DNA
Flash steam condenser

Safety information

1. General 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 (see 'Safety Information' at the end of this document). 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 with.

This Manual is appointed to installation, maintenance and using of Heat Exchanger into systems with working mediums classified according to art. 2, PED 2014/68/EU: Nondangerous fluids – group 2

2. Application

The DNA flash steam condenser is based on the standard DNA heat exchanger, with an additional connection. It utilises flash steam from discharge and exhaust vent pipework to pre-heat make-up or process water thereby recovering valuable heat energy that would otherwise be lost to the atmosphere.
The DNA flash steam condenser will improve steam system efficiency and is environmentally friendly, reducing CO_2 and carbon emissions and removing visible discharges from the atmosphere whilst saving valuable energy. It is easy to install and provides an optimised heat transfer solution when compared to other heat exchanger designs used in similar applications.

This product is appointed to work with fluid group 2 (non-dangerous media according to PED 2014/68/EU).

3. Operating principle

The DNA flash steam condenser is a Shell and Coil heat exchanger in which heat is transferred from flash steam to another flowing fluid.
By standard, DNA heat exchangers are counterflow units, which, from a thermodynamic point of view, extracts more heat from a given fluid stream than the other common types of heat exchangers.
The flash steam flows through the shell side and the other medium flows through the tubes.
Thermal energy is transferred through the tube walls. The total heat load depends on the flow parameters of the fluid.

4. Construction features and dimensions

The DNA heat exchanger is designed and fabricated as a single unit with non-removable parts. The cylindrical shell encloses a tube bundle which consists of helically wound smooth tubes. The tube bundle is equipped with two tube sheets, which are welded in the opposite sides of the cylindrical shell. Both ends of the cylindrical shell are enclosed within dished heads provided with longitudinally fitted flanged nozzles. These nozzles transfer the fluid in/out the tube bundle. Shell side nozzles are connected radially on the shell. Nozzles are oriented against each other and therefore the DNA should be used in horizontal position.

In case of leakage in the DNA heat exchanger, up to 5% of the heat exchange tubes can be blinded. Keeping up to a maximum of 5% of the total number of tubes does not entail any risk to the guaranteed properties of the heat exchanger. This condition is not considered as a manufacturing defect and is not covered by the warranty. The tubes are blinded by welding or other suitable means in both tube sheets.

DNA Marking:

Type of heat exchanger	DNA
Shell outer diameter	159
Tube outer diameter	10
Heat exchange area	S37

5. Material

The DNA heat exchanger is made from austenitic stainless steel A316L / EN 1.4404.
Standard materials (WNR (AISI / ASTM)):

Tube bundle	1.4404 (A316L) 1.4571 (A316Ti)
Shell	1.4404 (A316L)
Dished ends	1.4404 (A316L)
Connection flanges	1.4404 (A316L)

6. Nameplate

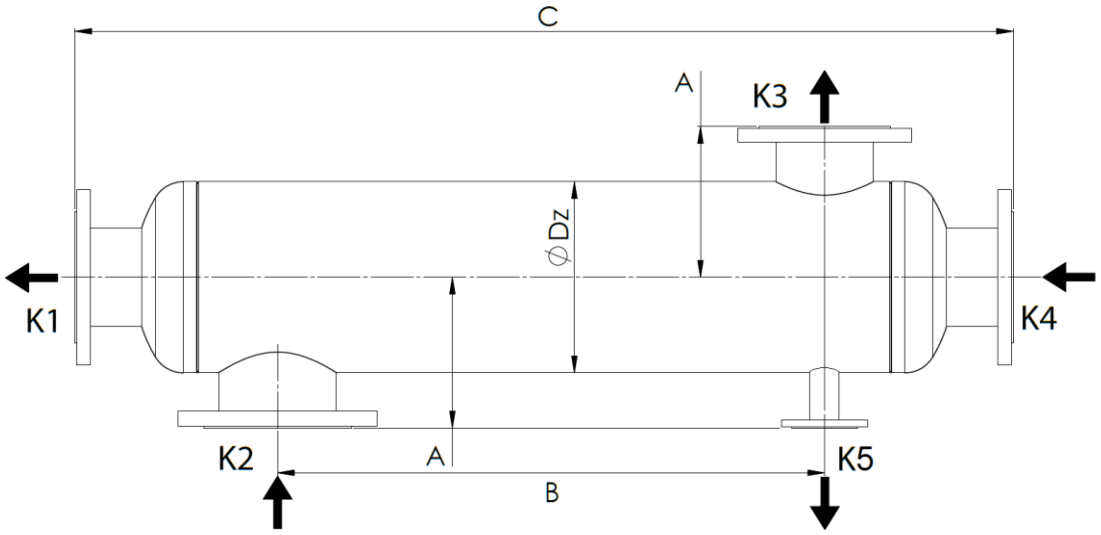
The name plate is placed on the shell and includes the following data:

