintenance

6.1 General information

6.1.1 Do not open the heat exchanger until the unit is fully depressurized, drained of all fluids, and the equipment surfaces cooled to ambient temperature.

6.1.2 Do not blow out heat exchangers with air when operating fluids are of a flammable or otherwise hazardous nature.

⚠ Warning: Proper precautions must be taken (special clothing, equipment, etc.) to protect personnel from injury due to escaping fluids or hot heat exchanger surfaces.

6.1.3 Provide convenient means for frequently cleaning of the heat exchangers as suggested below:

- a. Circulate naphtha or its distillate through tubes or shell at good velocity in order to remove sludge or other similar soft deposits.
- b. Soft salt deposits may be washed out by circulating hot fresh water.
- c. Some cleaning compounds on the market may be used to advantage for removing sludge or coke, provided hot wash oil or water, as described above, does not give satisfactory results.
- d. If the above methods are ineffective for removal of hard scale, a mechanical means may be used.

⚠ Warning: Care must be exercised when handling certain fluids. Follow manufacturer's instructions. Use eye and skin protection. Wear a respirator when required.

6.1.4 Do not attempt to clean tubes by blowing steam inside tubes. This overheats the tube and results in tube expansion and related leaking.

6.1.5 Frequently and at regular intervals, observe interior and exterior condition of all tubes and keep them clean. Frequency of cleaning should be according to scale build-up.

⚠ Warning: Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes with consequent overheating of these tubes, resulting in severe expansion, leaking tube joints, and damage to the heat exchanger.

6.2 Cleaning

6.2.1 Heat exchangers for which fouling or scaling are likely to occur should be periodically cleaned. A light sludge or scale coating on the tube greatly reduces its effectiveness. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary, if the unit has been checked for air or vapour binding and this has been found not to be the cause.

Since the difficulty of cleaning increases rapidly as the scale thickens or deposits increase, the interval between cleanings should not be excessive.

6.2.2 At times, it may be necessary to locate a ruptured tube or leaking joint between the tubes and the tube sheet of a single wall heat exchanger. The following procedure is recommended:

- a. Remove the head and replace it with a test flange (see Fig. 10) that mates with the shell flange. Bolt the test flange in order to block the tube bundle.
- b. Pressurize to design value the shell side of the heat exchanger with a cold fluid, preferably water.
- c. Check if there are leakages on tubes to tube sheet joint.
- d. To fix a leakage on tubes to tube sheet joint, use a suitable parallel roller tube expander and/or welding for required welding bundle (Appendix 2).

Note: When using a mechanical tube expander, set the depth control collar to assure at least 1/8" between the expansion roller end and the inside of the tube sheet.

⚠ Warning: When tightening leaking tube joints:

1. Do not roll the tubes beyond the back face of the tube sheet (Fig. 12).
 2. Do not re-roll tubes that are not leaking since this will thin the tube wall. The result of either of the above conditions can lead to failure of the tube and a leaking bundle.
- e. If an emergency repair of a tube is required, use suitable tube plugs to seal off both ends of the U-bend tube. Some loss of performance will result until a new replacement tube bundle is obtained. Consult your local Spirax Sarco representative for proper replacement of the bundle.

