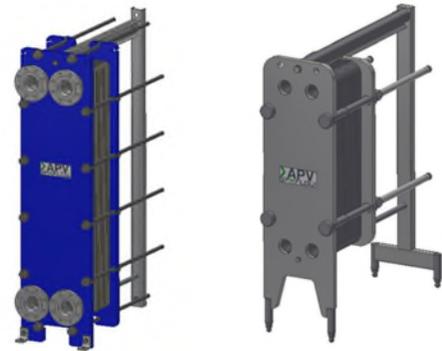


Installation, Operation and Maintenance Manual



MODELS: Gasketed PHE's

FORM NO.: GPHE IOM

REVISION: 01

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APV GASKETED PLATE HEAT EXCHANGER (GPHE)

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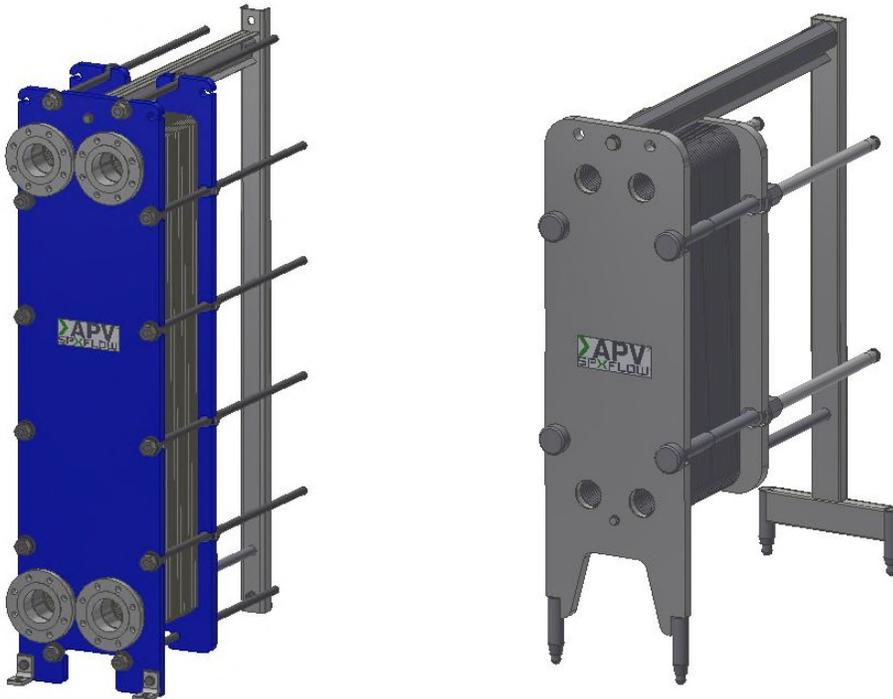
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1. INTRODUCTION

WARNING

These operating instructions must be read and thoroughly understood for the safe commissioning, operation, and maintenance of the APV brand Gasketed Plate Heat Exchanger. The following procedures must be performed by qualified, trained personnel who are familiar with this equipment. While every attempt has been made to ensure clarity, the intent of this document is to provide basic guidance and it is the responsibility of the end user to review each application thoroughly for suitable usage. Users should utilize sound engineering judgment prior to, and during, product operation. Failure to comply may result in damage, injury, or death.

This manual is specific to industrial and sanitary tie bar tightened frames. Separate publications address Plate Heat Exchangers tightened by other means.



2. SAFETY SYMBOLS and DEFINITIONS

The safety signal word designates the degree or level of a hazardous situation.

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

Caution: Used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

IMPORTANT: Important is used when action or lack of action can cause equipment failure, either immediate or over a long period of time.

3. SAFETY PRECAUTIONS

3.1. General

DANGER

- The necessary actions to avoid an accident with or any damage to the GPHE are:

Before putting an SPX FLOW GPHE into operation, the operator shall analyze the application for all foreseeable risks, their likelihood to occur and the potential consequences of the identified risks as per the current revision of ISO 31000 and ISO/IEC 31010.

- Read and understand these operating instructions. Failure to correctly install, commission, and operate the GPHE, can create a condition in which hazardous fluids or gases leak and result in serious injury or death. Observe warning signs on equipment and act accordingly. Form safe working habits by reading the rules and abiding by them. Keep this booklet handy or save the link to this manual and review it from time to time to refresh your understanding of the rules.

The following general safety precautions must be followed to avoid personal injury or equipment damage:

- Always observe any applicable local and national safety codes.
- Always use appropriate protective gear, such as safety gloves, cut-resistant sleeves, safety glasses and safety shoes when touching and handling the equipment.
- Follow correct personal and equipment lifting procedures while handling the equipment.
- Never expose the equipment to heat, aggressive chemicals or mechanical impact that can cause damage.
- Only qualified persons should handle and operate the equipment.
- Upright GPHE's can have a high center of gravity. Ensure the GPHE is stable. Use foundation bolts if necessary.

⚠ WARNING



- **The following procedures must be performed by qualified, trained personnel who are familiar with this equipment. Operators must read and understand all safety precautions and operating instructions included with the GPHE. If the operator cannot read these instructions, operating instructions and safety precautions must be read and discussed in the operator's native language.**
- **These products are designed for general use in normal environments. These products are not designed for use in special work environments such as: explosive, flammable, or corrosive. Only the user can determine the suitability of this product in these conditions or extreme environments. SPX FLOW can supply information upon request to assist the user in making these decisions. Consult your nearest SPX FLOW facility. (Listed on www.spxflow.com)**



Safety glasses and hearing protection must be worn at all times by the operator and anyone within sight of the equipment. Additional personal protection equipment can include gloves, apron, hard hat, and safety shoes.



The owner must verify that safety-related decals are visible and understood.



The OPERATING INSTRUCTIONS cannot cover every hazard or situation so perform activities with SAFETY FIRST.



The user must be a qualified operator familiar with the correct operation, maintenance, and use of the GPHE. Lack of knowledge in any of these areas can lead to personal injury or death.

Always observe the Safety Notes designated by the Danger, Warning, and Caution symbols listed throughout this manual:



The APV GPHE is designed and manufactured with due consideration and care for generally accepted safety standards. As with any mechanical device, the correct and safe performance of the equipment depends on safe handling, operation, and maintenance.

Note: Illustrations of APV GPHE and equipment presented in this manual serve as examples to support the instructions. Your actual equipment may look different.

Important!

In addition to this instruction manual, the following key documents are included with your APV GPHE. In case of conflict between this instruction manual and the order and product documents, the order and product specific documents take precedence.

- APV GPHE plate arrangement diagram
- APV GPHE customer drawing which may be integrated with the plate arrangement diagram
- Other order-specific documentation
- Supplementary instruction manuals dealing with specific topics

Further details can be found in Section 7.0: “Receiving of Equipment”.

How to contact SPX FLOW:

Your nearest SPX FLOW office is listed on our website www.spxflow.com. Information regarding our Service and Spare Parts offerings can also be found on the website.

3.2. Operating Zone

An operating zone should be established around all heat exchangers. A brightly painted guard rail or warning stripe should define the zone. Only the operator or other authorized personnel should be within the operating zone when equipment control circuits are energized, or the heat exchanger is operating. No tools or other equipment should be kept within the operating zone.

3.3. Installation

Utilities, such as water, steam, electricity, and pressurized air, should be installed by trained and authorized personnel only. Installations must comply with all applicable codes and standards, including those established by OSHA.

3.4. StartUp and Shutdown Instructions

Before Operating a GPHE

- a. Ensure all necessary guards and safety devices are installed and operating correctly. This includes safety screen or pressure relief devices.
- b. Be sure all personnel are clear of the GPHE.
- c. Remove (from the operating zone) any materials, tools or other foreign objects that could cause injury to personnel or damage the GPHE.

After Shutdown

Make certain all pressure in the heat exchanger is released.

3.5. General Operating Safety

- a. Do not operate this heat exchanger until you read and understand the operating instructions and become thoroughly familiar with the equipment and its operation.
- b. Never operate a heat exchanger while a safety device or guard is removed or disconnected.
- c. Always wear safety glasses, safety hat, steel-toed shoes, ear protection and any other required safety equipment.

- d. Never remove “Warning” tags displayed on the heat exchanger. Torn or worn labels should be replaced.
- e. Do not start the heat exchanger until all personnel in the area have been advised and have moved outside the operating zone.
- f. Remove any tools or other foreign objects from the operating zone before starting.
- g. Keep the operating zone free of obstacles that could cause a person to trip or fall.
- h. Never sit or stand on anything that might cause you to fall against the heat exchanger.
- i. “Horseplay” around a heat exchanger at any time is dangerous and prohibited.
- j. Never operate the GPHE above specified capacity, pressures, or temperatures.
- k. Do not operate faulty or damaged equipment. Ensure correct service and maintenance procedures have been performed.
- l. A safe work surface should be provided around the heat exchanger, including correct guarding of elevated platforms and the design and use of ladders.

3.6. Service and Maintenance Safety

- a. Do not service a heat exchanger until you are thoroughly qualified and familiar with the tasks to be performed.
- b. Follow your organization’s safety policies and lock out tag out procedures. Never operate any valves, pumps, or controls while personnel are performing maintenance on the heat exchanger.
- c. Do not bypass safety devices.
- d. Always use the correct tool for the job.
- e. Do not enter a confined space. Follow your organization’s safety policies and procedures regarding confined space entries.

3.7. Safe Cleaning Procedures

Manual Cleaning Procedures

- a. Do not use toxic or flammable solvents to clean a heat exchanger.
- b. Always clean spills around the heat exchanger as soon as possible.
- c. Never clean a heat exchanger while it is operating.
- d. The customer is responsible to ensure that the cleaning chemicals are compatible with the plate and gasket materials.

Cleaning In-Place Procedures

- a. Ensure all connections in the cleaning circuit are tight to avoid contact with hot water or cleaning solutions.

- b. When the cleaning cycle is controlled from a remote or automated control center, establish fail safe procedures to avoid automatic startup while servicing equipment in the circuit.
- c. On heat exchangers that include safety screens, ensure the screens are correctly installed prior to starting the cleaning cycle (see Section 13.3).

3.8. List of Safety Precautions

⚠ DANGER

- a. The welded and gasketed chambers of an APV welded plate pair may have different pressure and fluid capabilities. Ensure the fluids are connected correctly. (See page 24)
- b. The lifting equipment must be in good condition and used in full compliance with the manufacturer's specifications and limitations. (See page 40)
- c. Never exceed 120° between the lifting wires at any time. (See page 40)
- d. If the ceiling height does not allow for a safe lifting angle, dollies or creepers can be used to move the equipment. (See page 41)
- e. Always observe correct procedures for lifting and/or moving equipment. Qualified personnel should perform the lifting and moving. Personnel must follow prescribed rigging practices. (See page 41)
- f. Do not use a forklift truck to lift a heat exchanger unless it is securely mounted to a pallet or skid. (See page 41)
- g. Startup and shutdown of the heat exchanger must be undertaken slowly and smoothly. This is to avoid any pressure shocks or water hammering, which can damage the equipment or cause leakage. Pressure changes must occur gradually, at a maximum rate of 1.7 bar (25 psi) every 10 seconds. Similarly, temperature changes must be gradual and limited to less than 10°C (18°F) per minute. Operators should monitor and record pressure and temperature changes in at least the mentioned intervals. (See page 50)
- h. Exceeding the design temperatures and pressures can be harmful to the equipment and personnel and must be avoided. (See page 54)
- i. Sudden changes in the operating pressures and temperatures must be avoided. Shock cooling of the APV GPHE may cause leakage, due to sudden contraction of the sealing gaskets. (See page 55)
- j. Temperature and pressure cycling must be limited to the rate changes specified in Section 11-1 (startup and shutdown). (See page 55)
- k. Never open a pressurized GPHE. (See page 55)
- l. Always wear protective gloves and cut-resistant sleeves when handling plates or any other objects with sharp edges (nuts, tie bars, safety screens, etc.). (See page 56)

 **WARNING**

- a. Leakage from an APV DuoSafety plate is always the early warning for the user to act. (See page 23)
- b. Do not exceed the maximum operating pressure or temperature listed on the customer drawing or damage to the heat exchanger and personnel serious injury or death may result. (See page 38)
- c. Lifting from the follower is not permitted since plate damage may occur. (See page 41)
- d. Never tighten a GPHE which is under pressure. (See page 46)
- e. Never tighten a GPHE while piping is connected to the follower or connector grids. (See page 46)
- f. Refer to the plate arrangement diagram for the maximum compressed dimension of the plate pack. (See page 47)
- g. Never open a GPHE until the equipment is below 38°C (100°F). (See page 48 and 55)
- h. Never open a GPHE which is under pressure. (See page 48)
- i. Never open a GPHE while piping is connected to the follower or connector grids. (See page 48 and 55)
- j. Ozone-producing equipment, salt air and other corrosive atmospheres must be avoided. (See page 49)
- k. The plate pack must be tightened to the correct pitch before commencing operation. Use the maximum pitch when new plates and gaskets are installed. For all other conditions, tighten the plate pack to the previous plate pack dimension and if leaks occur then reduce the plate pack dimension in small steps. Never tighten the heat exchanger below the minimum pitch. (See page 49)
- l. Correct assembly and tightening are required for safe startup and operation. (See page 50)
- m. The heat exchanger must never be started or operated with a closed valve in the outlet piping. Any such operation can cause leakage and irreversible damage. (See page 50)
- n. As for any bolted vessel, bolts must not be slackened or tightened indiscriminately. Use a sequence that balances the opening on the right and left sides of the heat exchanger throughout the process. (See page 56)
- o. During maintenance, secure the follower to the end support to prevent accidental rolling. (See page 57)
- p. **Do not use any chlorine-containing agents as this will attack the heat transfer plate.** (See page 60)

- q. Excess Nitric acid can seriously damage NBR and other rubber gaskets. (See page 60)
- r. Insufficient clamping force can cause leaking. (See page 66)
- s. Never tighten below the minimum pitch shown on the customer drawing. (See page 66)

⚠ CAUTION

- a. APV welded plate pairs are not suitable for sanitary duties where organic fouling is expected, for example, dairy products. (See page 24)
- b. Ensure sufficient space around the APV GPHE. (See page 37)
- c. When assembling a GPHE, all components must be sufficiently supported to prevent damage. (See page 41)
- d. Use the customer drawing or plate arrangement diagram to correctly install the plates. For simplification, whole blocks of identical left or right hand plates are shown on the customer drawing or plate arrangement diagram. The total number of each is given. (See page 43)
- e. Do not permanently bend or scratch the plates or damage the gaskets during installation. Some plates must be carefully flexed to install them. (See page 44)
- f. **Never-Seez® Regular Grade** is not suitable for stainless steel tie bars. (See page 45)
- g. A heat exchanger which has been in storage for more than five (5) years should be inspected by a qualified SPX FLOW representative prior to preparing it for operation. (See page 49)
- h. Prior to startup, all pipework must be inspected and flushed clean. Strainers are recommended to prevent debris from entering the heat exchanger. (See page 50)
- i. Cleaning agents must not be aggressive or corrosive to the plates or the gaskets. If in doubt, contact SPX FLOW. (See page 58)
- j. The heat exchanger must be rinsed and then thoroughly drained immediately following CIP. Residue from CIP may cause corrosion if left in the heat exchanger. (See page 60)
- k. Overheating the plates can cause discoloring and damage. (See page 62)
- l. To avoid leakage, never tighten to a more relaxed pitch than the previous closing. (See page 66)

4. MAIN COMPONENTS

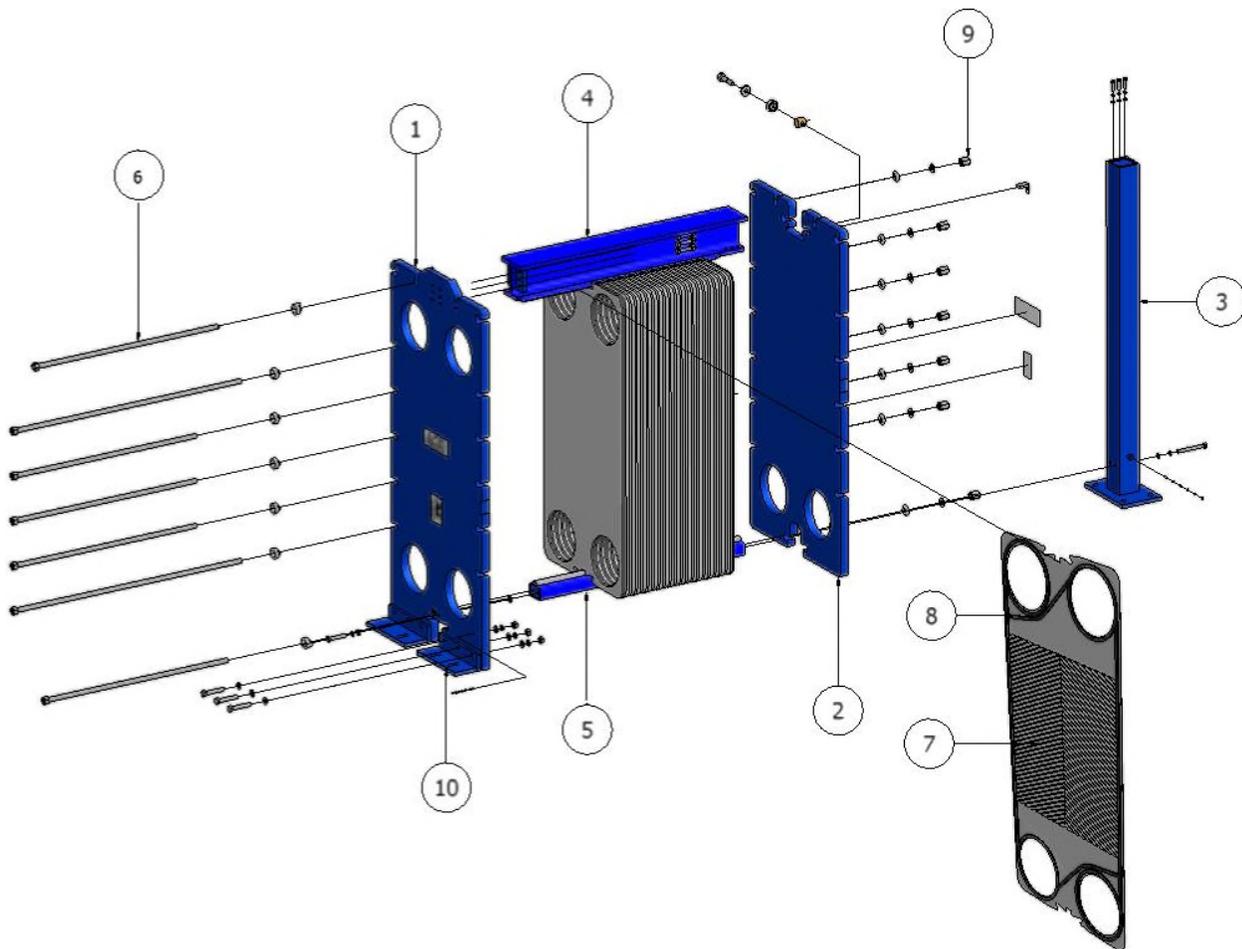


Figure 1: A typical APV industrial GPHE

Figure 1: Main components of APV GPHE, industrial design

1. Head for connections and clamping the plate pack
2. Follower for clamping the plate pack and any additional connections
3. End support for supporting the top and bottom bars
4. Top bar for carrying and guiding the follower and plate pack
5. Bottom bar for guiding the follower and plate pack
6. Tie bars for clamping the plate pack between head and follower
7. Flow plate
8. Flow gasket
9. Nut for tie bar
10. Foot for securing the GPHE to the ground or mounting surface