- Manufacturer logo
- Type & code of heat exchanger
- Serial number
- Production year
- Heat transfer area
- Weight
- Maximum working pressure
- Maximum working temperature
- Internal volumes (tube side, shell side)
- Value of test pressure
- Working mediums
- Category acc. to PED 2014/68/EU

It is not allowed to take off the name plate.

7. Connections and dimensions

Note: Flanges according to EN 1092-1 2002 type 01/B1 (01B) / stainless steel material (SS): 1.4404



Standard of connection location
K1 - Outlet tube side - secondary side fluid (water)
K2 - Inlet shell side - primary side fluid (flash steam from e.g. atmospheric condensate tank)
K3 - Outlet shell side - primary side fluid (excess uncondensed flash steam, vented to the outside)
K4 - Inlet tube side - secondary side fluid (water)
K5 - Drain shell side - primary side fluid (drain of condensate back to e.g. atmospheric condensate tank or to waste)

Type of DNA (FS.PRO.SS.SXS)	Heat exchange surface	Weight	Volume tubes	Volume shell	Dimensions (mm)				Connections			
					A	B	C	Dz	K1 K4	K2	K3	K5
	m²	kg	l	l								
159.10.S24	2,4	40,1	7,8	14,3	140	850	1260	159	DN80	DN100	DN80	DN40
159.10.S37	3,7	50,5	8,5	20,8	140	1350	1760	159	DN80	DN100	DN80	DN40
159.10.S49	4,9	60,9	10,0	27,3	140	1850	2260	159	DN80	DN100	DN80	DN40
219.10.S47	4,7	70,1	15,0	25,8	185	815	1297	219	DN100	DN125	DN100	DN40
219.10.S72	7,2	91,3	15,9	38,0	185	1315	1797	219	DN100	DN125	DN100	DN40
219.10.S96	9,6	112,4	19,9	50,2	185	1815	2297	219	DN100	DN125	DN100	DN40
273.10.S74	7,4	100,3	25,5	40,0	216	785	1371	273	DN125	DN150	DN125	DN40
273.10.S114	11,4	130,9	26,9	59,1	216	1285	1871	273	DN125	DN150	DN125	DN40
273.10.S151	15,1	162,2	33,3	78,1	216	1785	2371	273	DN125	DN150	DN125	DN40
324.10.S110	11,0	153,0	36,0	53,1	236	785	1384	324	DN125	DN150	DN125	DN50
324.10.S168	16,8	205,0	40,4	79,6	236	1285	1884	324	DN125	DN150	DN125	DN50
324.10.S224	22,4	258,0	49,7	106,0	236	1785	2384	324	DN125	DN150	DN125	DN50
406.10.S181	18,1	280,8	66,2	82,7	271	720	1438	406	DN150	DN200	DN150	DN50
406.10.S277	27,7	359,0	71,0	123,7	271	1220	1938	406	DN150	DN200	DN150	DN50
406.10.S369	36,9	434,5	86,4	164,7	271	1720	2438	406	DN150	DN200	DN150	DN50
508.10.S296	29,6	388,0	101,3	126,8	340	660	1511	508	DN150	DN250	DN200	DN80
508.10.S446	44,6	514,0	119,4	189,3	340	1160	2011	508	DN150	DN250	DN200	DN80
508.10.S610	61,0	640,0	144,6	251,8	340	1660	2511	508	DN150	DN250	DN200	DN80

8. Installation

Only qualified personnel should install the heat exchanger. The heat exchanger should be installed, operated and maintained without exposing it to mechanical stress or moments. (Example: in cases of pipe expansions, use expansion compensators to relieve the stress from the connections of the heat exchanger).

The Heat Exchanger should be located in a suitable **horizontal position** e.g. against a wall where the vent can easily be piped to the atmosphere. It is recommended that appropriate clearance is maintained around the unit for easy access.
The DNA flash steam condenser needs to be installed above the atmospheric condensate tank.