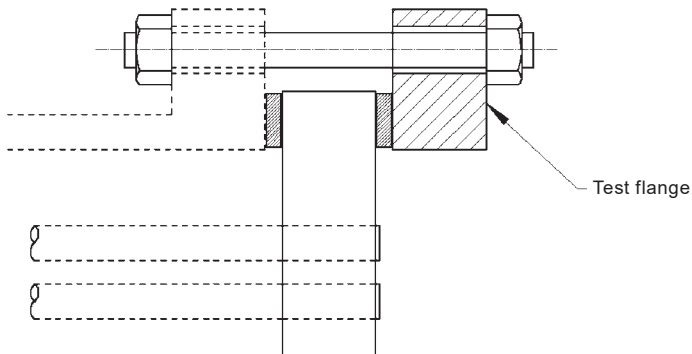


Fig. 10

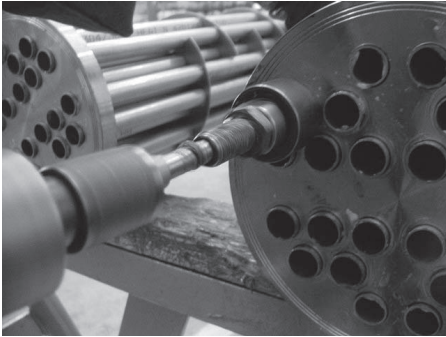


Fig. 11

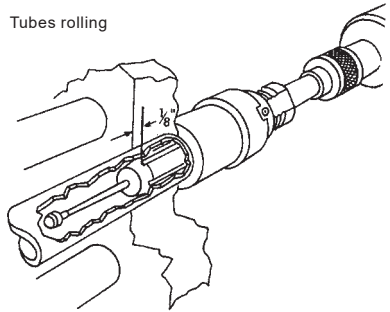


Fig. 12

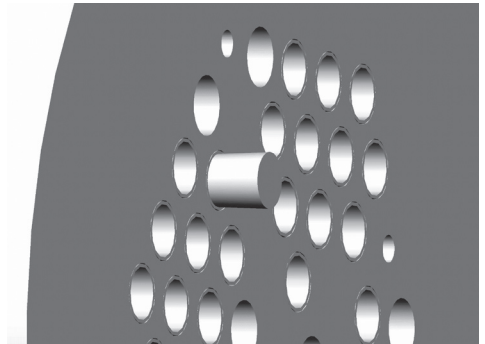
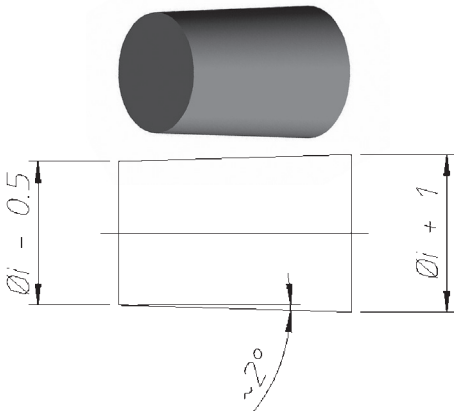


Fig. 13

6.3 Tube bundle removal

Tube bundle removal will be necessary to:

- Clean the bundle.
 - Substitute an external tube. (Appendix 1)
 - Substitute the bundle.
- a. During bundle removal, the dead weight of bundle should never be supported on individual tubes. Rest the bundle on the tube sheet, support plates, or woodblocks cut to fit periphery of the bundle.
- b. Tube bundles may be raised using slings formed by bending light plates into a “U” form and attaching lifting lugs to the ends of sheets. Baffles can be easily bent and damaged if dragged over rough surfaces.

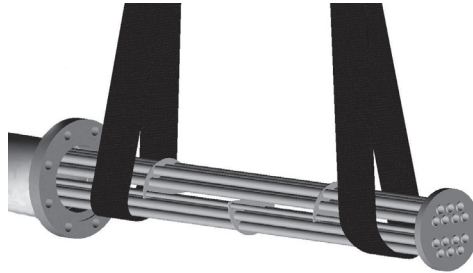


Fig. 14

△ Caution: When cleaning a tube bundle, tubes should not be hammered with any metallic tool and, in case it is necessary to use scrapers, care should be exercised that the scraper is not sharp enough to cut the metal of the tubes.

6.3.1 Before reinserting the tube bundle into the shell, place a gasket over the end of the tube bundle and bring forward to the backside of the tube sheet.

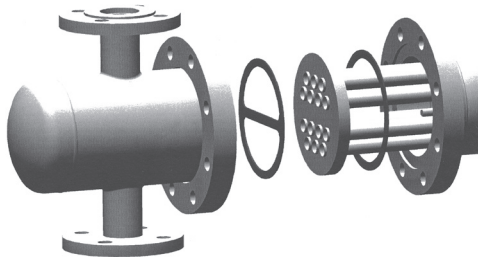


Fig. 15

6.3.2 The tube bundle can be reinserted using the tools and the reverse procedure of the extraction.

6.3.3 When it is necessary to substitute and/or connect the head's cover of the heat exchanger it is necessary to apply the torque indicated in table 1. The values are for lubricated surfaces of bolts and studs. The tightening must be done evenly operating on diametrically opposite bolts as Fig. 16.