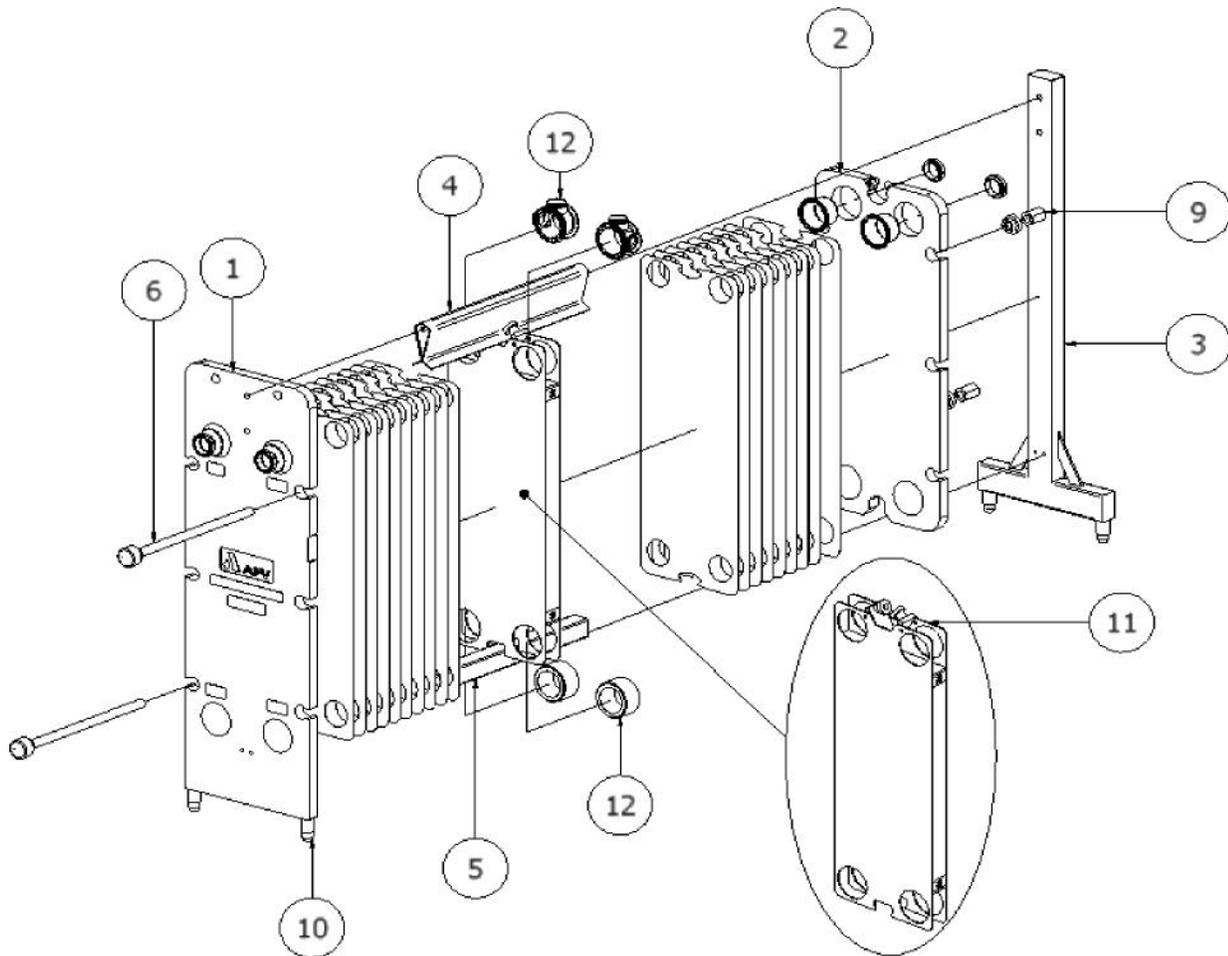


Figure 2: A typical SPX FLOW sanitary GPHE

Figure 2: Main components of typical APV sanitary GPHE.

1. Head for connections and clamping the plate pack
2. Follower for clamping the plate pack
3. End support for supporting the top and bottom bars
4. Top bar for carrying and guiding the follower and plate pack
5. Bottom bar for guiding the follower and plate pack
6. Tie bars for clamping the plate pack between head and follower
7. Flow plate (**Figure 1**)
8. Flow gasket (**Figure 1**)
9. Nut for tie bar
10. Adjustable or fixed legs
11. Connector grid for additional fluid connector bosses
12. Connector bosses

5. CONSTRUCTION

5.1. Standard Design

The APV GPHE is designed to provide maximum efficiency and cost effectiveness in handling heat transfer duties. The GPHE minimizes maintenance downtime and requires little floor space compared with other types of heat transfer equipment.

The heat transfer plate is a thin, corrugated metal sheet that transfers heat between the fluids on either side. The GPHE consists of multiple such plates, each surrounded by a sealing gasket and compressed together to form a rigid plate pack. Each plate typically includes an open port in each corner and a gasket that directs one fluid to pass over the plate surface and the other fluid to pass through. Plates are arranged in a pack to allow alternate fluids to pass over alternate plates. Frequently, certain plates in the pack include closed ports to redirect flow for the most efficient exchange of heat.

The GPHE may be a single section or multi-section heat exchanger. Each section will include an end plate, flow plates and seal plate. The end plate is a flow plate fitted with an end plate gasket and is located against the head and, in multi-section heat exchangers, is located against the divider plate or connector grid on the follower side. The seal plate is a flow plate fitted with a flow gasket and is located against the follower and, in multi-section heat exchangers, is located against the divider plate or connector grid on the head side. The flow plates, fitted with a flow gasket, are located between the end plate and seal plate.

As an example, the cold fluid (blue) enters and leaves the plate on the left side and the hot fluid (red) enters and leaves the plate on the right side (**Figure 3**).

5.2. Frame

The plates are compressed to a predetermined dimension by the tie bars between two thick metal covers: a stationary cover (head) and a moveable cover (follower). Connections for the fluid inlets and outlets can be made on either cover. The plates are supported and guided by the top bar and bottom bars. A column supports one end of the top and bottom bar (**Figure 4**).

Industrial GPHE's are secured to the ground or mounting surface by flat mounting pads (feet). Typically, two feet are attached to the head (very small GPHE's use one foot at the head), and one or two feet are attached at the end support.

Industrial or sanitary GPHE's that are installed on a level surface are not fully drainable. After the fluids are evacuated from the GPHE, there is a small amount of fluid retention located between the bottom of the port opening in the heat transfer plate and the gasket below the heat transfer plate port opening. Sloping the GPHE downward toward the stationary cover will help facilitate draining of the retained fluid. Multi-section GPHE's may also require drains in the heat transfer plates to facilitate draining.

Sanitary GPHE's are equipped with adjustable ball feet, which provide a point contact, for levelling the plate heat exchanger to ensure the GPHE can fully drain. A sanitary GPHE that can be fully drained meets one of the requirements for stamping a GPHE with the 3-A logo.

Some of the small sanitary GPHE's do not have adjustable ball feet and are only offered with industrial type feet. These GPHE's can be sold with a 3-A logo provided the following conditions are met for leveling and sealing of the flat feet:

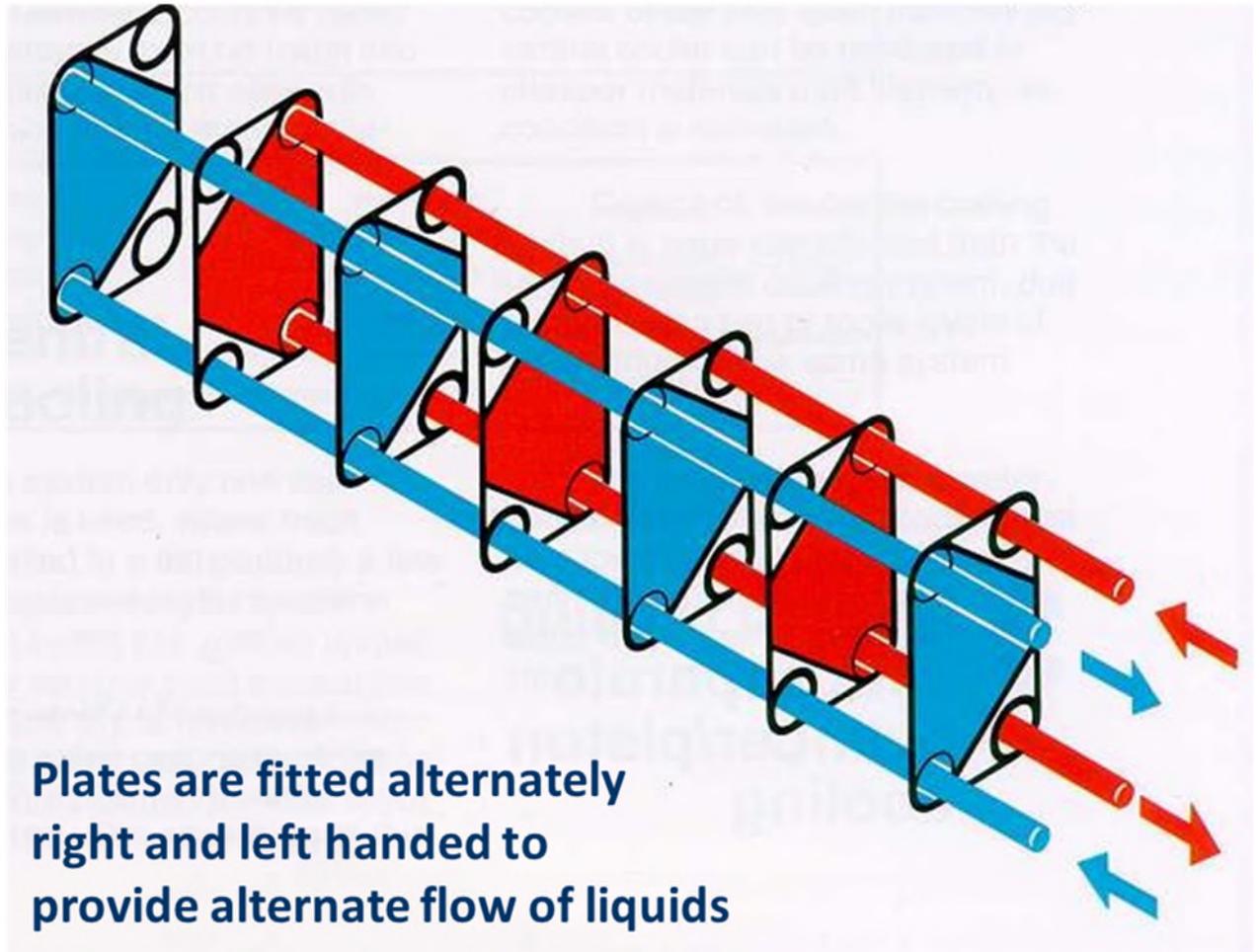
- 1) If the GPHE is mounted on an adjustable skid unit, the skid unit must be leveled such that the GPHE can fully drain.
- 2) If the GPHE is not mounted on an adjustable skid unit, the GPHE must be mounted on a surface(s) that render the GPHE level such that it can fully drain (eg: in the case of a sloping floor, the GPHE should be mounted on raised supports whose top surfaces are coincident with each other).
- 3) The full perimeter of the feet/pads must be sealed such that liquid ingress is prevented for GPHE's provided with flat mounting pads (feet). This requirement is applicable regardless of the mounting surface such as a skid framework, raised supports or the floor.

When plate heat exchangers are opened for maintenance, the follower moves back along the top bar to allow full access to each individual plate. Divider plates and connector grids also move freely on the top carrying bar to provide easy access to individual plates.

APV frames used in industrial duties are fabricated in carbon steel and are finished with a heavy duty chemical resistant paint. Industrial frame connections may be studded with various lining materials or nozzles. The nozzles are fabricated in carbon steel, stainless steel, or alternate metals. Connection types may be weld neck or specialty flanges. Sanitary unions may also be supplied on carbon steel frames. The connection materials and types may be mixed on an individual frame.

Frames used for sanitary duties are fabricated in solid stainless steel or carbon steel that is entirely clad with stainless steel (**Figure 5**). The finish is either a number 4 polish or glass bead blast depending on the model. Standard connections are sanitary unions at all locations. Industrial fittings may be supplied when required.

Liquid flow inside the plate pack



-  Hot Fluid
-  Cold Fluid

Figure 3: Flow pattern

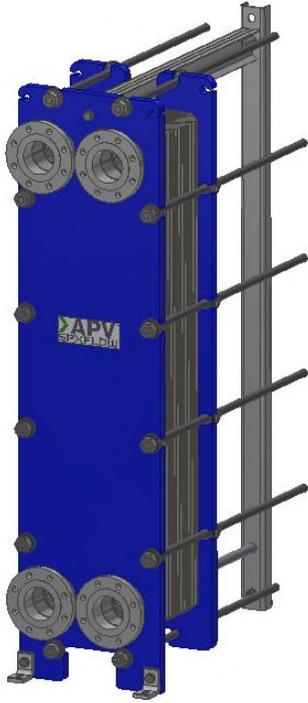


Figure 4: Industrial GPHE frame



Figure 5: Sanitary GPHE frame

Divider plates may be used to divide a heat exchanger into separate operating sections. Divider plates have no connections but may allow flow from one section to the next.

Connector grids (**Figure 6**) may be used to divide a heat exchanger into separate sections to accommodate multiple duties within a single frame. Connector grids may have up to two connections at any corner.

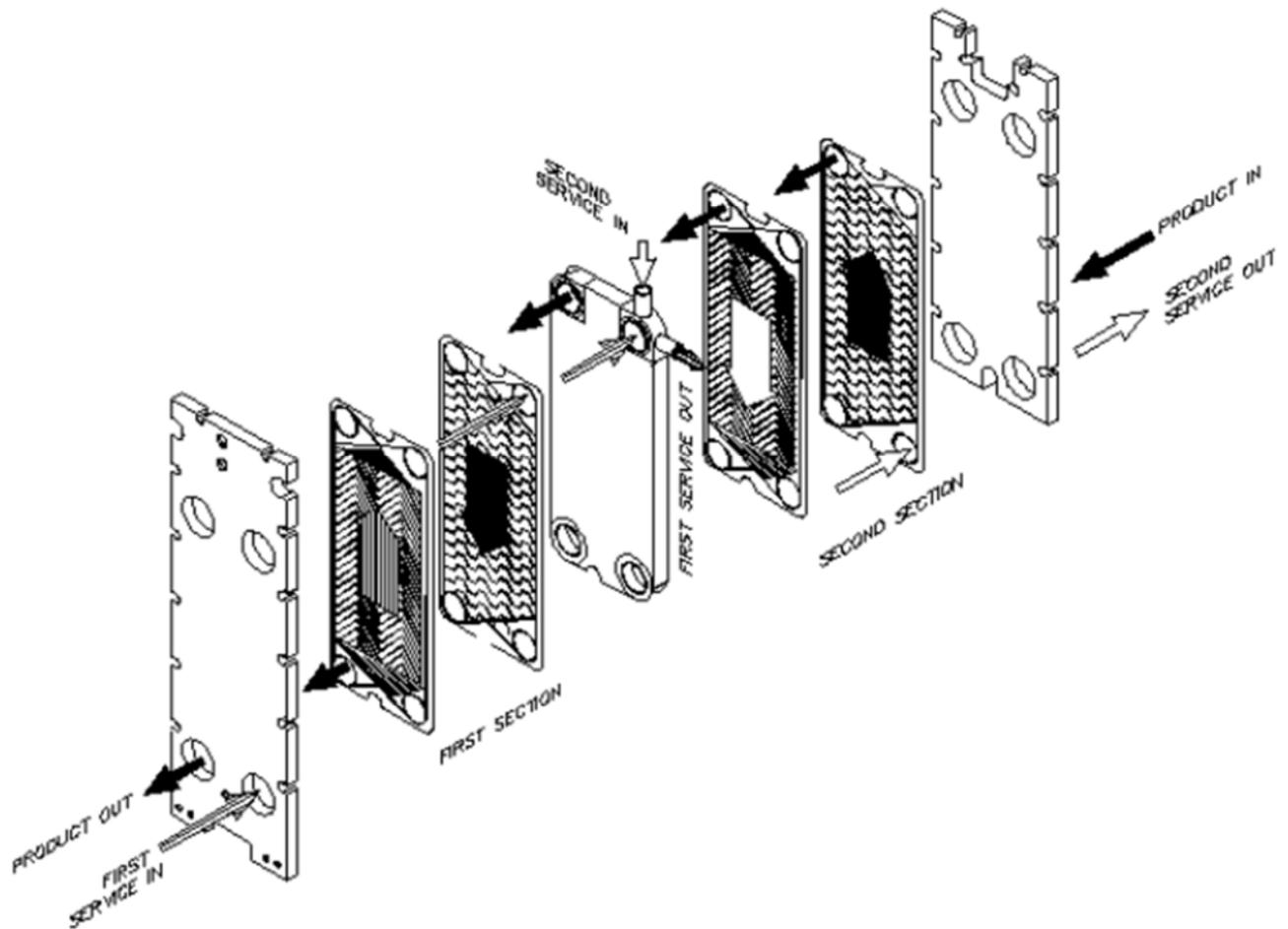


Figure 6: Connector Grid

5.3. Plates

APV heat exchanger plates come in multiple sizes and corrugation patterns. This allows the heat exchanger to be matched closely to a specific duty. The corrugations cause turbulence in the liquids as they flow in a thin stream in the passage between each plate (**Figure 7**). The plates have ports in each corner that, when arranged in a plate pack, form a manifold for even fluid distribution to the individual plate passages (**Figure 8**).



Figure 7: Turbulent Flow

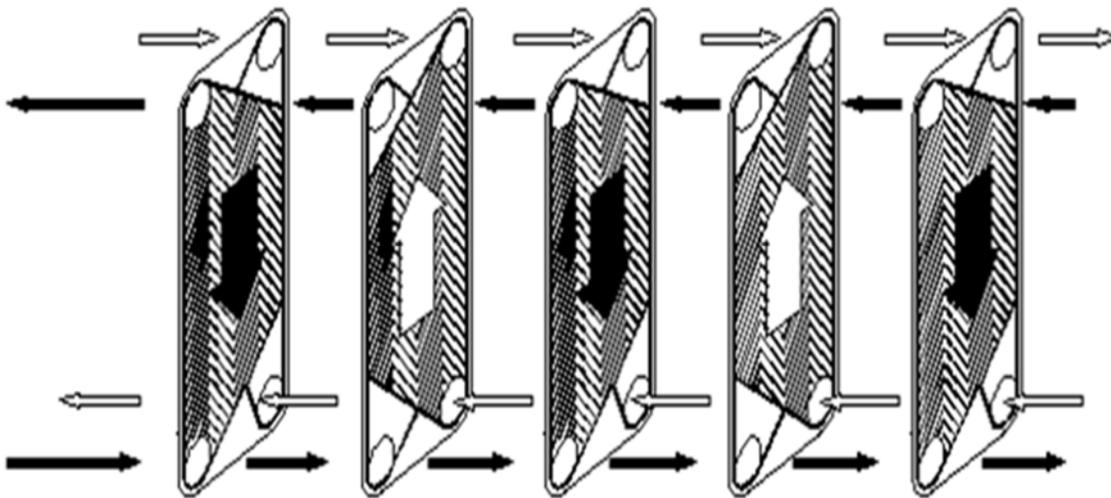


Figure 8: Countercurrent flow pattern

Plate Construction

All plates are designated as either diagonal flow or vertical flow (**Figure 9**) based on their flow pattern. Vertical flow plates have both flow inlet and outlet ports on the same side, e.g., left side for the hot medium and right side for the cold medium. For diagonal flow plates, the fluid enters in one corner and exits in the diametrically opposite corner. Plate packs consisting of vertical flow plates require only one type of plate, while packs using diagonal flow plates require a left hand and a right hand plate to form a flow channel.

Plates are pressed in thicknesses between 0.35mm – 0.9mm (0.014 in. and 0.035 in.) in a variety of materials (Plate Material section). The plate corrugation pattern alternates from plate to plate to provide support at the points of contact. One type of corrugation pattern looks like a washboard. It provides a wide gap between plates with contact points about every 1 to 3 square inch of heat transfer surface area.

Another design is the chevron pattern of relatively shallow corrugations with support provided at peak/peak contact. Alternate plates are arranged so that corrugations cross to provide contact points for every 0.2 to 1 square inch of surface. This greater density of contact points in the chevron pattern allows a higher differential operating pressure for a given plate thickness than the washboard pattern.