The vent connection (K3) must be piped unreduced and unrestricted to a safe atmospheric discharge point. The line should be vertical, if possible. If horizontal runs must be used, the line should be pitched so that it is self-draining to the DNA condenser. A suitably sized vent head should be fitted to the top of the vent pipe to ensure safe discharge of flash steam.

Connection K5 (Drain shell side) always needs to drain the condensate back to e.g. the atmospheric condensate tank or to a safe discharge point, remembering that any condensate that discharges may be hot. Care should be taken to ensure that hot condensate being discharged to a drain does not infringe local temperature or environmental regulations.

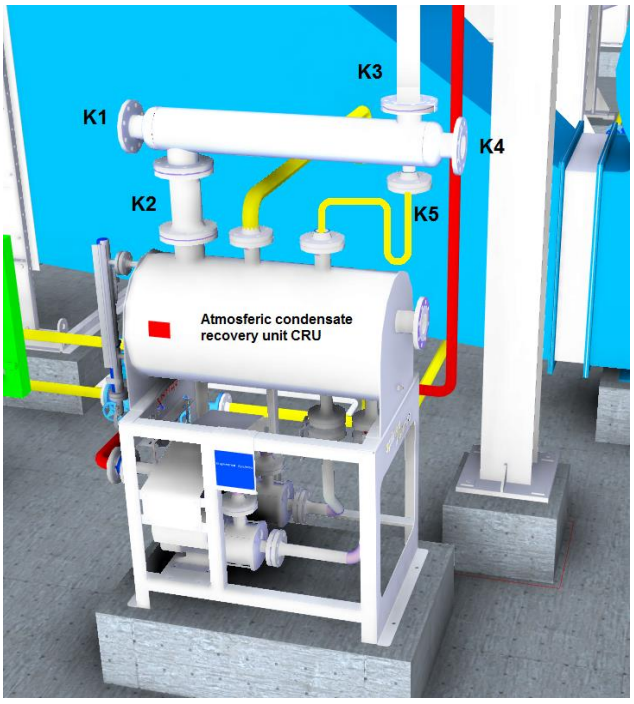
Connect a 'U' bend water seal of at least 0,5 m below the K5 drain connection.
No back pressure is allowed at the K5 condensate drain!

Any excess uncondensed flash steam will be vented to the outside.

The DNA should be mounted by means of stainless steel brackets and supports. These must be provided with proper underlay material to allow firm tightening (rubber, plastic). Contact between carbon steel and the heat exchanger is not allowed!

The joining of flanges have to be made with screws and nuts class 5 (ISO 898-1) and flat gasket rings.

There has to be an open space besides the heat exchanger, for easy mounting.



9. Insulation

After mounting and installing the heat exchanger and leakage inspection, the units should be insulated. Insulation prevents heat loss to the surroundings and, in cases of high temperature use, also protects the operators.
Surface contact with carbon steel and stainless steel could produce rust to the surface and corrosion.

10. Working equipment

The heat exchanger has to be equipped and secured (see PED 2014/68/EU) with safety accessories (safety valve) to prevent exceedance of the maximum allowable pressure and the maximum allowable temperature.
The heating system has to be equipped with an expansion tank. There has to be a thermometer, manometer and a pressure- and temperature sensor in a safety point. A sensor for the detecting of water shortage, or an air outlet valve could also be used.
The heat exchanger has to be equipped with insulation of the external surface, according to Section 9: Insulation.
Water-hammer should be avoided at all cost. Therefor the steam line needs to be equipped with steam traps in front of the shut-off valves, in order to drain any condensate formed.
Also it is necessary to secure that changes in pressure and temperature increase proportionally, so not in leaps.
On the tube-line, in front of the heat exchanger, is necessary to place a separator.

11. Operating precautions

In order to achieve maximum performance from the heat exchanger, the following must be strictly followed:

- Heat exchangers should be used according to the specifications in this document.
- Pressures and temperatures should not exceed the limits of the heat exchanger, see table below*.