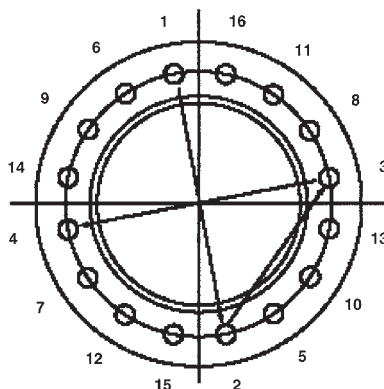


Fig. 16

Warning: It is extremely important to follow a proper tightening sequence. If it is not followed, the flanges can become cocked and a leak will result. When tightening flanges with spiral wound gaskets, if cocking occurs, the result can be deformation and non-repairable damage to the gasket in addition to a leak. Any gasket leak can result in potential injury to personnel.

Table 1 - Tightening torques

H.E:	N° of bolts	Type of bolts	Torque
DN125	8	M16	148 Nm
DN150	8	M16	158 Nm
DN200	12	M16	151 Nm
DN250	12	M18	212 Nm
DN300	16	M18	104 Nm

6.3.4 It is essential that the installer follows the gasket manufacturers installation guidelines when installing them. Metallic gaskets, such as the spiral wound gaskets, usually have dedicated installation instructions, especially concerning tightening procedure. The procedure recommends to torque the bolts/studs in four stages:

- Following the staggered tightening pattern, the bolts/studs should be torqued to 1/3 of the recommended tightening torque.
- The bolts/studs should be torqued to 2/3 of the recommended tightening torque.
- The bolts/studs should be torqued to the recommended torque valve shown in the above chart.
- Following the staggered tightening pattern the bolts/studs torques should be checked for equilibrium since the tightening of one bolts/studs can relieve the stress on adjacent bolts/studs.

If after following the gasket manufacturers recommended tightening procedure a leak still occurs, the bolts/studs tightening should be increment by 1/3, always following the staggered tightening pattern, until the leaks stops.

6.3.5 Refer to paragraph 5.2.3 regarding bolt retightening after commissioning.

6.3.6 Where frequent disassembly of the heat exchanger is encountered, the use of new bolting in conformance with dimension and specifications of the original design is recommended.

7. Inspection

The equipment has been engineered for a working time, in optimal conditions, of 10 years, provided that the following points are fulfilled:

1. Respect of all the prescription indicated in this instruction manual;
2. Respect of the maximum project limits indicated on the equipment nameplate;
3. Fulfilment of the recommendations given in the following table;
4. Biennial inspections: if during the inspections deposits and/or corrosion are identified that can compromise the equipment functionality, contact Spirax Sarco as this may affect the operation of the system.

The following table summarizes the recommended inspections and the suggested frequency.

Purpose of the inspection	Monthly	Twice a year	Every ten years
Eliminate possible deposits	✓		
Verify leakages from connections	✓		
Check tank's exterior/interior		✓	
Verify the integrity			✓

Should any problem be detected during inspection, please make reference to paragraph: 6. Maintenance.

8. Troubleshooting

	Possible defects		Cause	Remedy
	Output temperature	Pressure drop		
Shell side	Constant	Increased	- Initial fouling - Increased flow	- Program checking and/or cleaning - Check other parts of the circuit (possible opening of a by-pass, modifying the system, changing the circuit etc.)
	Constant	Decreased	Insufficient flow	- Check circuit and pump
	Falling	Increased	Advanced fouling	- Visually check tubes - Mechanical or chemical cleaning
	Falling	Constant	- Slight fouling throughout - Supply energy fluid insufficient - Variation of input temperature	- Visually check tubes - Cleaning - Check shell side
	Falling	Decreased	- Flow greatly reduced - Considerable fouling - Fluid loss	- Check circulation and pressurisation - Visual check - Radical cleaning - Check shell side