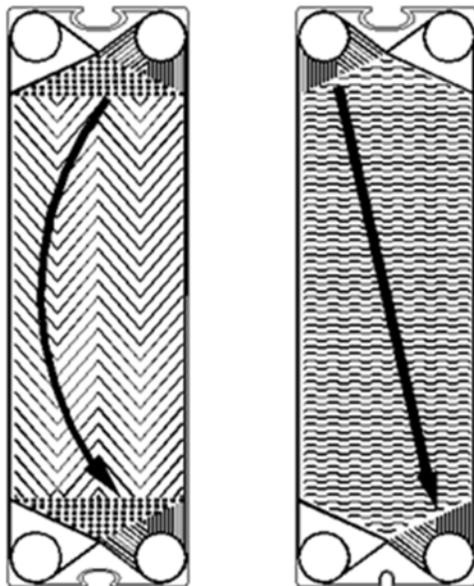


Figure 9: Vertical flow Diagonal flow

Mixing Plates

To obtain optimum thermal and pressure drop performance while using a minimum number of heat exchanger plates, plates of two or more corrugation angles may be mixed within the same frame. This is available for many APV GPHE models.

Mixing plate angles results in flow passages that differ significantly in their flow characteristics. This allows the GPHE design to be fine-tuned in a single or even multiple pass arrangement to closely match to the thermal and pressure drop requirements of the application. Examples of different plate angles are shown in **Figure 10**.

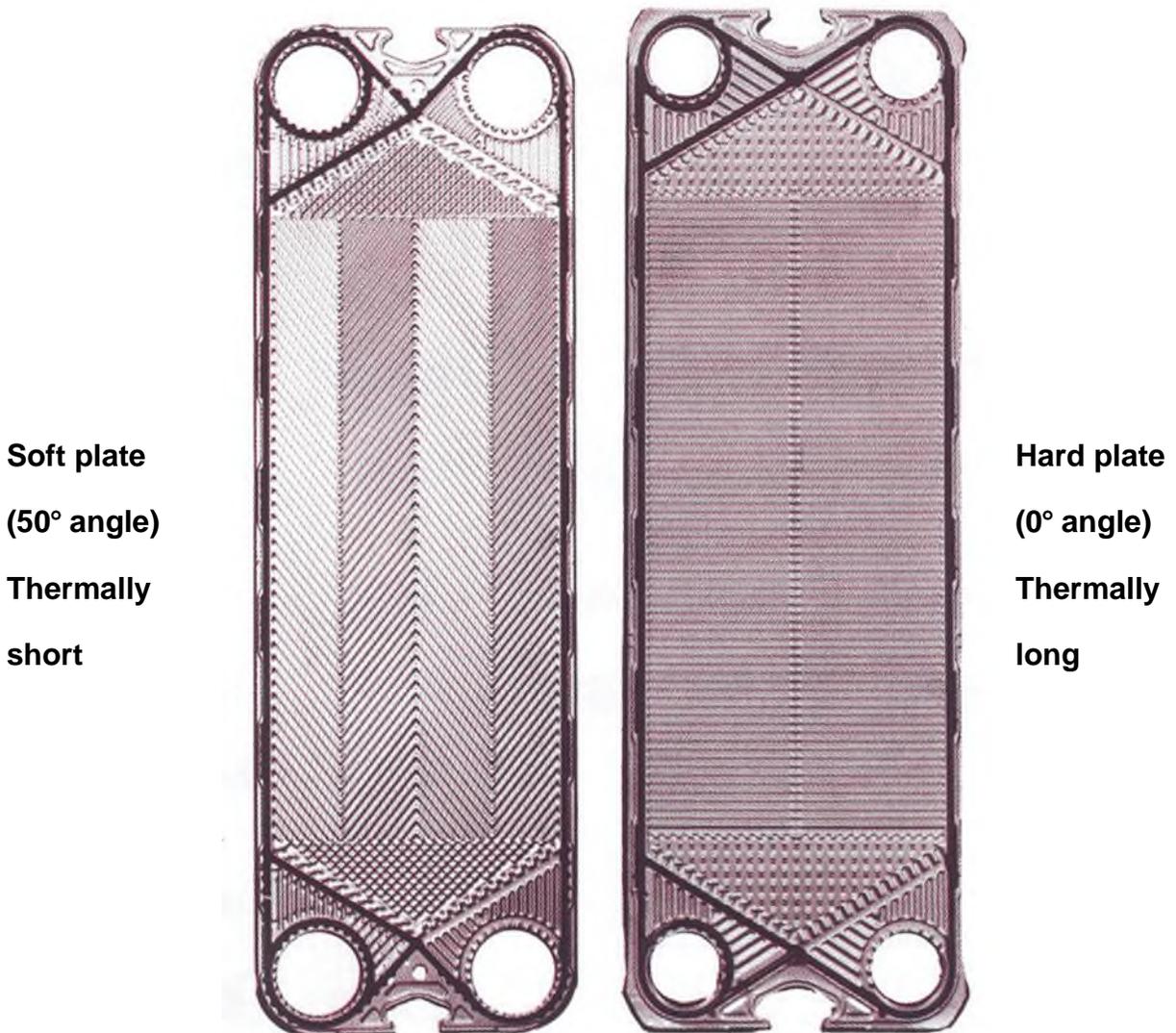


Figure 10: Plate angles

Plate Material

Heat transfer plates are pressed from 304/304L or 316/316L stainless steel, 254 SMO, or Titanium material. Other exotic alloys may be required to provide suitable corrosion resistance to the liquids being handled (please contact your SPX FLOW representative for availability of other exotic materials).

DuoSafety – Double Wall Plates

The APV DuoSafety GPHE plate is a double wall plate manufactured from two separate sheets pressed together to form a single DuoSafety plate (**Figure 11**). Each APV DuoSafety plate is equipped with a non-glue gasket, which seals and holds the halves together.

The space between the two halves of the APV DuoSafety plate serves as a safety zone in case of through-plate leaks. Should a leak occur in this safety zone (i.e., because of corrosion wear or age of seals), this space provides an extra security against mixing of the two liquids. The liquid will be discharged from the space between the two walls into the atmosphere and avoid cross-contamination.

When leakage from an APV GPHE containing APV DuoSafety plates is observed, immediate action must be taken to detect and replace the defective items before the leak can proceed through both plate walls and cause cross-contamination.

If an APV DuoSafety GPHE is fitted with a safety screen, it will be necessary to regularly remove the screen to observe that the plate pack edges have no tell-tale sign of leakage. A visual check should be made at least every 3 months.

WARNING

Leakage from an APV DuoSafety plate is always the early warning for the user to act.

Note: APV DuoSafety plates use special gaskets which can be confused with gaskets intended for single plates. Please confirm with SPX FLOW that you have the correct gaskets.

Welded Plate Pairs

An APV welded plate pair is a right- and left-hand vertical flow plate laser welded together to form a pair. This welded plate pair system is particularly suitable for use with refrigerants such as ammonia and freon or with other aggressive liquids that would otherwise attack the gaskets in a conventional heat exchanger plate.

When the welded pairs are installed in a frame, each pair is sealed to the next pair by elastomeric seals (**Figure 12**).

Note: An APV welded plate pair cannot be separated for inspection and cleaning. It is, therefore, important to prevent fouling and clogging of the welded passage. If fouling in

the welded passage cannot be prevented, then a cleaning solution must be circulated. It is recommended that you contact a supplier of cleaning agents for advice.

⚠ DANGER

The welded and gasketed chambers of an APV welded plate pair may have different pressure and fluid capabilities. Ensure the fluids are connected correctly.

⚠ CAUTION

APV welded plate pairs are not suitable for sanitary duties where organic fouling is expected, for example, dairy products.



Figure 11: DuoSafety plate

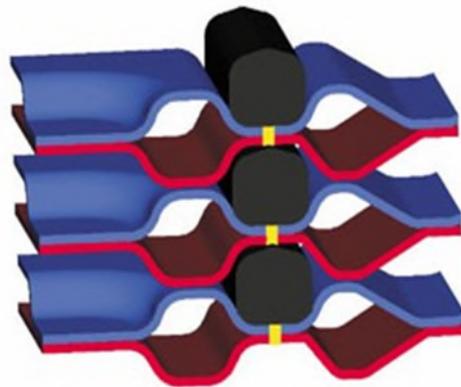


Figure 12: Laser welded plate

5.4. Gaskets

The seal between the plates is achieved by a single or multi-piece gasket around the perimeter of the plate and a double gasket around the two through ports. The double gasket separates the port from the heat transfer area with a double barrier. The space between the double gasket is vented to atmosphere to prevent cross contamination (**Figure 13**). Multi-piece gaskets are addressed in **Appendix 1**.

Interlocking Gaskets

APV Plate Heat Exchanger plates have interlocking gaskets with upstanding lugs and scallops evenly spaced around the outside edges. These scallops ensure that there are no unsupported portions of the gaskets and, in combination with the patented form of the pressed groove, provide mechanical plate-to-plate support for the sealing systems.

The upstanding lugs (**Figure 14**) maintain plate alignment in the plate during plate pack closure and operation. The groove form provides 100% peripheral support of the gasket, leaving none of the material exposed to the outside. In addition, the gasket exposure to the process liquid is minimized by the full depth plate gasket groove.

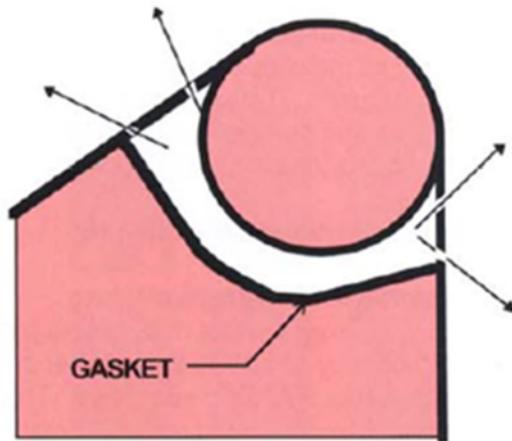


Figure 13: Bridge / Port gasket

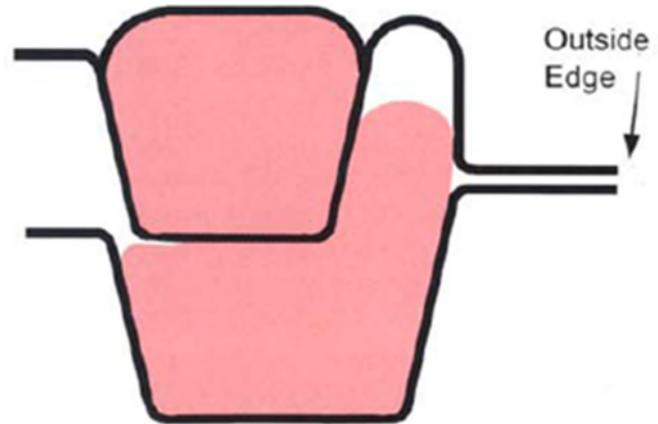


Figure 14: Interlocking gasket

Gasket Materials

Various gasket materials (**Table 1**) are available as standard which provide chemical and temperature resistance coupled with excellent sealing properties. Other gasket materials are available for special applications. Gasket material selection must take into consideration the chemical composition of the fluids involved as well as the operating conditions.

MATERIALS	APPLICATION
NBR	General purpose material for aqueous and fatty duties
EPDM	High temperature general purpose material for chemical and steam applications
Paraflo (FKM)	Mineral oils, acids, steam, and hot water at high temperatures
Paradur (FKM)	Organic solvents, chemicals, and sulfuric acid
Paraprene (Neoprene)	Refrigeration duties with ammonia and freon

Table 1: Gasket materials and applications

Gasket Attachment

APV Plate Heat Exchanger gaskets are attached to individual plates by one of two methods, glued or clip in. The glued in gaskets are attached by a thermoplastic adhesive which is heat cured for maximum strength.

5.5. Connector Grid and Bosses

The connector grid divides the plate heat exchanger into separate sections that may operate independently. The connector grid is equipped with removable connector bosses (**Figure 15**).

The connector bosses can also form the connections between sections of the plate heat exchanger and provide external connections to and from these sections. On some models, two connections can be provided in the same connector grid boss with connections to both adjacent sections.

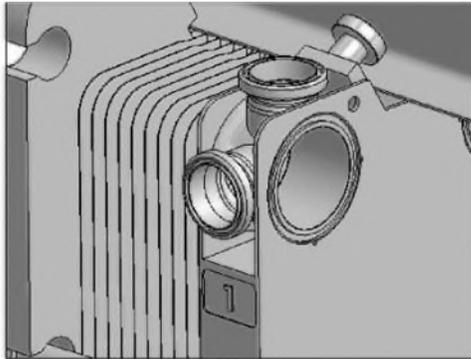


Figure 15: Grid and boss

5.6. Solid Divider Plate

A divider plate (**Figure 16**) is typically a solid plate between 6mm and 10mm (1/4 in. – 3/8 in.) thick. The divider plate has the same outer shape as the flow plates. A divider plate is used to divide a heat exchanger into two separate operating sections and have no external connections but may allow flow from one section to the next through their ports.

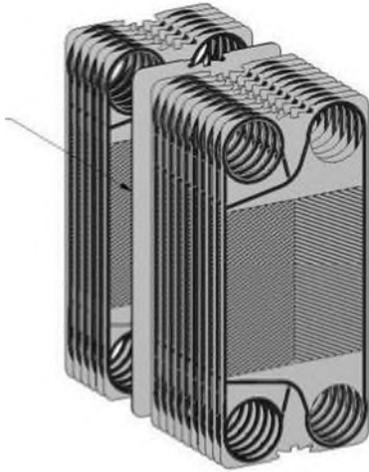


Figure 16: Divider plate

6. DRAWINGS

6.1. Customer Drawing

A customer drawing is supplied with each APV Plate Heat Exchanger. This drawing provides detailed information concerning design specifications, operating conditions, dimensions, connections, plates and gaskets, plate arrangement diagram and key, bill of material and special notes. An example of the customer drawing is shown in **Figure 17**.

Design Specifications

The data list on the design specifications provides the key mechanical information used to design the plate heat exchanger. This includes the design code, maximum allowable working pressure and temperature, maximum and minimum pitch dimensions, heat transfer area, frame size, maximum plate capacity, weights, and liquid volume in the GPHE.

Operating Conditions

This table on the customer drawing contains the duty or operating conditions for which the heat exchanger was designed. It specifies each fluid, the flow rates, the temperatures, and the pressure drop.

Connection Schedule

The connection schedule identifies the size, material and type of each connection supplied.

Plate and Gasket List

Each customer drawing contains a summary of the plates and gaskets used for the plate arrangement. This summary includes plate types, angles, and material, and gasket type, material, and attachment method (glued or clip in).

6.2. Plate Arrangement Diagram

Configuration of the Diagram

The plate heat exchanger is designed to perform a duty (or duties) by arranging the plates in a specific sequence. This arrangement is represented schematically by the plate diagram shown on the customer drawing. The schematic shows the fluid flows by heavy lines with arrows and the plates by thin vertical lines. Plate ports that block flow (not open) are represented by small black rectangles. An example of the plate arrangement diagram is shown in **Figure 18**.

Each connection on the plate diagram is identified and labeled. The connections are also identified on the dimensioned view or the isometric view of the plate heat exchanger and the connection schedule.

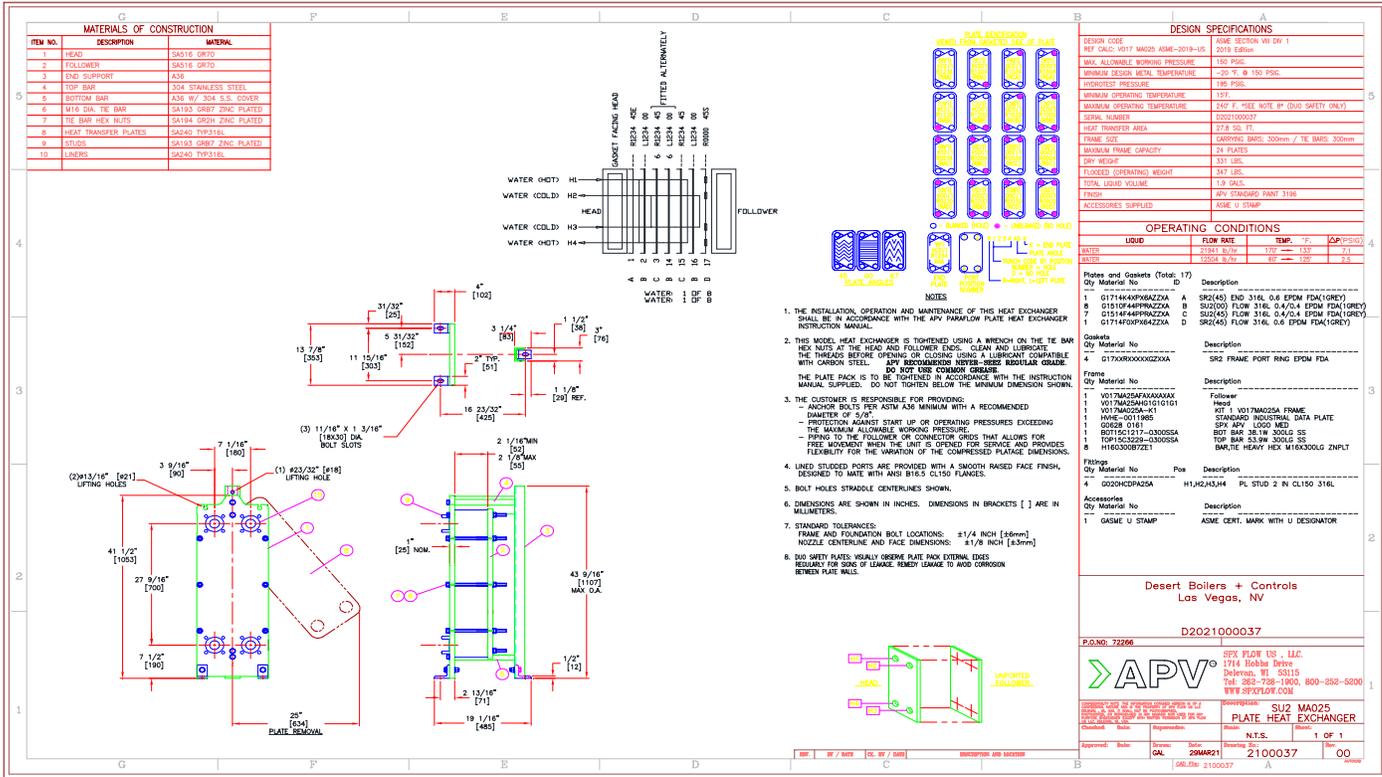


Figure 17: Typical GPHE customer drawing

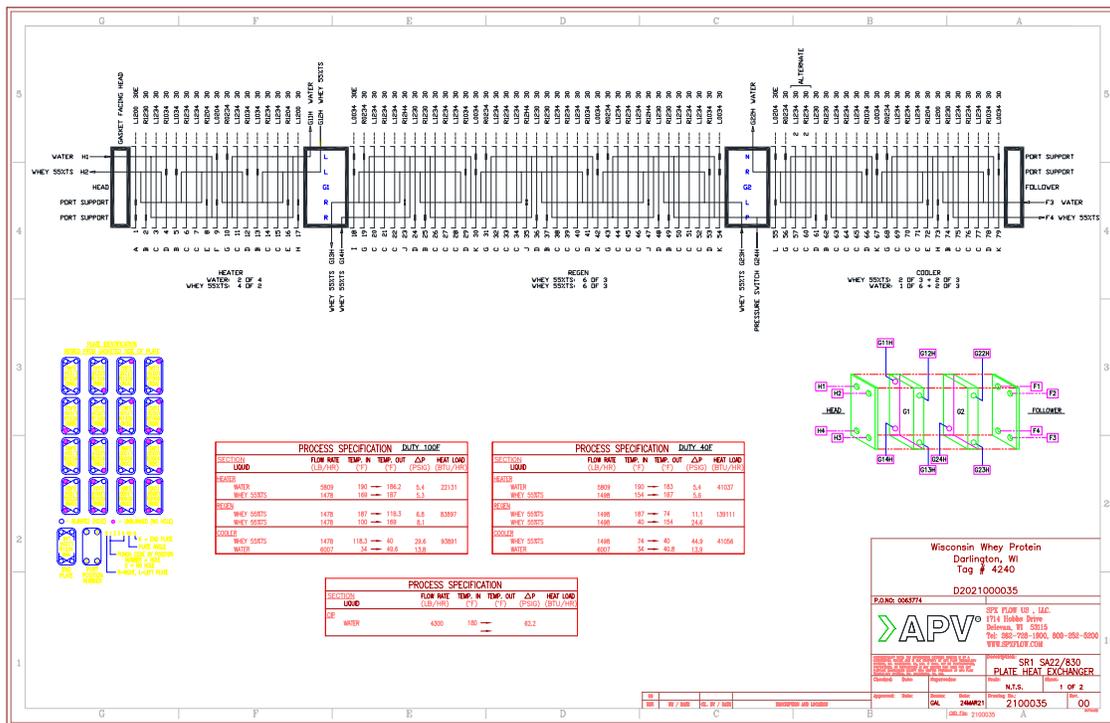
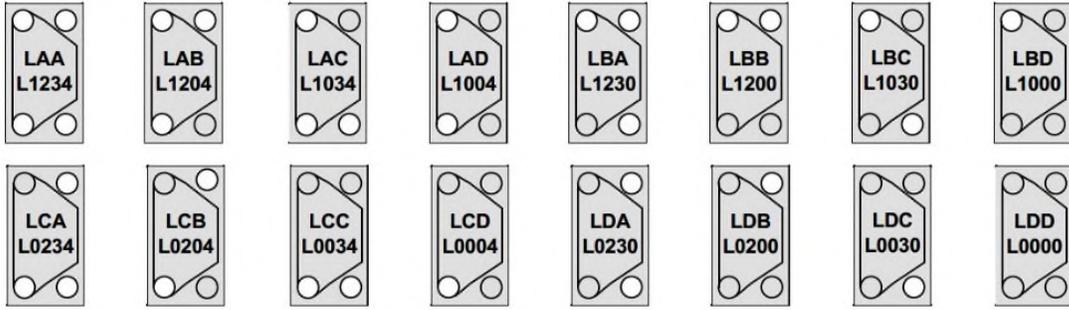