	Fluid group 2 (non-dangerous)	
Working side	**Tube bundle**	**Shell**
Working parameters	Max. allowable pressure (bara) / Max. allowable temperature (°C)	
DNA 159.10.S24	16 / 200	10 / 200
DNA 159.10.S37	16 / 200	10 / 200
DNA 159.10.S49	16 / 200	10 / 200
DNA 219.10.S47	16 / 200	10 / 200
DNA 219.10.S72	16 / 200	10 / 200
DNA 219.10.S96	16 / 200	10 / 200
DNA 273.10.S74	16 / 200	10 / 200
DNA 273.10.S114	16 / 200	10 / 200
DNA 273.10.S151	16 / 200	10 / 200
DNA 324.10.S110	16 / 200	10 / 200
DNA 324.10.S168	16 / 200	10 / 200
DNA 324.10.S224	16 / 200	10 / 200
DNA 406.10.S181	16 / 200	10 / 200
DNA 406.10.S277	16 / 200	10 / 200
DNA 406.10.S369	16 / 200	10 / 200
DNA 508.10.S296	16 / 200	10 / 200
DNA 508.10.S446	16 / 200	10 / 200
DNA 508.10.S610	16 / 200	10 / 200

*Maximum steam pressure: 10 bara.

- Initial start-up should be done according to Section 15: Start-up.
- Heat exchangers should be free of any debris in the fluid.
- Prevent heat exchanger against sudden temperature changes (temperature shocks). Increase of temperature should not exceed 10°C/min.
- It is necessary to remove any cold medium, before inserting a hot medium into the working space.
- Prevent any of the fluids from dropping below their solidification point (freezing point).
- Do not put inflammable objects or materials in dangerous distance to heat exchanger.
- In central heating applications the manufacturer recommend to use water treatment. If not, lime deposits will form on the tube walls when the water exceeds 60 °C.
- The water treatment may not contain chlorines and its solutions in order to avoid corrosion. See Section 14: Chemical regimes, 16: Cleaning.
- Shut down the heat Exchanger before commencing works that can cause a change of environment, i.d. using of glue, colours etc.
- Foresee sufficient working pressure on the cold side in order to avoid boiling of the cold medium in the heat exchanger at any time throughout the process.
- The system should be designed to prevent the heat exchanger from encountering pressure shocks.
- Prevent rapid (peak) pressure increases in the heat exchangers (pressure shock, water hammer), which can occur with quick closing of valves or break-down of pumps.
- It is necessary to include all foreseen risks, have particular attention for:
  - dangerous outputs of safety valves.
  - surface temperature, considering environment.
  - risk of external fire.
- Keep the maximal concentrations of chemical compounds within allowed limits

12. Chemical composition monitoring

It is recommended to check the operating conditions of the heat exchanger. Have particular attention for the chemical composition of process fluids and its compatibility with construct materials of the heat exchanger. The heat exchanger is approved for specific fluids in their pure chemical state. Any chemical treatments of the approved fluids the responsibility of the owner/operator.

The heat exchanger should not operate under conditions (with such chemical composition) which cause corrosive attacks of stainless steel used as construct materials. Any failure or damage of the heat exchanger which is caused by wrong treatment / chemical composition of approved process fluids is not covered by the warranty.

For a proper operation of the heat exchanger, the operator must continuously check the chemical composition of process fluids, in order to not exceed maximal concentration of certain compounds. There is a limitation to the compounds that cause stainless steel damage. Compliance with these limits is only effective if the heat transfer area is not fouled.

Maximal concentrations of listed compounds (mg/l).

Temperature		**20 °C**	**40 °C**	**60 °C**	**80 °C**	**100 °C**	**> 100 °C**
Chlorides (Cl^-)[(1)]	**PRO**	400	120	50	20	10	1
For treated heating water:							
Oxygen (O_2)		0,1	0,05	0,03	0,02	0,01	
Chlorine (Cl_2)		0,5	0,3	0,2	0,1	0	
Carbon dioxide (aggressive)		5	5	3	3	2	

(1) Valid for all halides

Values of other parameters for treated heating water, such as pH, electrical conductivity, hardness and alkalinity should follow local norms for steamquality and heating water quality for unfired pressure vessels.
In order to proper work, a filter must be mounted before the heat exchanger.

13. Construction material characteristics

13.1. Construction materials for the DNA heat exchanger

PRO: WNR 1.4404 - AISI 316L - %CrNiMo 17-12-2,5

Material PRO: Cr-Ni-Mo austenitic stainless steel with lowered carbon concentration. Molybdenium rises chemical resistance.

Although stainless steel is used as a construct material, there are environments that cause specific corrosions such as pitting and stress corrosion cracking.

Specific stainless steel corrosion is caused by forbidden chemicals or wrong treatment of approved process fluids:

13.2. Pitting corrosion

Corrosion causes a local disruption of the stainless steel passive layer, which results in perforation of the heat transfer tubes. Corrosion rate depends mainly on temperature and concentration of chloride ions.