	Possible defects		Cause	Remedy
	Differential temperature	Pressure drop		
Tube side	Constant	Increased	- Initial fouling - Increased flow	- Program checking and/or cleaning - Check other parts of the circuit (possible opening of a by-pass, modifying the system, changing the circuit etc.)
	Decreased	Increased	Insufficient flow	- Check circuit and pump
	Decreased	Constant	Advanced fouling	- Visually check tubes - Mechanical or chemical cleaning
	Decreased	Decreased	- Flow greatly reduced - Considerable fouling	- Check circuit - Check using optic probes - Brief and energetic CIP wash
	Increased	Increased	- Probable blockage in shell caused by foreign bodies	- Check flow in circuit - Check using optic probes
	Increased	Constant	- Thermal load on tube side excessive	- Check tubes circuit
	Increased	Decreased	- Flow greatly reduced	- Check circuit and pump

U-tube bundle type shell and tube heat exchangers UPI, UPC and UPF

9. Spare parts

When replacement parts are required, refer to part identified in the drawing of the unit. When ordering make sure to provide all data indicated on the nameplate:

- Series N°.
- Model.

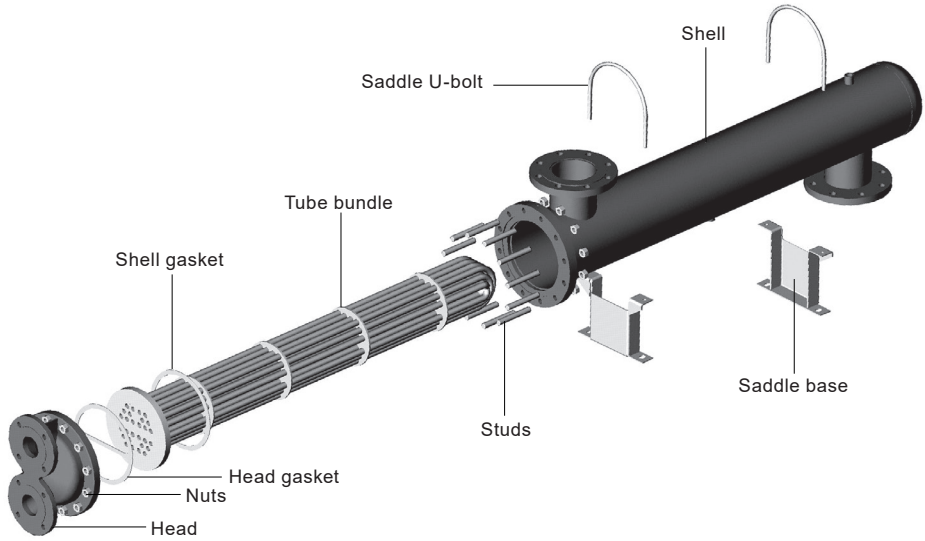


Fig. 17

Appendix 1 - Tube replacement procedure

Procedure phases:

- Releasing of replaced tubes with possible cleavage of the weld and pulling out of the tubes, without damaging the tubesheet and inside holes
- Restoring and cleaning of tubesheet
- Assembling new tubes
- Consistent electronic rolling
- Conclusive trimming
- Hydraulic tests

Appendix 2 - Tubes rolling

One of the most important procedure during the replacement of the shell and tubes plant is rolling. A tube is properly rolled in a tubesheet when the tube is stressed beyond its yield point, but not to its breaking point, and the tubesheet is not stressed beyond its yield point. The expanding procedure shall substantially provide a uniform expansion throughout the expanded portion on the tube without a sharp transition to the unexpanded portion. The optimal rolling must be executed in a single operation. The percentage of reduction is decided by builder or directly by our Company on the results of carried out texts.

$$K = \frac{(T - t) - (D - d)}{2s} 100$$

Where:

- K = % of tube diameter reduction
- s = Thickness before rolling
- D = Internal tube diameter
- d = External tube diameter
- T = Internal tube diameter after rolling
- t = Internal tube diameter before rolling