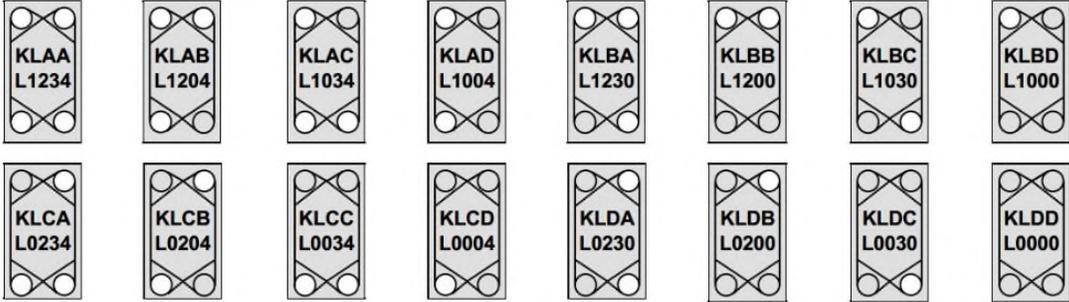
Figure 18: Typical plate arrangement diagram

Along the top of this diagram is a listing of each plate required, showing the hand of each plate (Right or Left), the direction the gaskets face (Head or Follower) and the plate punch code (blanking designation). The punch code indicates which ports are open and allow flow. Additional codes may be listed indicating plates with drains (D) and vents (V) or plates with end gaskets (K). Other symbols may be used to indicate special support pads or gaskets. The customer drawing includes a key which illustrates the punch codes. The punch codes are also illustrated in **Figure 19** for vertical flow plates and **Figure 20** for diagonal flow plates. The punch codes may vary depending on the manufacturing site.

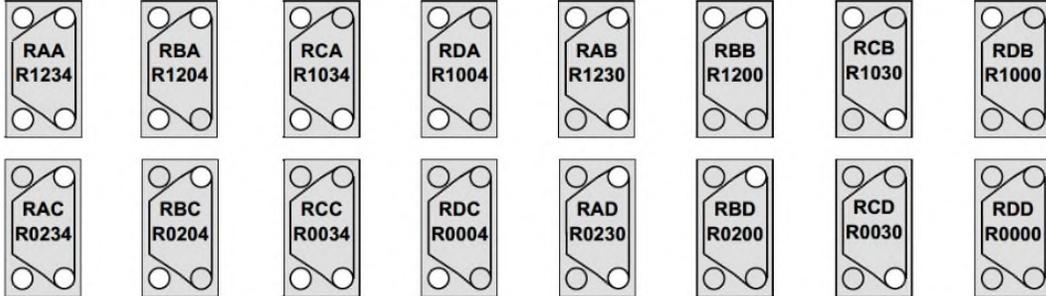
■ LEFT HAND FLOW PLATES:



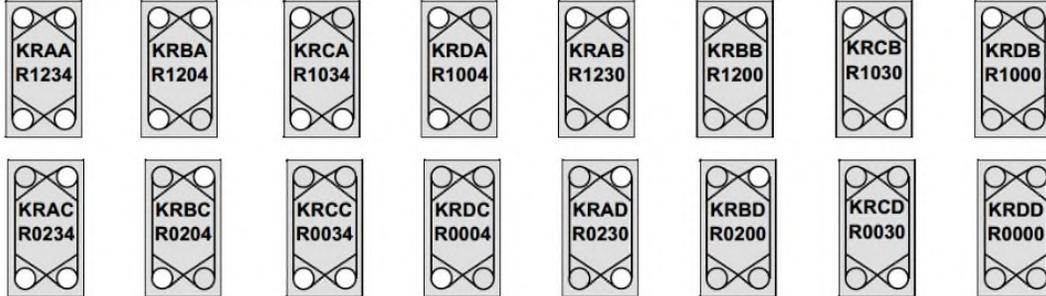
■ LEFT HAND END PLATES:



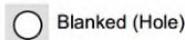
■ RIGHT HAND FLOW PLATES:



■ RIGHT HAND END PLATES:



Plates viewed from gasketed side.



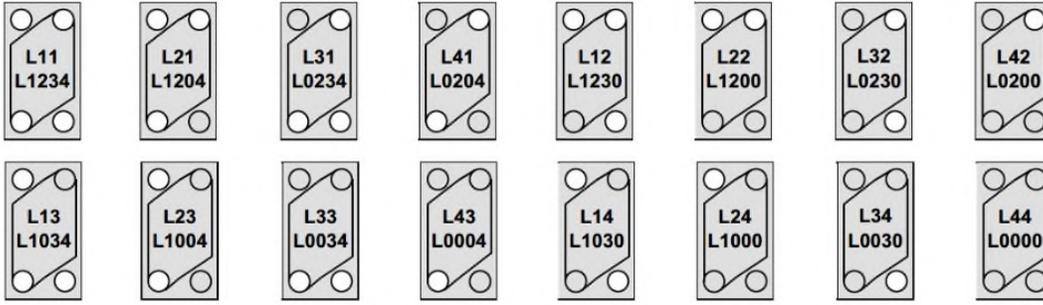
Blanked (Hole)



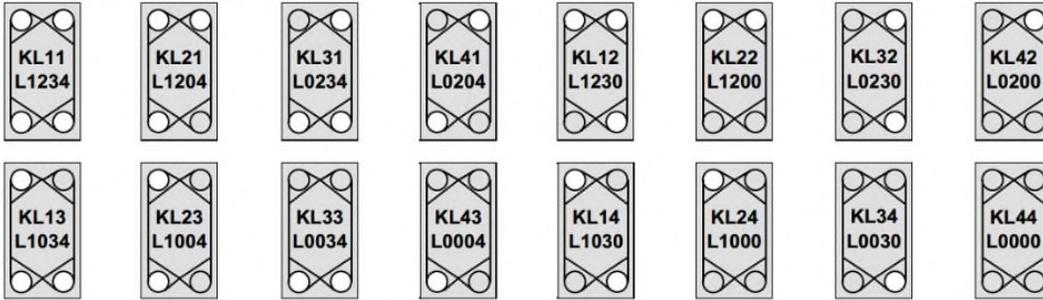
Unblanked (No hole)

Figure 19: Vertical plate punch codes

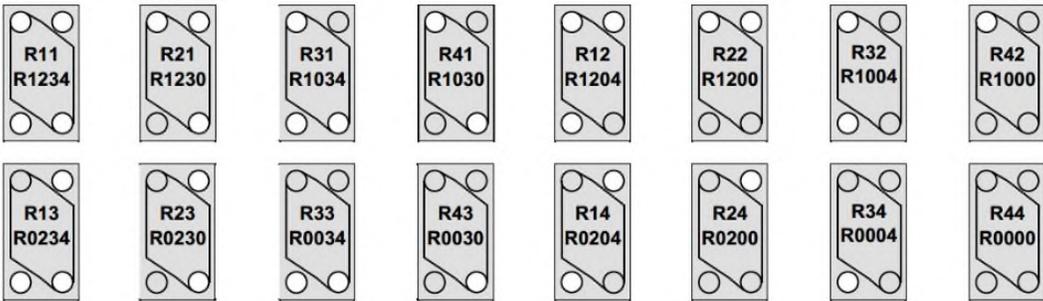
■ LEFT HAND FLOW PLATES:



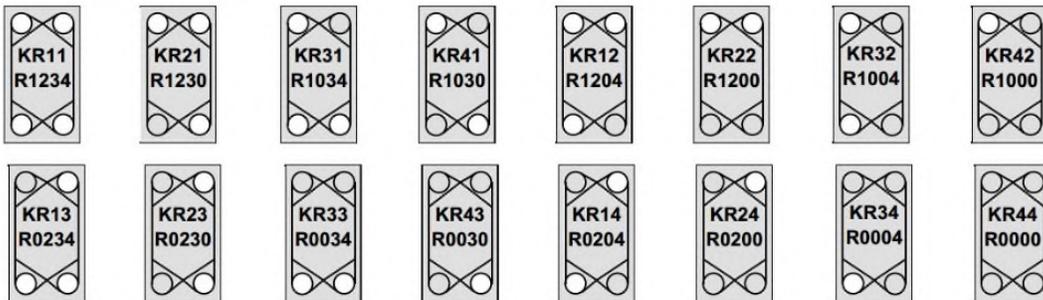
■ LEFT HAND END PLATES:



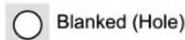
■ RIGHT HAND FLOW PLATES:



■ RIGHT HAND END PLATES:



Plates viewed from gasketed side.



Blanked (Hole)



Unblanked (No hole)

Figure 20: Diagonal plate punch codes

The plate punch code will use a five character code as shown in **Figure 17** or **18**. The obsolete three and four character codes are shown for reference. The connection positions (ports) are numbered as shown in **Figure 21**. The complete plate identification number is constructed as shown in **Figure 22**:

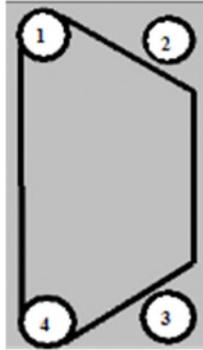


Figure 21: Position numbering

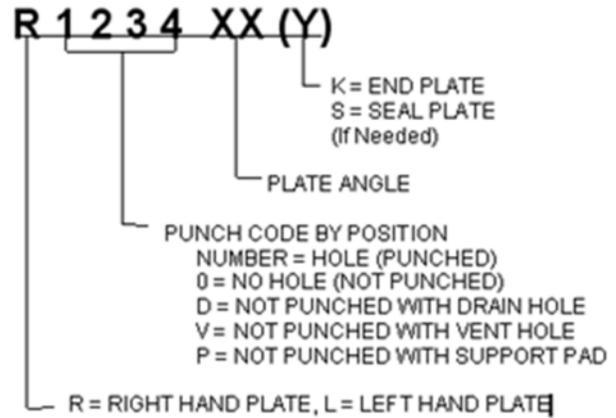


Figure 22: Plate identification number

The plate arrangement diagram and the customer drawing typically show the head or fixed cover on the left. Frame connections are labeled with an H (head) or F (follower) and a number corresponding to the connection position (**Figure 23**).

Connection grids are labeled with a four character code. The first character, “G”, indicates this is a connection grid. The second character indicates the position of the grid in the GPHE with 1 being the first grid from the head. The third character indicates the connection position on the grid. The fourth character indicates the orientation of the connection. Grid connections are labeled as shown in **Figure 24**.

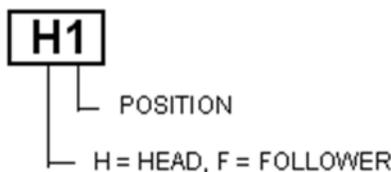


Figure 23: Head / follower labeling

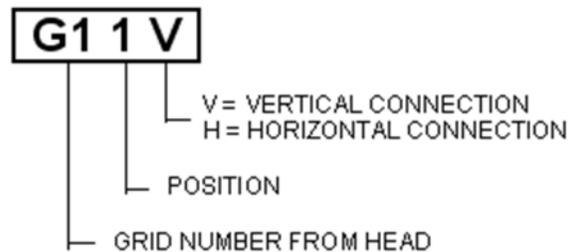


Figure 24: Grid labeling

The head, follower, and connection grid labeling are shown in **Figure 25**.

Note: All possible connections are shown in **Figure 25**. Only the connection provided will be shown on the customer drawing.

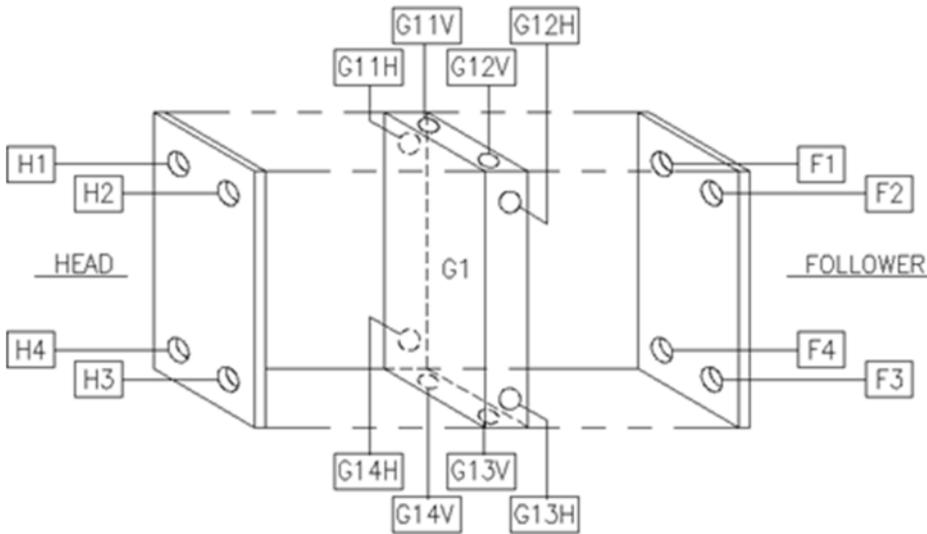


Figure 25: Head, follower, and connection grid labeling

Examples

A typical single pass arrangement using diagonal flow plates with all connections on the head (**Figure 26**).

Note: PLATES MUST BE ARRANGED ALTERNATELY LEFT AND RIGHT. FOR CONVENIENCE ON THE DRAWING, WHERE BLOCKS OF R1234 AND L1234 PLATES OCCUR, THE TOTAL NUMBER OF EACH IS GIVEN, BUT ONLY ONE OF EACH IS SHOWN.

Figure 27 shows a two-section arrangement with connections on the head, follower, and connector grid. It also shows the use of the special codes to indicate drain plates (D), support pads (P) and seal plates (S) typical for certain plates.

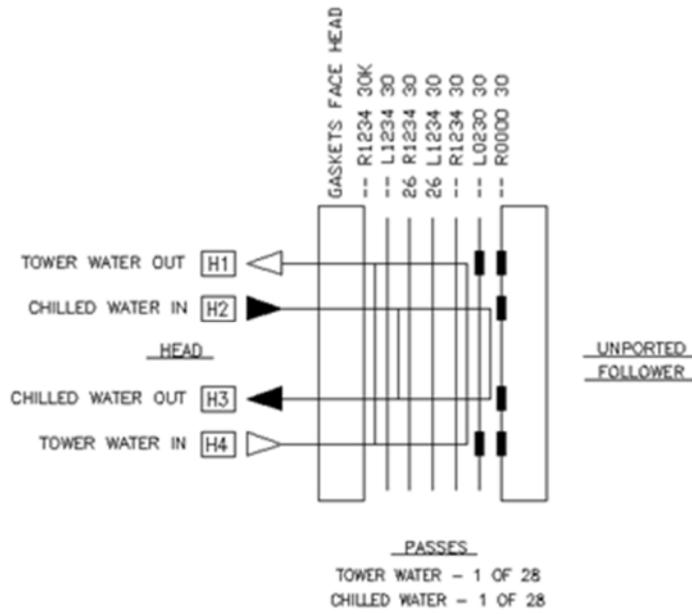


Figure 26: Single pass arrangement example

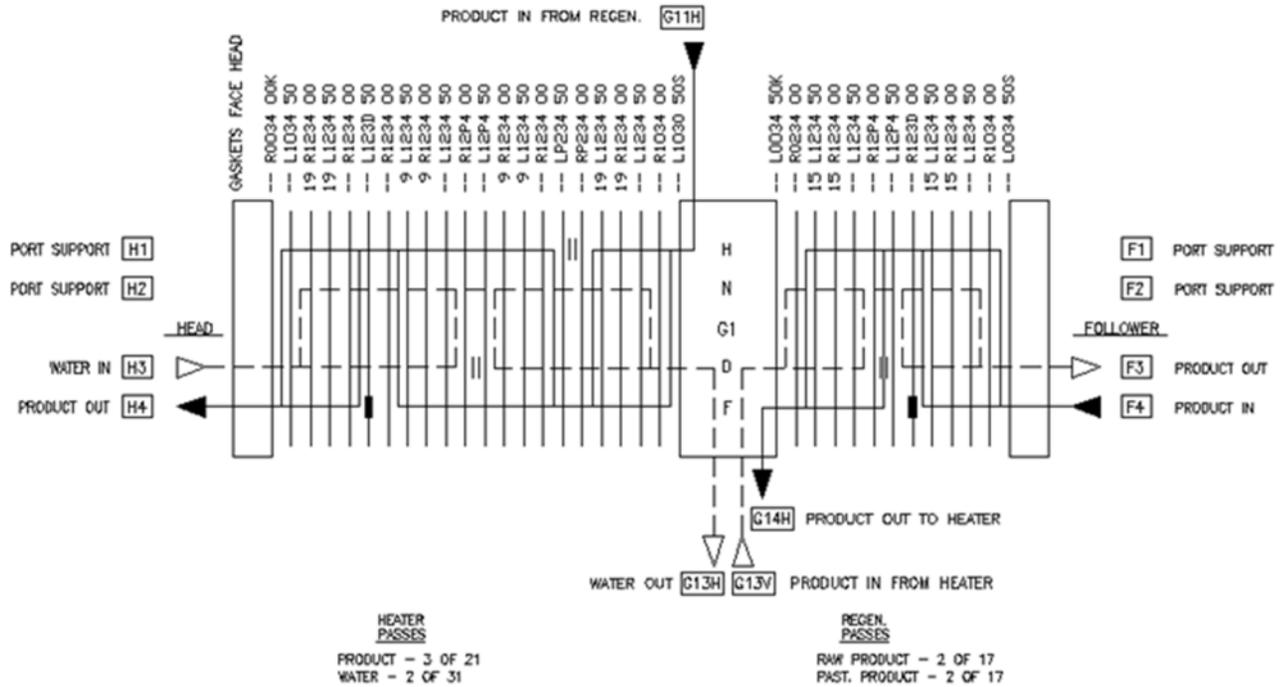


Figure 27: Two-section arrangement example

7. RECEIVING of EQUIPMENT

7.1. Receiving Check

The APV GPHE is typically shipped fully assembled, skid mounted and wrapped in protective plastic. Other packaging methods could include an open box or seaworthy packaging. See **Figure 28**.

Upon receipt of the equipment, check all received items against the packing list for damage or missing parts. Damaged or missing items must be reported immediately to the transportation carrier.

7.2. Documents

The following documents are included with the equipment (the drawings can be separate or integrated into one customer drawing):

- a. APV GPHE customer drawing
- b. APV GPHE plate arrangement diagram including a part list
- c. Installation, Operation and Maintenance Manual
- d. Nameplate copy
- e. Other order or product specific documents

7.3. Nameplate

Identification of the equipment is printed on the nameplate (**Figure 29**) and is typically mounted on the head or nameplate bracket attached to the head (may be mounted on the follower under special circumstances). When contacting SPX FLOW for service or spare parts, always reference the serial number on the nameplate.