13.3. Crevice corrosion

Corrosion causes a local disruption of the stainless steel passive layer, which results in perforation of the heat transfer tubes. Corrosion rate depends mainly on temperature and concentration of chloride ions.
This type of corrosion occur very often if the heat transfer area is fouled. Pitting and crevice corrosion is most likely to be found together.

13.4. Stress corrosion cracking

This type of corrosion occur in corrosive environment (most likely chloride ions) with simultaneous application of mechanical or temperature stress. Risk factors are big temperature difference and fouling of heat transfer tubes (for example steam heating of drinking water).

Deposits in the heat exchanger and fouled heat transfer surface significantly increase the probability that specific types of corrosion occur in the heat exchanger.

14. Chemical regimes

The most widespread mistake in heat exchanger operation is a wrong water treatment, which creates a corrosive environment for stainless steel materials. Water treatment has to be executed with care so that concentration of forbidden compounds is not exceeded.

14.1. Water clarification - coagulation and flocculation

Regularly used coagulants on chloride basis ($FeCl_3$, $FeCl_3.6H_2O$) can rise the concentration of chloride ions in treated water. Their activity may also be raised by sulphates, which is a undesirable effect of water treatment as well. Sulphate concentration can be affected by coagulants with sulphate basis ($Al_2(SO_4)_3.18H_2O$). The safest choice is to use alternative coagulants as $NaAlO_2$.

14.2. Deoxygenation of treated water

An increased oxygen content has a significant impact on the corrosion rate and on the incubation period before corrosion begins to perforate material. There is a risk of this when there is poor deoxygenation (increased level of oxygen) or if there is deoxygenation in chemicals excess, where it probably will increase the sulphates level (deoxygenation by sulphites oxygenation).

14.3. Drinking water treatment

14.3.1. Chlorine treatment (Cl_2)

The addition of chlorine rises the concentration of chloride ions. Therefore, specific corrosion (pitting etc.) can occur with temperature dependence. This can also occur when using halides.

14.3.2. Treatment against Legionella (ClO_2)

The addition of ClO_2 rises the concentration of chlorides, chlorites, chlorates and free Cl_2 in water. This gives a high risk of specific corrosion in temperature dependence.

The manufacturer cannot guarantee the service life of heat exchangers in situations where it is probably to expect specific stainless steel corrosion due to the corrosive environment or fouling of the heat exchanger.

15. Start-up

Before start-up of the heat exchanger, it is necessary to check all the safety valves and safety equipment, which have to be used according to PED 2014/68/EU, national standards, norms or other directives.

To prepare the heat exchanger for operation, it should initially be
- mounted properly.
- filled with working fluids.
- deaerated.
- checked for leaks on all connections.

The pressure increase/decrease should not exceed **3 bar/min**.
The temperature increase/decrease should not exceed **10 °C/min**.

During start-up, first open the valves, then start the pump of the cold medium followed by opening the cycle of the heating medium. The valves should be opened gradually in order to achieve a steady increase in flow and pressure.
During start-up of the steam system, it is useful to preheat the heat exchanger slowly to working temperature for minimally 5 - 10 min. Afterwards, use steam with full working parameters.

16. Cleaning

The working of the heat exchanger has to be checked continuously and cleaned with partial scaling. The need can be recognised by increasing pressure drop of heated water, worse subcooling of the heating medium and related necessity of flow or decreasing of heat load.
Periodical checking must be done, to control for the formation of hard scaling inside heat exchanger. This has to be done according to the regulations described below:
- Heat exchangers working in a system with water treatment: min. every 18 months (according to quality and quantity of the added water)
- Heat exchangers working in a system of natural water: min. every 12 months.

In order to take the heat exchanger out of the system, the following requirements should be fulfilled:
1. All of the pumps are switched off and secured to unforeseen start up.
2. The equipment is not under pressure.
3. The temperature of heat exchanger has dropped under 40 °C but not lower than 10 °C.

The heat exchangers need to be cleaned by flushing the units with fluids that do not react with stainless steel.

Dirt deposited in the heat exchanger will result in an increase of pressure drop, lower temperature difference in the heated medium or a higher exit temperature on the heating medium side. Flushing can be done without removal of the heat exchanger from the system, although extra connections and bypasses would be required.