8. INSTALLATION

8.1. Location

The heat exchanger should be installed in an area with adequate clearance around the equipment to install or remove plates and perform maintenance. Certain APV GPHE's require space in front of the head for tie bar removal. Additionally, the equipment should be located with consideration for the required pipework. Product and service lines should be designed to minimize pressure drops and must be adequately supported since APV GPHE connections are not designed to accommodate pipework loads.



Figure 28: Shipping methods

>APV®

SPXFLOW®

CERTIFIED BY
 SPX FLOW US, LLC
 1714 Hobbs Dr. Delavan, WI 53115
 UNITED STATES
 TEL. (800) 252-5200

SERIAL No. YEAR BUILT

PLATE ID

FRAME ID

DESIGN CODE

MAX. ALLOWABLE WORKING PRESSURE

CHAMBER AT

CHAMBER AT

MIN. DESIGN METAL TEMPERATURE

CHAMBER AT

CHAMBER AT

OPERATING TEMP: MAX/MIN

IMPORTANT:
 The instruction Manual must be strictly observed during
 installation and operation of the equipment.

FOR PARTS, SERVICE AND AFTER MARKET ASSISTANCE
 CALL 1-888-276-4321

Figure 29: Typical nameplate

8.2. Foundation

The foundation pad for industrial heat exchangers should be level and sized correctly for the outline of the frame. It must also be of adequate strength to support the full operating weight of the equipment. The overall dimensions and operating weights are listed on the customer drawing. Sanitary heat exchangers are typically installed on sloping floors.

8.3. Space Requirements

On at least one side of the plate heat exchanger there must be sufficient clearance to remove a plate from the top bar. Also, there must be adequate room to tighten or remove the tie bars and inspect the plate heat exchanger (**Figure 30**). Certain APV GPHE's require space in front of the head for tie bar removal. The follower must be free to move along the full length of the top bar (**Figure 31**). The customer drawing provides overall dimensions and plate removal clearance distance.

CAUTION

Ensure sufficient space around the APV GPHE.

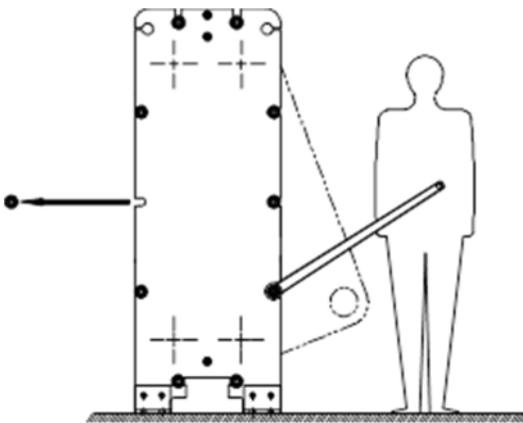


Figure 30: Required clearance space

8.4. Connections and Piping

The plate heat exchanger must be connected in accordance with the arrangement shown on the customer drawing provided with the heat exchanger. The APV GPHE models are compliant with API 667 Table 1 allowable nozzle loads and moments for the connections at the head.

Piping to the follower and connector grid(s) must be configured to allow the equipment to be easily opened for inspection and maintenance. These lines must also be sufficiently flexible to allow for small variations in the tightening dimensions and possible thermal expansion. The line flexibility may be accomplished by use of expansion joints.

If the APV GPHE has liquid connections on the follower, it is important that the compressed dimension is checked against the customer drawing before the pipes are connected. For easy disassembly and reassembly of the APV GPHE, a pipe elbow should be used at all follower connections. The APV GPHE follower and connector grid connections have little strength against pipework or nozzle loads. Therefore, avoid transfer of pipework loads and moments to the follower and connector grid connections.

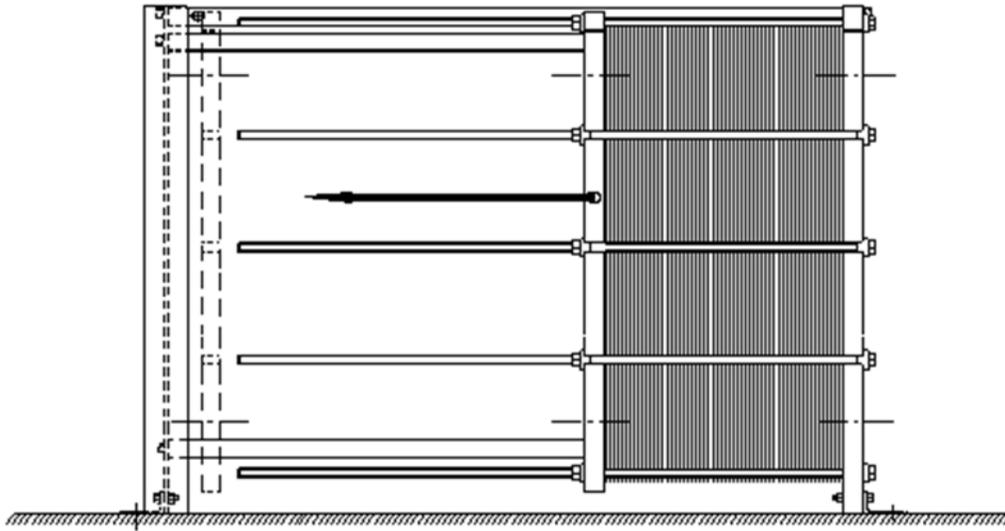


Figure 31: Follower movement

8.5. Pressure Pulsation and Vibration

Piston pumps, gear pumps, valves, etc. must not be able to transfer pressure pulsations or vibrations to the plate heat exchanger as this can cause fatigue fracture in the plates. The use of pressure dampers in the pipeline is recommended to minimize this effect.

8.6. Pressure and Temperature Ratings

The pressure and temperature ratings for a specific heat exchanger are listed on the customer drawing provided with the equipment. These ratings must not be exceeded at any time during startup or operation.

Over pressure protection must be provided if it is possible that the GPHE could experience a higher pressure than the maximum allowable working pressure.

⚠ WARNING

Do not exceed the maximum operating pressure or temperature listed on the customer drawing or damage to the heat exchanger and personnel serious injury or death may result.

8.7. Hydraulic Shock

The plate heat exchanger could be damaged by any hydraulic shock that occurs during startup or operating changes. To avoid damage, throttling valves and soft pump starts are recommended.

9. ASSEMBLY

9.1. Handling

APV Plate Heat Exchangers are shipped either fully assembled and skid mounted, or if required, unassembled in boxes. In either case, correct handling practices must be followed. The weight of an assembled heat exchanger is listed on the customer drawing. The skids and boxes are designed to be moved by standard forklift trucks of sufficient capacity.

Plate heat exchangers that must be transported via cargo ship typically require special procedures, including export packing and nitrogen purge and / or pressurization. Document GPHE IOM-PACK provides generic details.

9.2. Lifting

All APV heat exchangers are provided with lifting holes, lugs, or eyebolts to simplify lifting. The customer drawing shows their size and location. When lifting an assembled heat exchanger frame, ensure that the lifting point is approximately above the center of the plate pack (**Figure 32**). SPX FLOW will specify the use of a spreader beam when required for weight considerations. The customer may also specify that a spreader beam is required for lifting. The spreader beam requirement will be indicated on the customer drawing and a separate lifting drawing may be required.



Figure 32: Lifting point

If the APV GPHE is packed and transported lying flat on the head, care must be taken during removal from the pallet, to avoid sliding and bending of the equipment base or feet (**Figure 33**).

Note: Typically, the feet are removed from the GPHE and attached to the pallet. Caution must be used during lifting to avoid damage to the studded or nozzle connections.

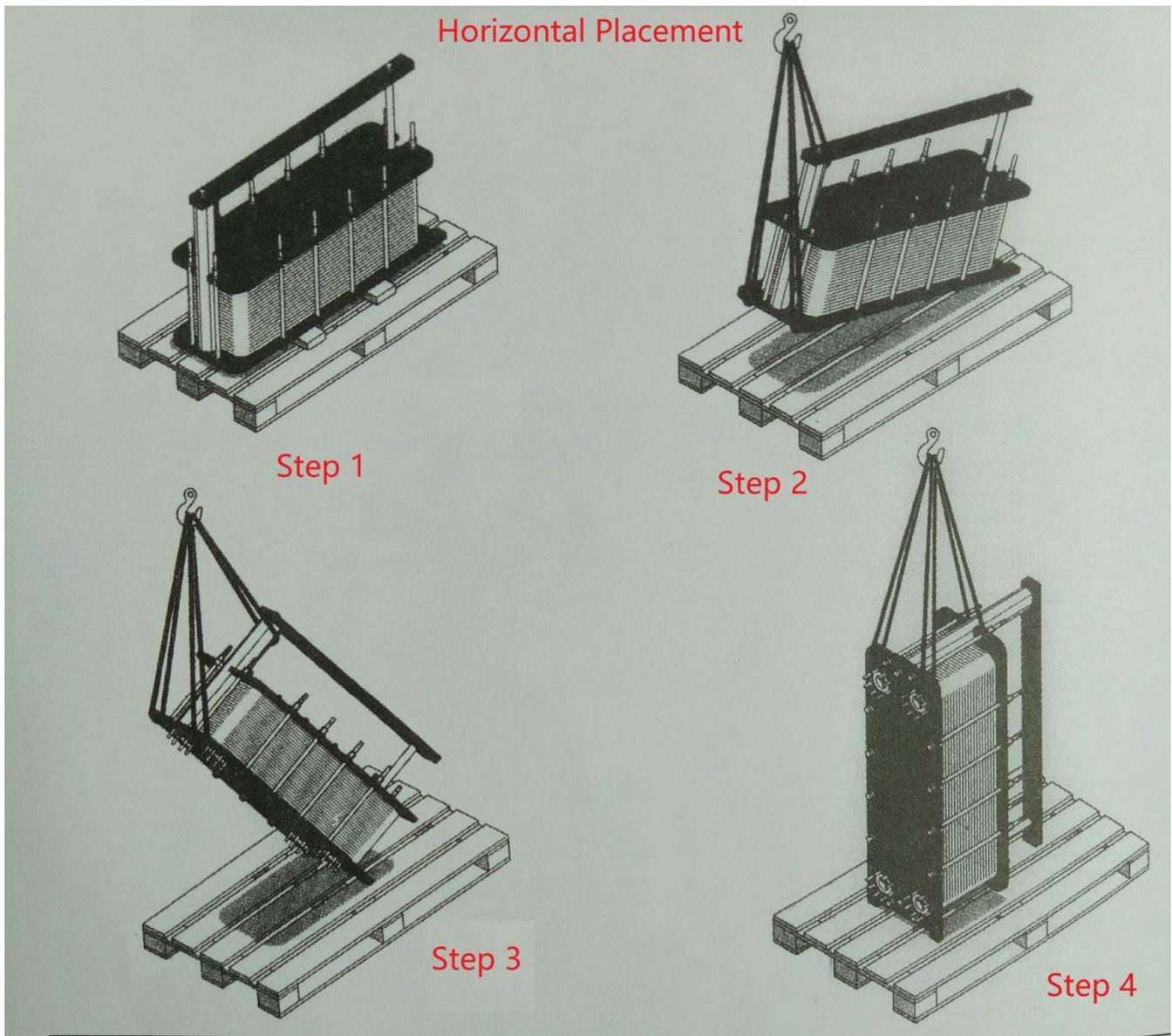


Figure 33: Lifting GPHE shipped lying flat on the head

⚠ DANGER

- The lifting equipment must be in good condition and used in full compliance with the manufacturer's specifications and limitations.
- Never exceed 120° between the lifting wires at any time (**Figure 34**).

- If the ceiling height does not allow for a safe lifting angle, dollies or creepers can be used to move the equipment.
- Always observe correct procedures for lifting and/or moving equipment. Qualified personnel should perform the lifting and moving. Personnel must follow prescribed rigging practices.
- Do not use a forklift truck to lift a heat exchanger unless it is securely mounted to a pallet or skid.

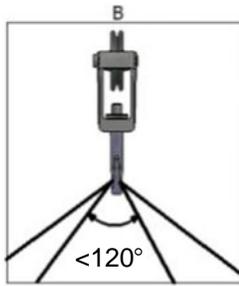


Figure 34: Lifting wire maximum angle

▲ WARNING

Lifting from the follower is not permitted since plate damage may occur.

9.3. Frame Assembly

▲ CAUTION

When assembling a GPHE, all components must be sufficiently supported to prevent damage.

The following steps are recommended to safely assemble an APV GPHE. These instructions refer to the components illustrated in **Figure 1** in Section 4.0.

It is recommended that assembly be performed at the intended final location of the GPHE. Alternatively, if the GPHE is assembled remotely from its final location, there must be sufficient space and capability (sufficiently sized forklift, overhead crane, dollies, etc.) to move the GPHE once assembled.

When assembling a heat exchanger frame (**Figure 35**), start by erecting and securing the head to the forklift. Fasten the bottom guide bar to the head using the supplied bolts and support the free end. Bolt the end support to the bottom guide bar with the bolts supplied. Typically, shorter bolts are used at the end support.

Position the follower in the frame next to the head and brace it securely while allowing it to rest on the bottom guide bar (**Figure 36**). Plain followers should be oriented with the

better face on the inside (unless there are features that mandate a specific orientation such as follower guides, labels, etc.).

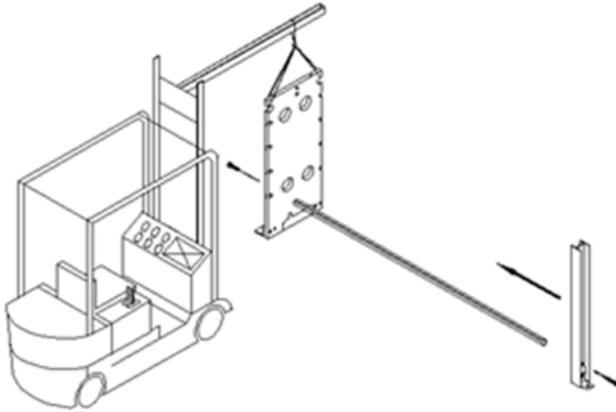


Figure 35: Erect and secure head

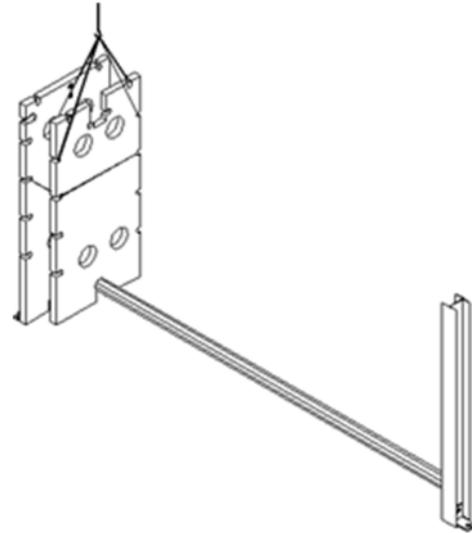


Figure 36: Position follower

Position the top carrying bar between the head and end support and using the bolts provided, fasten it securely (**Figure 37**).

Lift the follower into place and install the roller and axle assemblies if not already installed (**Figure 38**). Roll the follower back to the end support to allow plate installation.

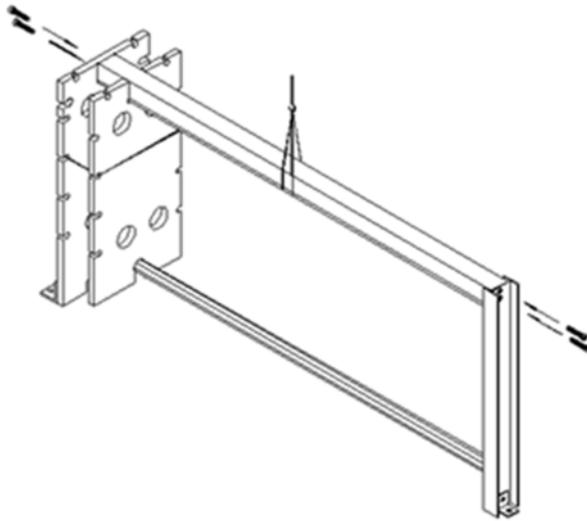


Figure 37: Position top bar

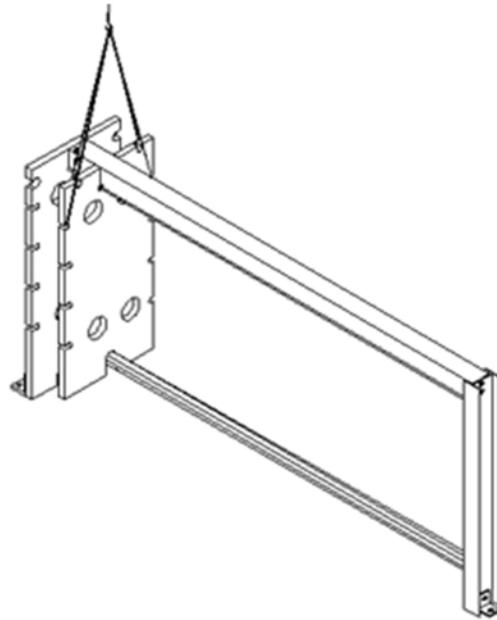


Figure 38: Lift follower in place

Place a heat transfer plate against the head to check that the port holes in the plate align with the port holes in the head. If the follower is ported, verify plate alignment with the follower in the approximate position the follower will rest on the top bar when the plate pack is at nominal pitch. The alignment may be adjusted by loosening top and bottom bar bolting and shifting the fasteners within the tolerance of the bolt holes.

9.4. Plate Installation

Verify the heat transfer plate contact surfaces on the inside surface of the head and follower and the head and follower port sealing surfaces are clean and smooth. Ensure that port rings, when required, are installed in the proper location and the sealing surfaces are clean.

The entire length (between the head and end support) of the plate hanging area of the top carrying bar and both sides of the bottom guide bar in contact with the plates must be wiped clean. Apply a white or clear, food grade grease to the cleaned areas so that the plates can slide freely.

CAUTION

Use the customer drawing or plate arrangement diagram to correctly install the plates. For simplification, whole blocks of identical left or right hand plates are shown on the customer drawing or plate arrangement diagram. The total number of each is given.

Install all plates of the type and quantity specified on the plate arrangement diagram, starting at the head end of the frame. Ensure all plates are oriented correctly and

installed in the proper sequence, that gaskets are fully or securely seated in their grooves, and there is no debris on the plates or gaskets. Clean the gasket sealing surface with a lint free cloth. Push each plate firmly against the previous one. Use special care with mechanically retained gaskets (gaskets clipped to the plates) to avoid dislodging them (**Figure 39**).

CAUTION

Do not permanently bend or scratch the plates or damage the gaskets during installation. Some plates must be carefully flexed to install them.

Note: The plate arrangement on the customer drawing indicates whether the gasket side of the plate faces the head or follower.

Perform a final pre-tightening inspection after all plates have been added. Count the number of plates at least twice, preferably three counts, to ensure the counts match the plate quantity on the customer drawing. Inspect the sides of the plate pack for alignment and continuous orientation pattern. When the plate pack has been correctly assembled, in most models, plate edges will create a honeycomb pattern.

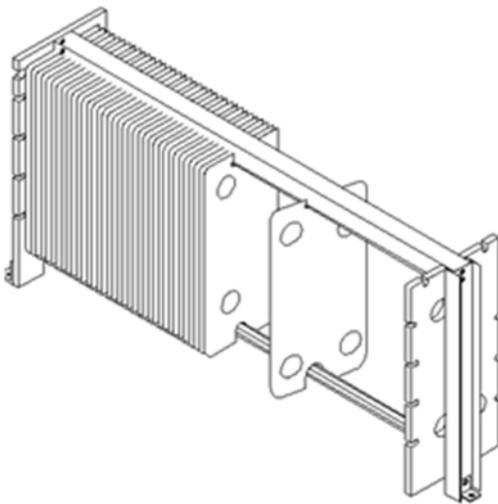


Figure 39: Plate installation

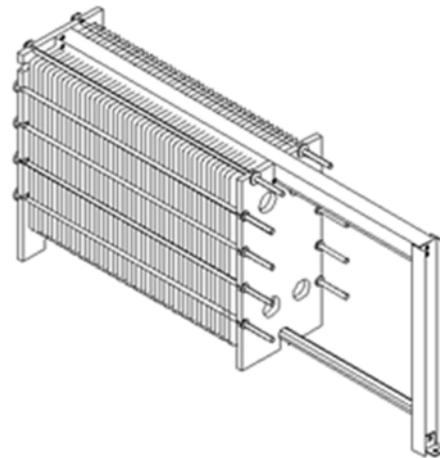


Figure 40: Assembled frame

9.5. Tie Bar Installation

When all plates have been correctly installed, move the follower to the end of the plate pack. Install the tie bars into the frame holes or key-hole slots as specified by the tightening instructions below.

Check that the tie bar threads are free from damage. Clean the tie bar threads and liberally apply the applicable anti-seize compound along the area where the nuts will travel during tightening. Also apply the compound to both sides of the plain washer under the tie bar nut. APV recommends **Never-Seez® Regular Grade Lubricant** for carbon steel tie bars and **Never Seez® Black Moly Lubricant** for stainless steel tie bars. White or clear, food grade grease is recommended for plate heat exchangers that will be used in food processing plants. Do not use standard grease as it may result in galling. **Figure 40** shows an assembled frame with tie bars installed.

⚠ CAUTION

Never-Seez® Regular Grade is not suitable for stainless steel tie bars.

9.6. Closing Tie Bar Frames

These instructions provide a method to safely tighten an APV Plate Heat Exchanger with tie bars. Correct tightening is essential for satisfactory operation and maximum gasket life. These instructions should be followed closely for both initial assembly and whenever the exchanger is closed after maintenance.

- 1) Confirm the plate installation (section 9.4) and tie bar installation (section 9.5) steps have been completed. Install tie bars 1 through 4 when the distance between tie bars 1 and 3 is less than 1200mm (4 ft.) or install tie bars 1 through 6 when the distance between tie bars 1 and 3 exceeds 1200mm (4 ft.) (**Figure 41**).
- 2) The sequence for tie bar tightening starts with the upper tie bar pair (1 and 4), then move to the lower tie bar pair (2 and 3), and if necessary, move to the center tie bar pair (5 and 6). Repeat this sequence as many times as necessary to complete step 2. Tighten the tie bars evenly in 12.5mm to 25mm (1/2 in. to 1 in.) increments until the platage dimension (thickness of the plate pack) measured at the installed tie bars is equal (+/- 3mm or 1/8 in.) and the follower is parallel to the head. The final measurement in step 2 should be approximately 10% greater than the final plate dimension specified on the plate arrangement diagram. Throughout this step, ensure the dimensions at each adjacent tie bar remain within 6mm (1/4 in.) of each other. Also, always tighten the top pair of tie bars first to keep the plates from riding up.

Note: It is important that head and follower are kept parallel during the compression work. In this regard, compression must be measured at the top, middle, and bottom sides. Measurements are to be taken close to the tie bars.

▲ WARNING

- Never tighten a GPHE which is under pressure.
 - Never tighten a GPHE while piping is connected to the follower or connector grids.
- 3) Install the remaining side tie bars located between the ports (if applicable) and tighten them evenly until the plate dimension is the same at all installed tie bars.
 - 4) Starting with the top installed pair of tie bars (1 and 4), continue tightening equally in 6mm (1/4 in.) increments until the plate dimension measures approximately 5% greater than the final dimension.
 - 5) Install the remaining tie bars above the top ports and below the bottom ports of the frame, if applicable. Starting with the top pair and working down, tighten each pair at 3mm (1/8 in.) increments. After each tightening cycle of 3mm (1/8 in.), return to the top set of bars and repeat the procedure.

Note: On heat exchangers using 2 inch, 42mm or 48mm diameter tie bars, it may only be possible to achieve 1.6mm (1/16 in.) movement during the final stages of tightening.

Note: By using hydraulic compression tools 2, 4 or 6 bolts can be compressed at the same time. The order of bolts and increments must be the same as above.

- 6) Tighten the heat exchanger to the maximum plate dimension specified on the plate arrangement diagram. The dimension must be the same at all tie bars (**Figure 42**).

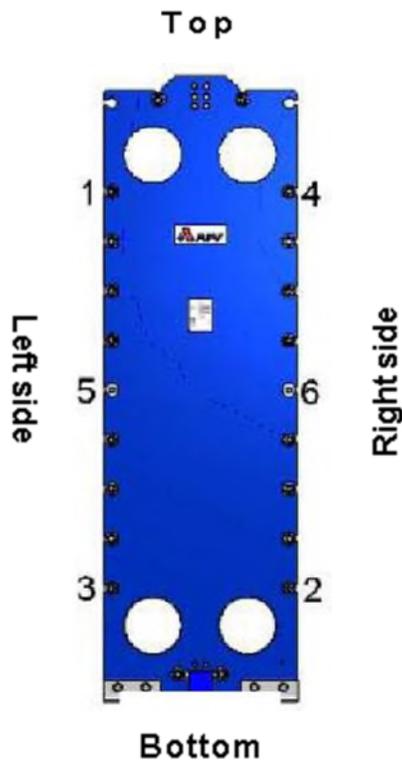


Figure 41: Tie Bar Numbering

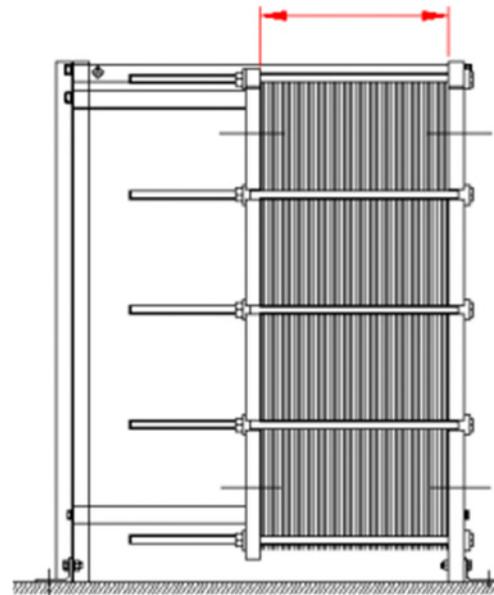


Figure 42: Step 6 – maximum platage

⚠ WARNING

Refer to the plate arrangement diagram for the maximum compressed dimension of the plate pack.

Note: Due to the o-ring type gasket seal, **the final closed dimension is determined by dimension**, not tie bar torque.

Manufacturing tolerances of the plate may result in the actual minimum platage dimension varying. Refer to your plate arrangement diagram for actual minimum and maximum dimensions.

In multi section heat exchangers, differences in pressures through the sections can set up a concertina effect where higher pressure sections open-up by a few hundredths of a millimeter per plate and lower pressure sections close down. Opening-up of higher pressure sections can cause leakage of that section. The robustness of the APV GPHE is also linked with the percentage division of plate counts in various sections.

Note: To ensure leak free operation in such applications, it is even more important that the plates contact well with each other. Well contacting plates are far more resistant to the concertina effect. Always tighten to full plate contact.

The concertina effect at minimum compressed dimension is always very small and therefore the plate pack is more rigid and robust against leakage.

- 7) Test the heat exchanger for leaks by using potable water at the desired pressure but do not exceed the test pressure specified on the customer drawing. The test may be done on each side separately (unbalanced) or on both sides (balanced) at once. Ensure the correct test pressure is used for the unbalanced or balanced tests. Make sure all air is vented from the heat exchanger before performing the pressure test.

Note: Pneumatic pressure tests using air, helium or nitrogen are not recommended. Pneumatic tests shall only be used when the APV GPHE cannot be completely drained of the hydrostatic test water and the remaining traces of test water are detrimental to the operating fluid(s). **The pneumatic pressure test shall comply with all applicable codes, standards, and regulations, including those established by OSHA.**

- 8) Leaks presenting as more than a very slow weep at low pressure will require the heat exchanger to be drained and opened per the guidelines in step 10.
- 9) If slow weep leaks occur, the heat exchanger may be further tightened and retested. It is suggested that this be done in increments of approximately 0.025mm (0.001 in.) per plate until the leak stops or the minimum dimension specified on the customer drawing is reached. **The plate pack must not be compressed below the minimum dimension without written authorization from SPX FLOW Engineering.**
- 10) If the leaks continue, mark them carefully, drain and open the heat exchanger in accordance with Section 9.7. Inspect the area of the leaks closely for damaged gaskets, plates, sealing surfaces or debris. Replace all suspect plates or gaskets, clean the sealing surface with a lint free cloth, and repeat steps 1 through 7.

9.7. Opening Tie Bar Frames

Tie bar frames may be opened safely by following steps 1 through 6 in Section 9.6 in reverse order. The tie bars must be loosened in the same sequence and amount as described in each step.

WARNING

- Never open a GPHE until the equipment is below 38°C (100°F).
- Never open a GPHE which is under pressure.
- Never open a GPHE while piping is connected to the follower or connector grids.

10. STORAGE

10.1. Short Term Storage (less than 6 months)

All heat exchangers and components must be stored in a cool and dry environment away from sunlight. They must be protected from water and debris with a waterproof cover, while also allowing for air circulation. Please refer to document GPHE IOM-GASKET for the detailed gasket storage procedure.

10.2. Long Term Storage (more than 6 months)

All heat exchangers and components must be stored in a cool and dry environment away from sunlight. They must be protected from water and debris with a waterproof cover, while also allowing for air circulation. Please refer to document GPHE IOM-GASKET for the detailed gasket storage procedure.

All connections must be closed to prevent water or debris from entering the heat exchanger. Factory installed plugs or covers may be used.

To extend the gasket operation lifetime, it is recommended to relax the gaskets by loosening the tie bars by approximately 10% of the compressed plate pack dimensions.

Please refer to document GPHE IOM-STORE for the detailed long term storage procedure. This procedure must be used when a heat exchanger will not be placed in operation within six months after shipment from the factory or when an installed heat exchanger will be out of operation for more than six months.

WARNING

- Ozone-producing equipment, salt air and other corrosive atmospheres must be avoided.
- The plate pack must be tightened to the correct pitch before commencing operation. Use the maximum pitch when new plates and gaskets are installed. For all other conditions, tighten the plate pack to the previous plate pack dimension and if leaks occur then reduce the plate pack dimension in small steps. Never tighten the heat exchanger below the minimum pitch.

CAUTION

A heat exchanger which has been in storage for more than five (5) years should be inspected by a qualified SPX FLOW representative prior to preparing it for operation.

11. STARTUP, OPERATION and SHUTDOWN

11.1. General

Prior to startup, ensure the equipment is correctly assembled and the piping connected properly. Also, check that the plates have been compressed to the correct dimension specified on the customer drawing (**Figure 42** and refer to Section 9.0).

WARNING

Correct assembly and tightening are required for safe startup and operation.

11.2. StartUp and Shutdown

CAUTION

Prior to startup, all pipework must be inspected and flushed clean. Strainers are recommended to prevent debris from entering the heat exchanger.

WARNING

The heat exchanger must never be started or operated with a closed valve in the outlet piping. Any such operation can cause leakage and irreversible damage.

At startup, if steam or another condensable vapor is used as a heating media, it must be turned on after the liquid has been introduced on the product side.

During initial startup, the heat exchanger may develop minor leaks. If these leaks do not stop when the equipment has reached operating temperatures, refer to Section 15.0 Troubleshooting.

Air in the heat exchanger will normally be carried out by the liquid flow. However, it is good practice at startup to vent air from the system at a high point in the piping. This will ensure the system is filled with liquid.

DANGER

Startup and shutdown of the heat exchanger must be undertaken slowly and smoothly. This is to avoid any pressure shocks or water hammering, which can damage the equipment or cause leakage. Pressure changes must occur gradually, at a maximum rate of 1.7 bar (25 psi) every 10 seconds. Similarly, temperature changes must be gradual and limited to less than 10°C (18°F) per

minute. Operators should monitor and record pressure and temperature changes in at least the mentioned intervals.

The system, in which the heat exchanger is integrated, needs to provide the necessary functional components to allow for the specified gradual startup and shutdown. This can be achieved with variable speed pumps and/or the correct sequence of operating valves.

After shutdown, the heat exchanger must be allowed to cool naturally to ambient temperature. If steam is used as a heating media, it must be shut off first. In cooling duties, the cooling liquid must be shut down first to avoid freezing of the product. All liquids must be drained from the heat exchanger after shutdown to prevent precipitation of products or scale buildup. In the case of corrosive media, it may also be necessary to flush with clean, non-corrosive water.

If the heat exchanger will be out of operation for six months or longer, it must be correctly prepared for storage. See Section 10.2 for instructions.

Figure 43 shows an example of a typical system configuration for a liquid/liquid (Cold/Hot) application. Each circuit (Cold and Hot) has a similar configuration. The exact piping, control arrangement, design and installation is outside of SPX FLOW's scope and responsibility.

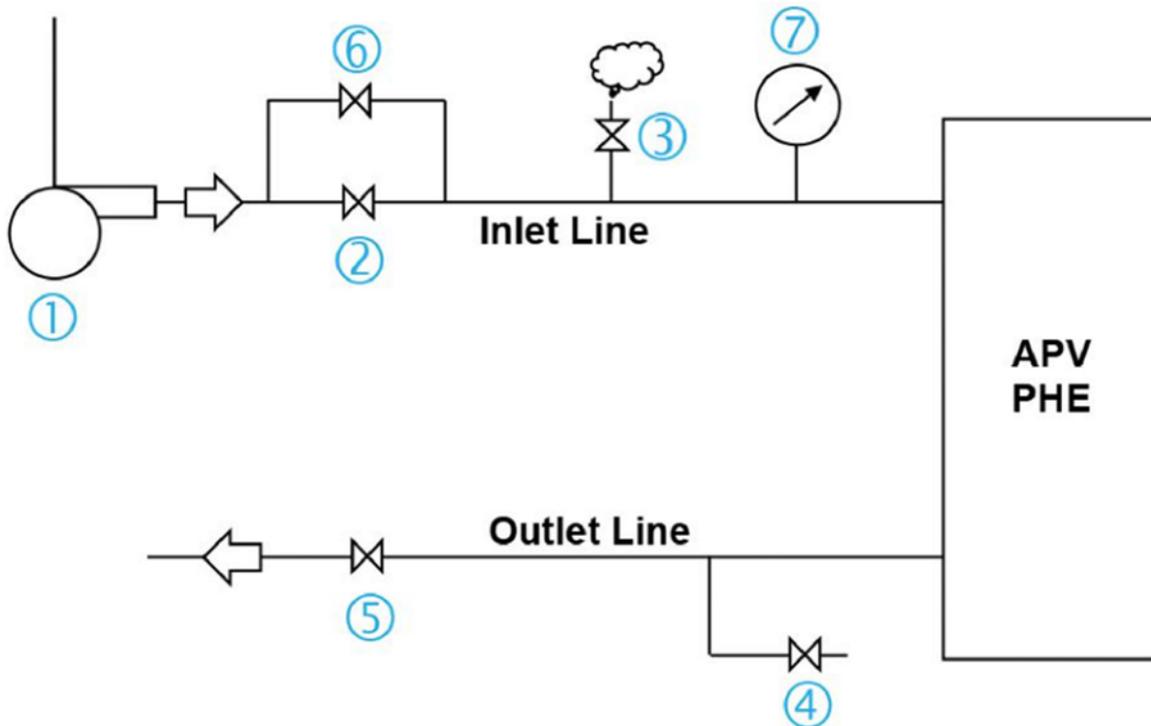


Figure 43: Typical liquid / liquid system configuration components

1. Pump, centrifugal
2. Inlet valve
3. Vent valve (always on top line)
4. Drain valve
5. Outlet valve for isolation
6. Bypass valve
7. Pressure gauge at inlet of the GPHE

Acceptable startup and shutdown procedure for the configuration in **Figure 43**:

Before startup, check that these conditions are met.

VALVE	COLD MEDIUM	HOT MEDIUM
Inlet valve (2)	Closed	Closed
Outlet valve (5)	Open	Open
Drain valve (4)	Closed	Closed
Vent valve (3)	Partly open	Partly open
Bypass valve (6), if fitted	Open	Open

Startup process (suffix C is for Cold liquid circuit; H is for Hot liquid circuit)

STEP	COLD MEDIUM	HOT MEDIUM
1	Start pump (1C)	
2	Open inlet valve (2C) slowly, building inlet pressure at a rate of less than 1.7 bar (25 psig) every 10 seconds. Monitor (7) and record pressure in at least these intervals.	
3	Vent (3C) then close (3C)	
4		Start pump (1H)
5		Open inlet valve (2H) slowly, building pressure at a rate of less than 1.7 bar (25 psig) every 10 seconds. Monitor (7) and record pressure in at least these intervals. Temperature increase should be limited to 10C (18F) per minute. Therefore, it is necessary to increase the hot medium pressure (and flow) in small steps to comply. Seek written advice for your specific application if this temperature change restriction cannot be met.
6		Vent (3H) then close (3H)
7	Continue steady state operation	Continue steady state operation

ShutDown Process (suffix C is for Cold liquid circuit; H is for Hot liquid circuit)

STEP	COLD MEDIUM	HOT MEDIUM
1		Close valve (2H) slowly, reducing pressure from operating to atmospheric at a rate of less than 1.7 bar (25 psig) every 10 seconds. Monitor (7) and record pressure in at least these intervals. Temperature drop should be limited to 10C (18F) per minute.
2		Stop pump (1H)
3	Close valve (2C) slowly, reducing pressure at a rate of less than 1.7 bar (25 psig) every 10 seconds. Monitor (7) and record pressure in at least these intervals.	
4	Stop pump (1C)	
5	Drain any media that could cause corrosion or fouling during non-flowing condition through drain valve (4C).	
6		Drain any media that could cause corrosion or fouling during non-flowing condition through drain valve (4H).

For partial shutdown, the same limits for pressure and temperature changes apply.

Note: This is just one example of a possible system configuration. Other circuits (i.e., for refrigeration applications – see document GPHE IOM-REFRIG, for amine applications – see document GPHE IOM-START), might require a different configuration or procedure. The system integrator is ultimately responsible for ensuring the correct components and control logic are in place, so that the heat exchanger is operated within the permissible pressure and temperature gradients specified above.

11.3. Operation

The APV plate heat exchangers are designed according to predefined temperatures, allowable pressure drops, design pressures and fluid compositions.



- Exceeding the design temperatures and pressures can be harmful to the equipment and personnel and must be avoided.

- Sudden changes in the operating pressures and temperatures must be avoided. Shock cooling of the APV GPHE may cause leakage, due to sudden contraction of the sealing gaskets.
- Temperature and pressure cycling must be limited to the rate changes specified in Section 11-1 (startup and shutdown).

Deviations from the designated fluid composition may cause corrosion of the plates and damage of the gaskets, even if the deviations occur over relatively short time periods.

Before starting operation, you should ensure that the media do not exceed the corrosion resistance level of the materials chosen for your heat exchanger. Even unprocessed water may contain a sufficiently high level of corrosive content (e.g., chloride content) that may attack the plate surface. A high temperature may accelerate the corrosion process. Visit www.spxflow.com for more info.

Once normal operating conditions are reached, temperature and pressure drops must be regularly checked. Increasing pressure drops and/or falling temperature may indicate reduced performance of the heat exchanger. This must be investigated to determine the cause. See Section 15.0 Troubleshooting

For DuoSafety GPHE's, regular external leakage inspection must be made of the plate pack edges, to look for leaks as they will start quite small and can quickly evaporate. Where CIP-cleaning is carried out at regular intervals, check approximately 30 minutes after starting the circulation of hot CIP liquid, thoroughly inspecting the floor below the plate pack for any drops. Leakage is more easily detected if the area under the plate pack is dry before the inspection procedure starts. If the floor is not dry, an indicator liquid must be sprayed on the floor and on the plate pack to detect product or CIP drops from the heat exchanger.

12. MAINTENANCE

DANGER

Never open a pressurized GPHE.

WARNING

- Never open a GPHE until the equipment is below 38°C (100 °F).
- Never open a GPHE while piping is connected to the follower or connector grids.

12.1. Disassembly

Close the shut-off valves and drain the heat exchanger as much as possible. Disconnect any pipes connected to the follower or connector grid. Measure and record the compressed dimension of the plate pack before loosening the tie bars.

Loosening and tightening of tie bars in the APV range of plate heat exchangers can normally be accomplished with ratchet wrenches/ spanners. Larger plate heat exchangers may require hydraulic equipment or pneumatic/ electric torque converters.