Cleaning solutions (detergents) are easily obtained by manufacturers of chemical cleaning agents for heat exchangers or tubing and piping applications. As a guideline to purchasing the cleaning solutions, check for the following product data:
- Compatibility with stainless steel;
- Accepted for use in food processing industries (if applicable);
- Remove scale, slag, tarnishes, and hard water deposits;
- Easily rinsed out of the system;
- Has no objectionable or corrosive fumes;

The following fluids are not to be used for cleaning or using inside heat exchangers:
- Hydrochloric acid and its solutions;
- Free chlorine with concentrations higher than 0,5 ppm; (Cl_2 < 0,5 ppm);
- Solutions containing ions of Cl^- , with concentration higher than the following :
  - Cl^- < 50 ppm for heating of water up to 50 to 60°C;
  - Cl^- < 20 ppm for heating of water up to 70 to 80°C;
- All fluids that can deposit alkaline residues or phosphorus.

Note:
- After each cleaning, use a weak oxidizing acid solution for stainless steel regeneration. For this, it is sufficient to use 5% formic acid, 8% acetic acid or 1-2% nitric acid with batch duration about 30 minutes.
- Afterwards, it is necessary to rinse out the heat exchanger by a neutralizing fluid (for example 1-2% solution NaOH or $NaHCO_3$) with inhibitors of corrosion.
  Lastly, rinse out the heat exchanger by clear water.
- The cleaning period depends on the type of deposits, level of fouling and on flow velocity.

Important:
- Beware of filter regeneration of cation exchanger water treatment (catex). Catex regeneration by salt containing chloride ions must not cause chloride contamination of process fluid (chloride ions are strictly limited for use in stainless steel heat exchangers). Exceeding the limits of chloride ions may cause pitting corrosion and stress corrosion cracking.
- Fouling of the heat exchanger is a risk factor for material corrosion.
- Make a report of each cleaning process of the heat exchanger.

17. Storage, packing and transportation

The heat exchanger has to be protected from damage during transportation. It should be stored in a clean place, away from corrosive environments or weather elements (e.g. rain).
Be aware of residual water inside the heat exchanger. If there remains any water inside (due to rain or during transport), freezing will damage the heat exchanger. The same applies when the apparatus is stored away.
During transportation, ensure that the heat exchanger is not exposed to mechanical damages.

18. Certification

The manufacturer issues a declaration of conformity to each unit.

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 with.

Intended use

Referring to the Installation and Maintenance Instructions, product marking and Technical Information Sheet, check that the product is suitable for the intended use/application. The product complies with the requirements of the Pressure Equipment Directive (PED) and fall within category 'SEP'.
It should be noted that products within this category are required by the Directive not to carry the mark.

i. The product has been specifically designed for use on steam, compressed air and water/ condensate which are in Group 2 of the above mentioned Pressure Equipment Directive.
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 protection covers from all connections and protective film from all name-plates, where appropriate, before installation on steam or other high temperature applications.

Access

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

Lighting

Ensure adequate lighting, particularly where detailed or intricate work is required.

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.

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.

The system

Consider the effect on the complete system of the work proposed. Will any proposed action (e.g. closing isolation valves, electrical isolation) put any other part of the system or any personnel 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.

Pressure systems

Ensure that any pressure is isolated and safely vented to atmospheric pressure.
Consider double isolation (double block and bleed) and the locking or labelling of closed valves. Do not assume that the system has depressurised even when the pressure gauge indicates zero.

Temperature

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

Tools and consumables

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

Protective clothing

Consider whether you and/or others in the vicinity require any protective clothing to protect against the hazards of, for example, chemicals, high/low temperature, radiation, noise, falling objects, and dangers to eyes and face.

Permits to work

All work must be carried out or be supervised by a suitably competent person.
Installation and operating personnel should be trained in the correct use of the product according to the Installation and Maintenance Instructions.
Where a formal 'permit to work' system is in force it must be complied with. Where there is no such system, it is recommended that a responsible person should know what work is going on and, where necessary, arrange to have an assistant whose primary responsibility is safety.
Post 'warning notices' if necessary.

Handling

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.

Residual hazards

In normal use the external surface of the product may be very hot. If used at the maximum permitted operating conditions the surface temperature of the product may reach temperatures as high as the maximum temperature of the used medium.
Many products are not self-draining. Take due care when dismantling or removing the product from an installation (refer to ‘16. Cleaning’).

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.

Disposal

Unless otherwise stated in the Installation and Maintenance Instructions, this product is recyclable and no ecological hazard is anticipated with its disposal providing due care is taken.

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.