WARNING

As for any bolted vessel, bolts must not be slackened or tightened indiscriminately. Use a sequence that balances the opening on the right and left sides of the heat exchanger throughout the process.

In the process below, dimension X is the initial compressed dimension of the plate pack (**Figure 41**).

- 1) Loosen all tie bars in 3mm (1/8 in.) increments to “X + 5%”. At this point the tie bars above and below the ports may be removed, if applicable.
- 2) Loosen the remaining tie bars in increments of up to 6mm (1/4 in.) to “X + 10%”.
- 3) Remove all tie bars except 1 to 4 for plate heat exchangers where the distance between tie bars 1 and 3 is less than 1200mm (4 ft.). Loosen tie bars 1 to 4, moving in that order, in increments of max. 12.5mm (1/2 in.) until all tie bars become loose.
- 4) Remove all tie bars except 1 to 6 for plate heat exchangers where the distance between tie bars 1 and 3 exceeds 1200mm (4 ft.). Loosen tie bars 1 to 6, moving in that order, in increments of max. 12.5mm (1/2”) until all tie bars become loose.
- 5) When using hydraulic tightening tools, ensure that each tie bar is loosened approximately equally (+/- 3mm or 1/8 in.) during opening.
- 6) When the plate pack is fully released and the tie bars removed, the APV GPHE can be opened by pushing the follower back against the end support.

DANGER

Always wear protective gloves and cut-resistant sleeves when handling plates or any other objects with sharp edges (nuts, tie bars, safety screens, etc.). See **Figure 44**.

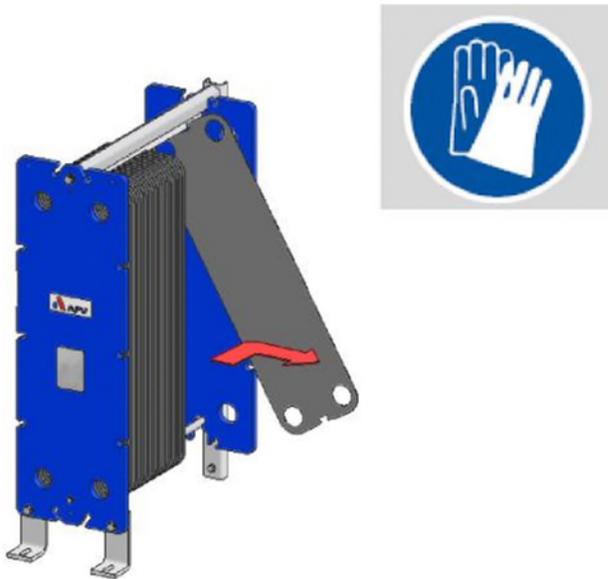


Figure 44: Precaution for removal of plates

⚠ WARNING

During maintenance, secure the follower to the end support to prevent accidental rolling.

Separate the plate pack carefully to avoid damaging the gaskets or the plates. Remove the plates by sliding the bottom portion of each plate backwards and then sideways off the top bar and then removing from the frame (**Figure 44**).

12.2. Inspection

Check the front and back of every plate for cleanliness and freedom from debris. Product build-up and scale will reduce the performance of the heat exchanger and cleaning is required - See Section 12.3.

Check each plate for cracks or holes. Some cracks may not be readily visible and will require dye penetrant inspection to locate them.

Gaskets must be thoroughly checked for cuts, flattening, cracks, brittleness, breakage, and correct fit in the gasket groove. The gasket groove in the plate must be free of distortion or kinks.

The entire gasket and sealing surfaces of the plates must be totally free of any debris since any foreign material will cause leakage and may damage the gasket. When installing clip in gaskets, careful inspection is required to be sure there is no debris or glue from previous gaskets under the installed gasket, which will cause leakage.

12.3. Cleaning

The APV GPHE can be cleaned without opening (i.e., clean-in-place, also called CIP) and manual cleaning. The purpose of cleaning is to remove deposits or trapped product on the plates.

12.4. Manual Cleaning

Manual cleaning is normally accomplished by washing the plates with a soft non-metal brush, water, and a cleaning agent (**Figure 45**).

⚠ CAUTION

Cleaning agents must not be aggressive or corrosive to the plates or the gaskets. If in doubt, contact SPX FLOW.

Cleaning agents should always be used according to safety regulations and as specified by the supplier.

It is recommended to lay the plate on a flat surface during brush cleaning to avoid the risk of bending the plate.

If the APV GPHE is heavily fouled, care must be taken to remove all debris from the gasket sealing surfaces when the heat exchanger is reassembled. Any debris will most likely lead to sealing failures. Do not forget that for glue free gaskets, gasket sealing surfaces must be checked at the top as well as bottom surface of the gasket.

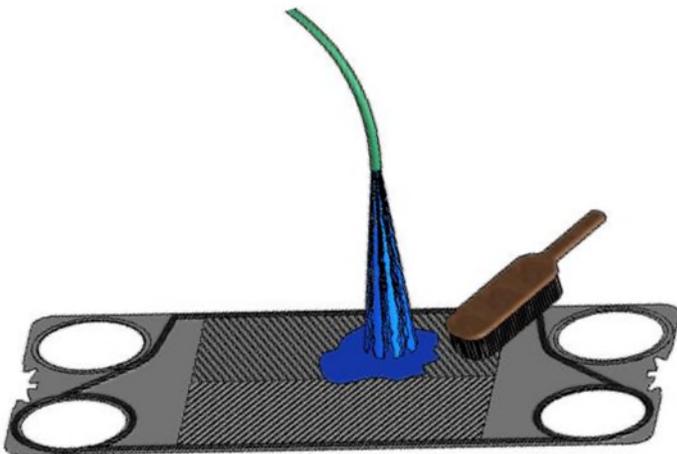


Figure 45: Manual cleaning

12.5. Cleaning-In-Place

Cleaning in place (CIP) is accomplished by circulating a suitable cleaning solution through the APV GPHE instead of opening it. CIP works best in the reverse direction of normal flow. Good results are also possible with same direction flow and at higher velocities than the product flow velocity.

The cleaning solution must be circulated at sufficient velocity to flush out the product. Higher viscosity products generally require higher velocity flushing to correctly clean.

Great care must be taken to select correct cleaning solutions and cycles to avoid damaging the plates and gaskets. Due to the large variety of cleaning needs, each user is responsible for determining the best cleaning method for their situation. It is recommended that a reputable supplier of cleaning materials be consulted for assistance. The capacities and resistance to corrosion of plate heat exchangers depend on the plate pack being kept clean.

Example of CIP-cleaning:

- Drain product residues, cooling, and heating media.
- Rinse with cold or lukewarm water.
- Circulate warm cleaning fluid solution.
- Rinse with warm water or warm water with softener added.
- Rinse with cold or lukewarm water.

In simple cases cleaning can also be affected without circulation, but by pouring a cleaning fluid solution into the system. After some time of standing, flush the solution with clean water.

If the APV GPHE is to be out of operation for a long period of time, it is advisable to empty it, separate the plates, and clean the equipment. After cleaning, lightly re-clamp the plate pack and cover it to protect from dirt and UV light. Please refer to Section 10.0 on Storage.

Determination of correct CIP system

The APV GPHE must be opened for inspection at regular intervals. This is necessary especially during the initial startup period, until experience has been gained on the effectiveness of the cleaning regime. With these inspections, it will gradually be possible to determine circulation times, temperatures, and chemical concentrations with great certainty.

Insufficient cleaning is most often due to:

- Insufficient circulation rate.
- Insufficient cleaning time or temperature.
- Insufficient concentration of the cleaning agent.

- Excessive periods of operation.

Acceptable CIP solutions

The definition of an acceptable CIP solution is brief and to the point. Fouling on the plates must be removed without damaging plates and gaskets or reducing the inherent corrosion resistance. It is important not to decompose the passive (protective) film on stainless steel - the film contributes to preserving the resistance of the steel to corrosion. The following examples are for informational purposes only. Each user is responsible for determining the best cleaning method for their situation.

WARNING

Do not use any chlorine-containing agents as this will attack the heat transfer plate.

Example of an acceptable solution for dairy applications and AISI 316 plates and NBR gaskets:

- Oils and fats are removed with a water-emulsifying oil solvent, e.g., BP-System Cleaner.
- Organics and greasy coatings are removed with Sodium Hydroxide (NaOH) - maximum concentration 2.0% and maximum temperature 85°C (185°F).
- Mineral scale deposits are removed with Nitric Acid (HNO₃) - maximum concentration 0.5% and maximum temperature 65°C (150°F).

WARNING

Excess Nitric acid can seriously damage NBR and other rubber gaskets.

Several alternatives to Nitric Acid can be used, e.g., Phosphoric Acid up to 5% maximum concentration and 85°C (185°F) maximum temperature. Consult SPX FLOW to find all the alternative CIP regimes possible.

CAUTION

The heat exchanger must be rinsed and then thoroughly drained immediately following CIP. Residue from CIP may cause corrosion if left in the heat exchanger.

To determine the correct quantity of chemicals for CIP cleaning, the cleaning fluid should be checked immediately before flushing. If the concentration is too low, <0.5%, the plate heat exchanger is probably not clean. If the concentration is too high, >1%, the chemical consumption can be reduced.

12.6. Regular APV DuoSafety Internal Inspection

Regular internal APV DuoSafety plate pair inspections must be made. SPX FLOW recommends at least an annual inspection for AISI316 heat exchangers. The APV GPHE must be opened and the APV DuoSafety plate pair separated. Carefully check the inside surfaces for traces of the product/ liquid processed in the APV GPHE. If visual inspection of the surface is difficult (e.g., because the product is transparent) then it is recommended that indicator dye is sprayed onto the inside surface of the plate pairs.

Fouling between the APV DuoSafety plate pair indicates that at least one of the APV DuoSafety plates has a defect. In this case, both plates in the APV DuoSafety plate pair must be removed from the APV GPHE.

12.7. Plate Replacement

Before replacing a plate in a heat exchanger, the new plate must be checked against the plate it is replacing. The new plate must be identical in every way.

The customer drawing provided with the heat exchanger provides information on the material, port punching, gaskets, and location of each plate in the heat exchanger.

Note: During the installation, **always alternate left and right hand plates**. For simplification only, whole blocks of identical left or right hand plates are shown on the plate arrangement diagram. The total number of each is given. Vertical flow plates may be changed from left hand to right or vice versa by turning the plate over.

12.8. Gasket Replacement

For ordering of genuine APV spare parts and for re-gasketing, refer to section 14.0: "Spare Parts, Identification and Ordering".

Plate heat exchanger gaskets are attached to individual plates by one of two methods, glued or clip in. Glued in gaskets are attached by a thermoplastic adhesive which is heat cured for maximum strength. The Paraclip clip in gaskets are attached to the plates by small nubs around the perimeter and port areas of the gasket which snap into matching holes on the plate. The EasyClip clip in gaskets are attached to the plates by tongues around the perimeter and port areas of the gasket which snap into matching slots on the plate.

Removal of old gaskets

To remove clip in gaskets, the gasket may be carefully pulled from the plate. If the gasket is to be reused, pull slowly to avoid tearing off the clips or stretching the gasket.

To remove glued in gaskets, the bond between the plate and gasket is softened by using a propane torch to heat the plate from the non-gasketed side directly behind the gasket. As the adhesive softens, use pliers to pull the gasket from the groove. Continue this process until the entire gasket has been removed.

⚠ CAUTION

Overheating the plates can cause discoloring and damage.

PLIOBOND glued gaskets can be loosened and removed by placing the gasketed plate in water at 100°C (212°F).

Cleaning

To remove remaining traces of old adhesive, grease, or dirt from gasket grooves, use a solvent such as Acetone or a commercial gasket removal product. Do not use abrasives to clean the gasket grooves. The gasket groove surface must be absolutely clean for plates with glued in gaskets.

For glued in gaskets, it is important that the degreasing agent has evaporated prior to the application of the glue. Typically, the degreasing agent will evaporate in approximately 15 minutes at 20°C (68°F). Consult the degreasing agent manufacturer for the proper evaporation time. It is advisable to clean the gluing surfaces of the gaskets with fine-grained sandpaper instead of a degreasing agent.

Attachment of Glued in Gaskets

To attach new replacement gaskets, apply a thin even film of 3M formula EC-1099 adhesive to the plate gasket groove. The adhesive may be spread evenly with a small acid brush dipped in acetone. Allow the adhesive to dry until tacky, about 30 seconds. Press the gasket firmly in place, starting at one corner of the plate and continuing across and along the length of the plate. The entire gasket must be firmly in place with no twists or bumps.

As each plate is gasketed, it should be stacked neatly on a clean, flat surface in the order it will be installed. Take special care not to move the gaskets out of position. After all the plates are re-gasketed, they may be placed in the frame. The frame is tightened per Section 9.6 to a platage dimension about 10% above the maximum compressed platage specified on the customer drawing.

Heat treatment is essential to cure the adhesive and obtain maximum bond strength. This is done using steam or hot water to heat the plate pack. Attach a low pressure desuperheated steam line to an upper port and slowly raise the temperature of the plate pack to at least 105°C (220°F). Maintain the temperature for a minimum of three hours.

If steam is not available, hot water may be used with the same temperature and time requirements as steam.

After the required time, allow the heat exchanger to cool naturally to room temperature and complete the tightening to the required dimension per section 9.6.

Attachment of Paraclip Gaskets

Non-glued Paraclip gaskets are an alternative to glued in gaskets that simplifies on site re-gasketing. The gaskets have a series of small nubs or projections molded into the underside of the gasket. These projections fit into corresponding slots located around the periphery of the plate and port areas, securing the gasket to the plate (**Figure 46**). When the plate heat exchanger is tightened, a complete and secure seal is assured.

To attach a Paraclip gasket, the gasket is laid out on the plate in its correct position. The projections are firmly pressed into the corresponding slots in the plates. After installing the gasket, the plate may be immediately installed in the frame in preparation for tightening.

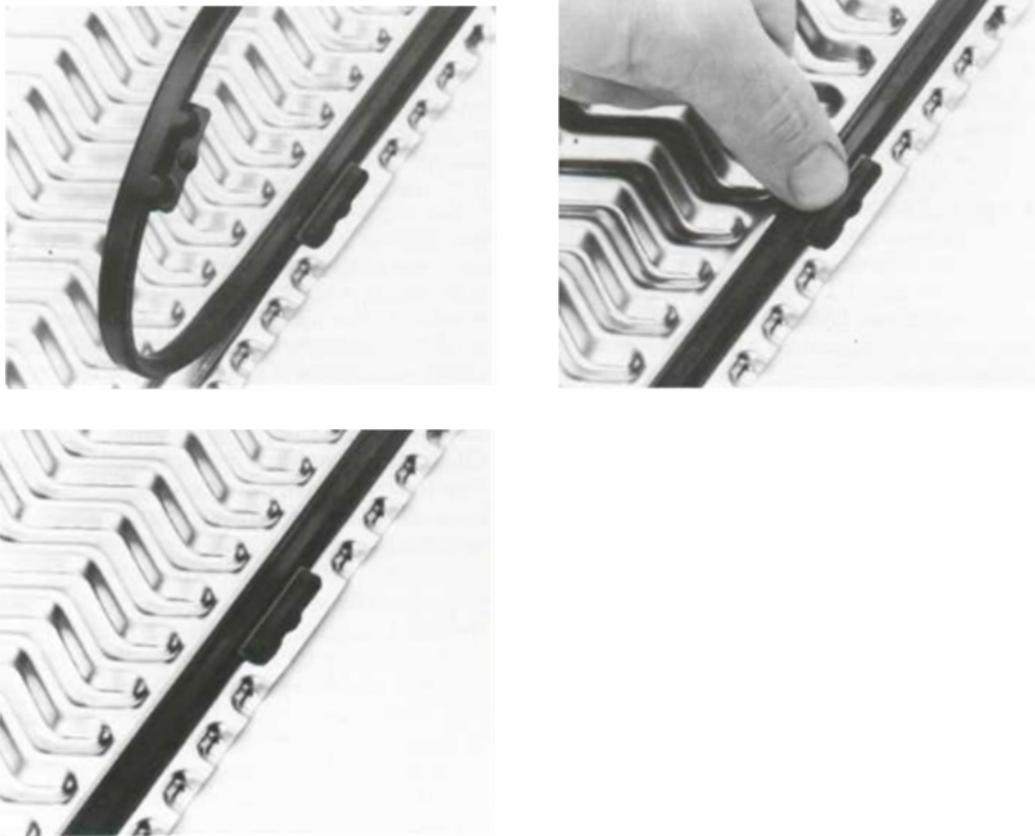


Figure 46: Attachment of Paraclip gaskets

Attachment of EasyClip Gaskets

Non-glued EasyClip gaskets are an alternative to glued in gaskets that simplifies on site re-gasketing. To attach the gasket, apply a pressure to expand the 2 tongues into 2 slots in the plate. The barbed effect (fishhook) secures the gasket to the plate, in fact it now takes more force to remove the gasket than to apply it. These tongues fit into corresponding slots located around the periphery of the plate and port areas, securing

the gasket to the plate (**Figure 47**). When the plate heat exchanger is tightened, a complete and secure seal is assured.

To attach an EasyClip gasket, the gasket is laid out on the plate in its correct position. The projections are firmly pressed into the corresponding slots in the plates. After installing the gasket, the plate may be immediately installed in the frame in preparation for tightening.

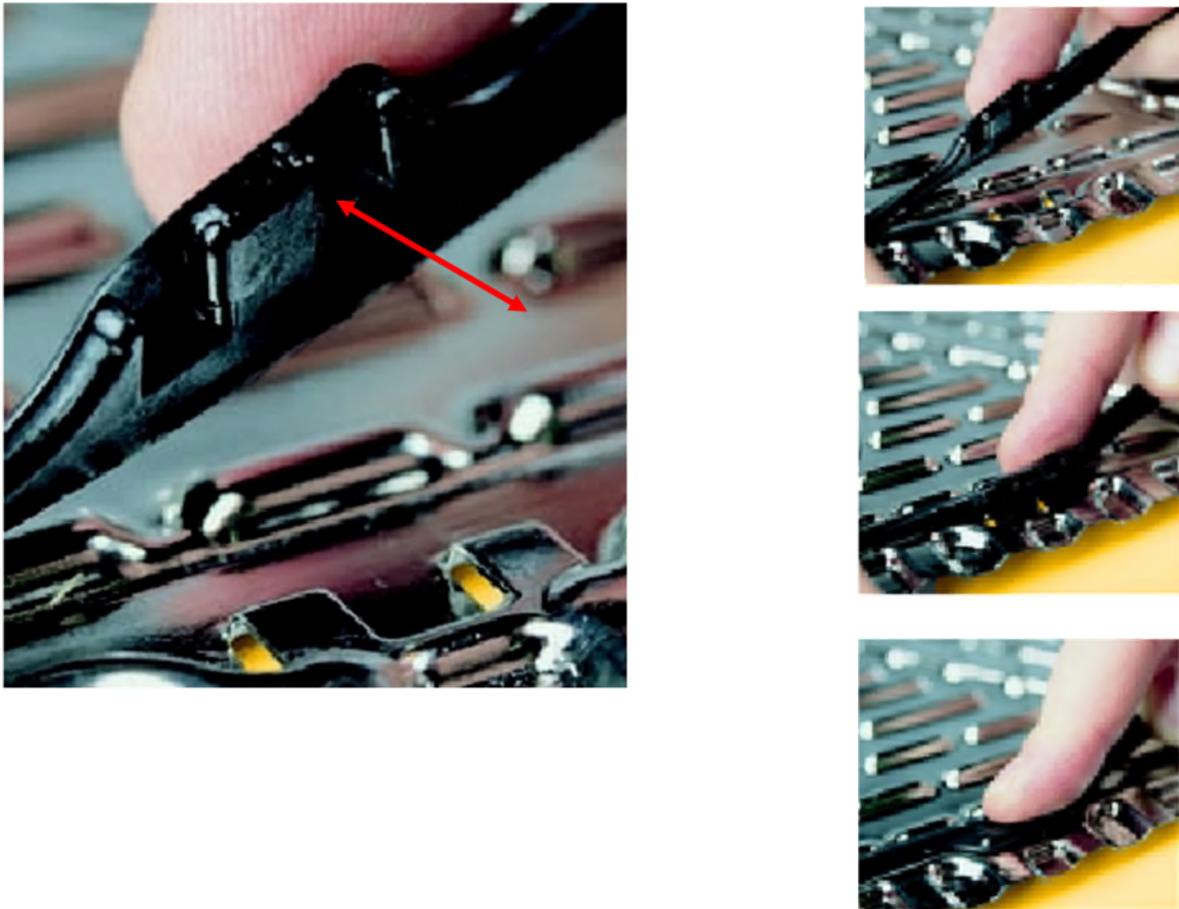


Figure 47: Attachment of EasyClip gaskets

Double Clip Gaskets

Non-glued Double Clip gaskets, only available on the Mira plate, are an alternative to glued in gaskets that simplifies on site re-gasketing. To attach the gasket, apply a pressure to move the upper tongue into the slot on the back side of the plate. The bottom tongue rests on the top side of the plate to secure the gasket to the plate. These tongues fit into corresponding slots located around the periphery of the plate and port

areas, securing the gasket to the plate (**Figure 48**). When the plate heat exchanger is tightened, a complete and secure seal is assured.

To attach a Double Clip gasket, the gasket is laid out on the plate in its correct position. The projections are firmly pressed into the corresponding slots in the plates. After installing the gasket, the plate may be immediately installed in the frame in preparation for tightening.

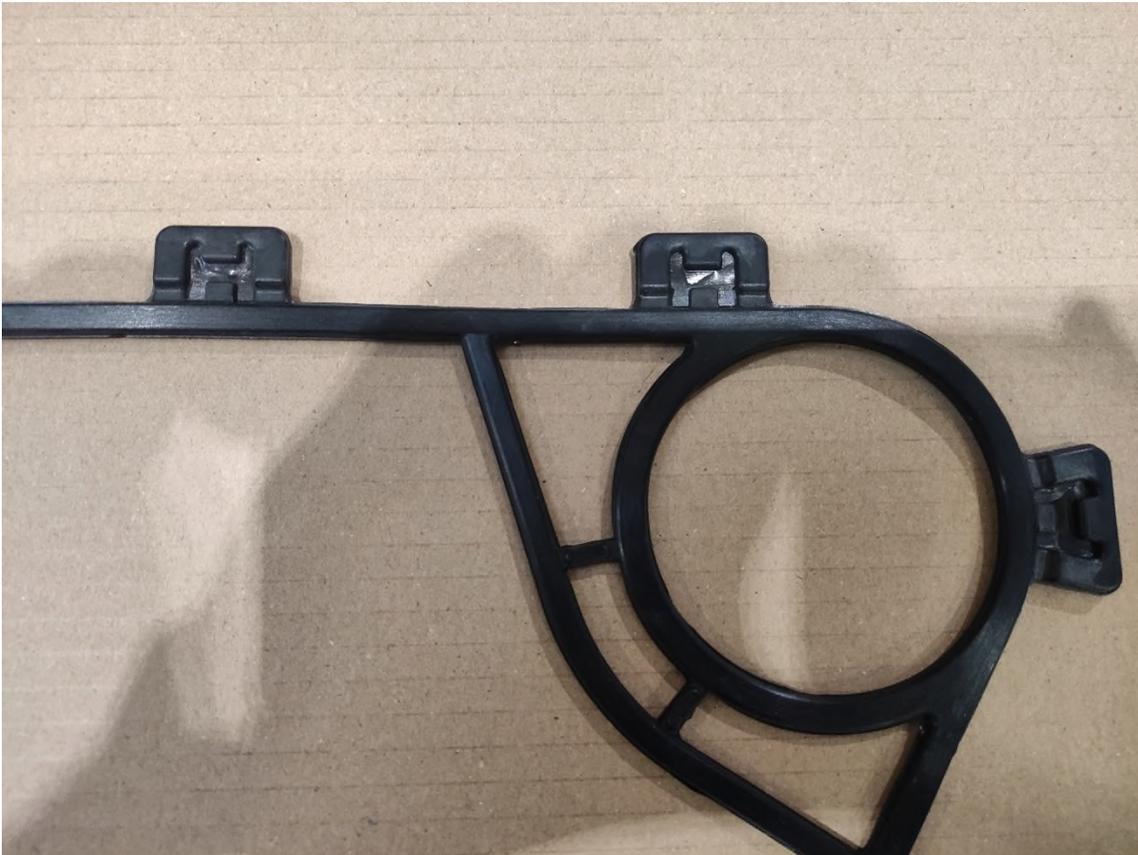


Figure 48: Double Clip gasket

12.9. Re-Assembly

Follow the guidance in Sections 9.4, 9.5 and 9.6 (steps 1 through 6) for reassembly after the maintenance event.

Irrespective of new or old plates or a mix of new and old plates, the plates must always be compressed to full contact. Due to tolerances the full plate contact is attained between maximum and minimum compressed pitch. Full plate contact is indicated by rapidly rising compression force.

⚠ WARNING

- Insufficient clamping force can cause leaking.
- Never tighten below the minimum pitch shown on the customer drawing.

⚠ CAUTION

To avoid leakage, never tighten to a more relaxed pitch than the previous closing.

Check the heat exchanger sealing before pipes on the follower are connected.

After any changes, a hydraulic pressure test should be made prior to operation of the equipment. A leak test at 1.1 x operating pressure is recommended. Please refer to document GPHE IOM-FIELD for the detailed field pressure test procedure.

12.10. Maintenance of In-Line Filter

The in-line filter, when supplied, needs to be cleaned at regular intervals (**Figure 49**). The frequency depends on the content and size of debris in the fluid being filtered. An increase in the pressure drop over the APV GPHE indicates the need for cleaning.

Clean the in-line filter in this sequence:

- Stop fluid circulation pump.
- Close valve on the filter side.
- Drain the filter side.
- Remove the full faced gasketed blind flange on the follower.
- Carefully pull out the in-line filter through the follower.
- Clean the filter with water and brush. Soap which is not damaging the filter material may be used.
- Before reinserting the in-line filter it is recommended that you flush any loose debris from the port where the filter is installed.
- Carefully re-insert the filter in the fluid inlet port through the follower.
- Check that the gasket is in place on the blind flange.
- Place the blind flange on the follower.
- Open the valve on the filter side and release air.
- You may now start your circulation pump.

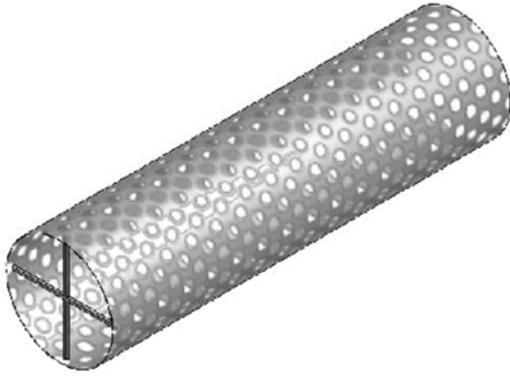


Figure 49: In-line filter

12.11. Preventative Maintenance

A preventative maintenance program will help keep APV GPHE's running at optimal levels. The frequency of the maintenance inspections is dependent on a variety of reasons, some of which are:

- Production hours.
- Product / process conditions.
- Regulatory inspection requirements.
- Design and operation of the overall system.
- Decreased efficiency of the PHE.
- Scheduled shutdowns.
- Customer / end user requirements.

A recommended Preventative Maintenance Checklist is included in Appendix 2.

13. ACCESSORIES

13.1. Manual Tightening Wrenches

Manual tightening wrenches are available for most APV Plate Heat Exchangers to allow opening and closing in the field. Ratchet type wrenches specifically designed for tie bars are available for medium to large heat exchangers. The T4, Junior, H17, SR1, TR1 and SR2 use box wrenches of the correct size. Power tightening equipment is required to tighten heat exchangers with port openings ≥ 8 inch.

13.2. Power Tightening Equipment

Pneumatic Wrench

To facilitate the closing and tightening of large heat exchangers or plate heat exchangers containing a large number of plates, pneumatic tightening wrenches (single or dual wrenches) are available in two models. **Table 2** shows the pneumatic power tighteners recommended for small heat exchangers with port opening ≤ 6 inch and large heat exchangers with port openings > 6 inch. **Table 3** gives a description of each tightener model. Other compatible or equivalent pneumatic power tighteners may be substituted for the models shown in **Tables 2 and 3**.

The power tightener assemblies require clean lubricated air at a minimum of 90 psig at the filter-regulator inlet. Air consumption is 25 scfm full load or 40 scfm no load for each tightener.

PORT SIZE	SINGLE PT-5	DUAL PT-5	SINGLE PT-7	DUAL PT-7
GPHE with ≤ 6 in. port opening	GOOD	BEST		
GPHE with > 6 in. port opening			GOOD	BEST

Table 2: Pneumatic wrench recommendations

TIGHTENER MODEL	DRIVE	SPEEDS	WEIGHT (EACH)
PT-5	1"	1 FORWARD 1 REVERSE	27 kg (60 lb.)
PT-7	1-1/2"	2 FORWARD 2 REVERSE	36 kg (80 lb.)

Table 3: Tightener data

Hydraulic Tightening

Hydraulic tightening equipment may be used in lieu of the pneumatic wrenches for closing and tightening of large heat exchangers and is recommended for heat exchangers with port openings ≥ 8 in. The hydraulic tightening equipment increases the closure increments, thus reducing the amount of time to close large heat exchangers. Contact the factory for detailed instructions.

13.3. Safety Screen

A safety screen may be supplied for new or existing plate heat exchangers. They are recommended whenever corrosive liquids or high temperatures present a safety hazard to personnel near the heat exchanger. The safety screen is made from folded stainless steel and is hung on the top bar or tie bars of the plate heat exchanger for easy

installation and removal. The safety screen encloses the plate pack completely on the top and sides and is open on the bottom to allow leak detection. See **Figure 50**.

13.4. In-Line Filter

For industrial applications involving fibers or particles which might foul the heat exchanger plates or block the heat exchanger passages, an in-line filter is recommended.

The in-line filter is inserted in the fluid inlet port of the heat exchanger through an opening in the follower and closed with a blind flange cover (**Figure 51**).

The in-line filter mesh size is typically between 2.0mm (0.08 in.) – 2.5mm (0.1 in.) and is, dependent on the heat transfer plate gap.

Where an in-line filter is purchased for an existing APV GPHE, please check whether the plate heat exchanger is prepared for the installation of an in-line filter. Additional modifications may be necessary.



Figure 50: Safety Screen

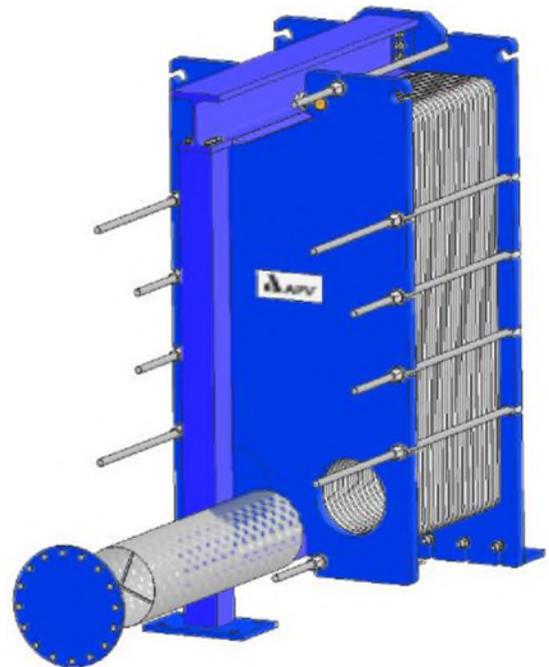


Figure 51: In-line filter

13.5. Drip Tray

The drip tray is a 304 stainless steel rectangular box (open at the top) with typically 50mm (2 in.) wall heights and thickness of 18 GA (**Figures 52, Figure 53, and Figure 54**). The length is typically provided to accommodate the maximum number of plates in a frame. The width varies from 50mm (2 in.) to 152mm (6 in.) larger than the plate

width. The drip tray is installed underneath the plate pack, elevated above the floor, and typically slopes at a small angle towards the head. A drain is attached at the head end of the drip tray to permit collection of media collected by the drip tray. Each manufacturing site may have a unique method of attaching the drip tray to the plate heat exchanger. The next two paragraphs provide examples of drip tray installation methods.

The drip tray in Figure 52 is attached to the inside of the head at the foot bolt locations and inside of the end support at the foot bolt location. The drip tray in Figure 53 is attached to the bottom side tie bars. These two types of drip pans may be installed on the floor by extending the bolting tabs in Figure 52 or clamp lengths in Figure 53.

A drip tray can be installed when the APV GPHE is insulated (see Section 13.6). The drip tray (Figure 54) has support blocks attached to the bottom surface of the drip tray and these blocks are attached beneath the plate heat exchanger feet with the drip tray resting on the floor. The insulation will enclose the plate heat exchanger and the drip tray. An opening in the insulation provides access to the drain.

13.6. Insulation Jacket

The insulation jacket is designed to enclose the plate heat exchanger with a “suitcase type” hook and latch system to attach the panels (**Figures 55 and 56**). The panels form a box structure that is open at the bottom. The insulation jacket is not designed to fully seal the plate pack, thus reducing the risk of unwanted build-ups.

The insulation jacket provides a safe temperature exterior surface when the plate exchanger is operating at hot / high temperature and protects personnel from injury in the event of a high temperature liquid discharge.

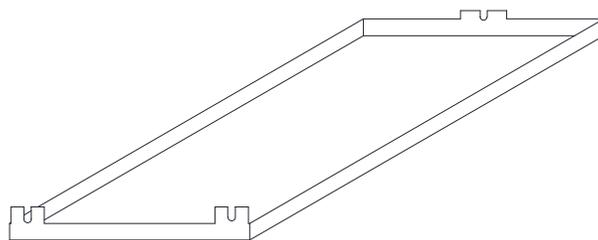


Figure 52: Drip tray

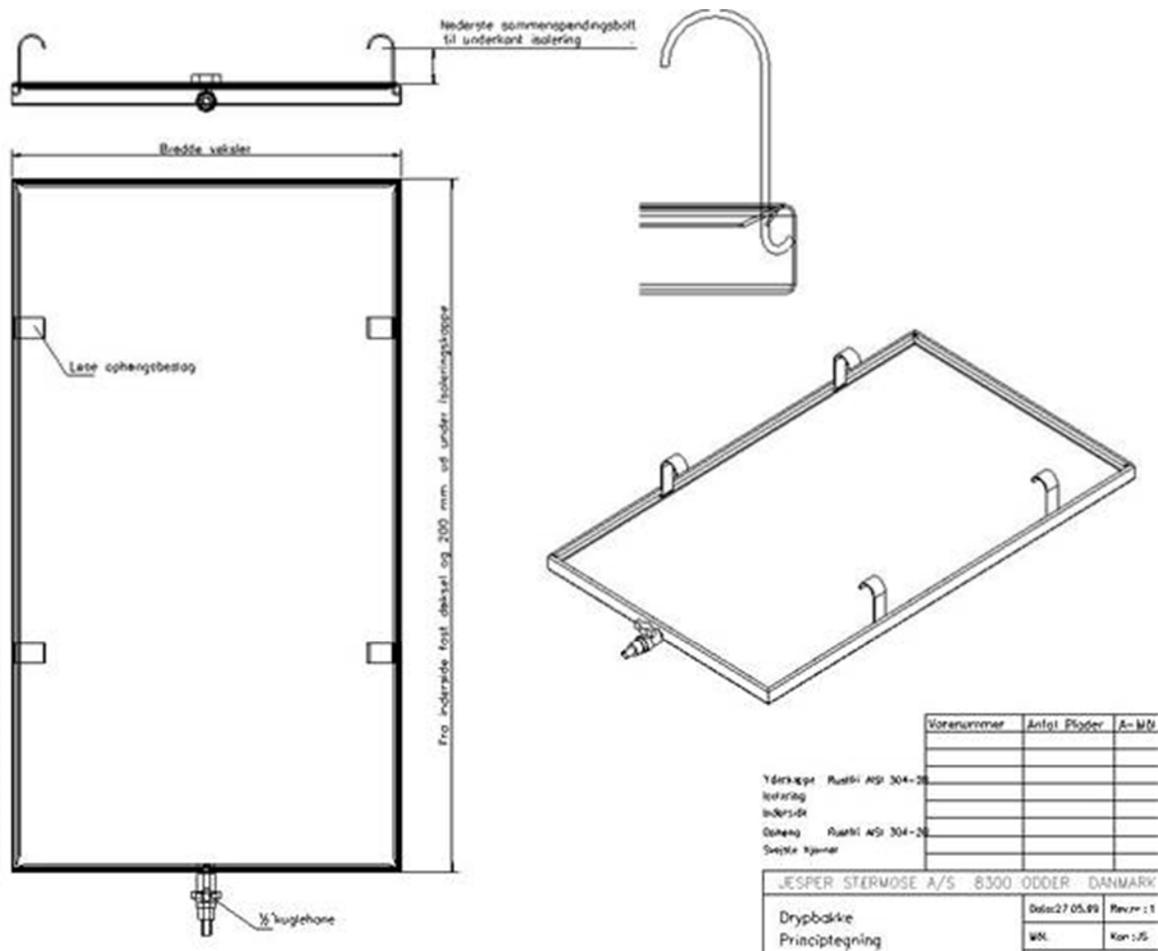


Figure 53: Drip tray

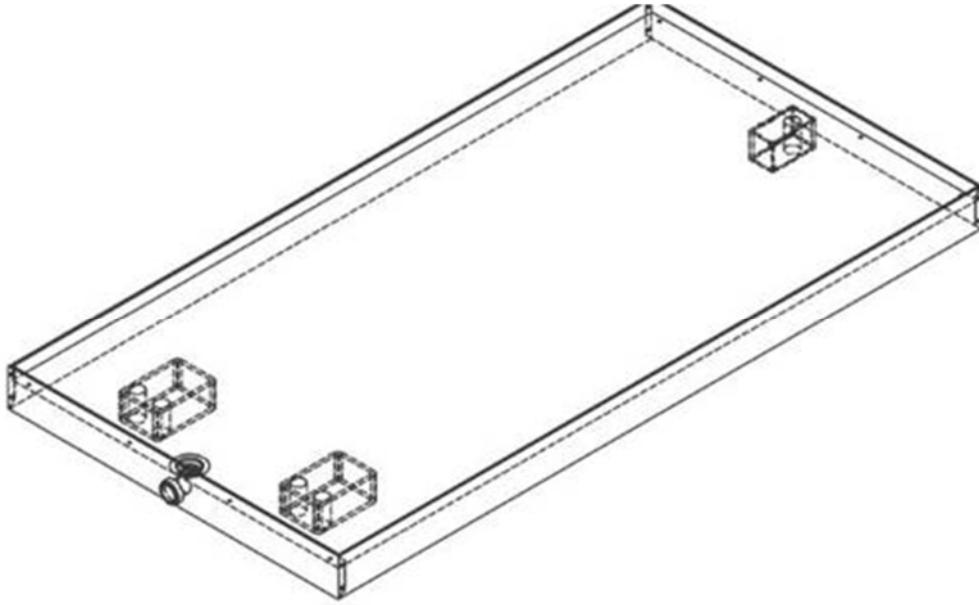


Figure 54: Drip tray

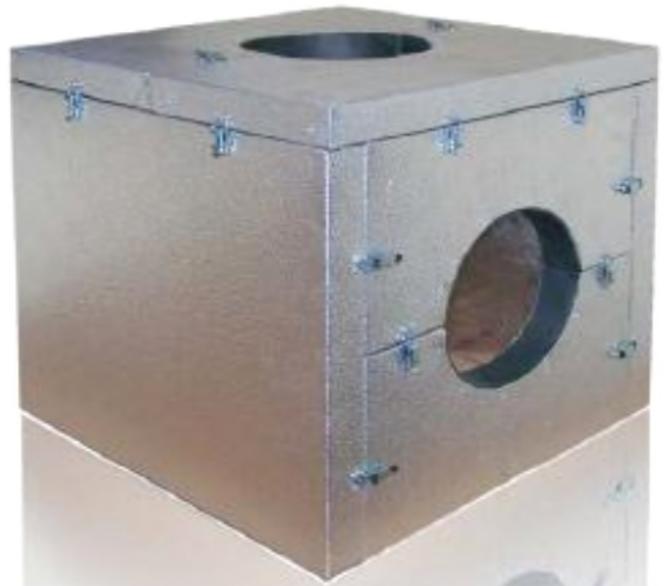


Figure 55: Insulation Jacket

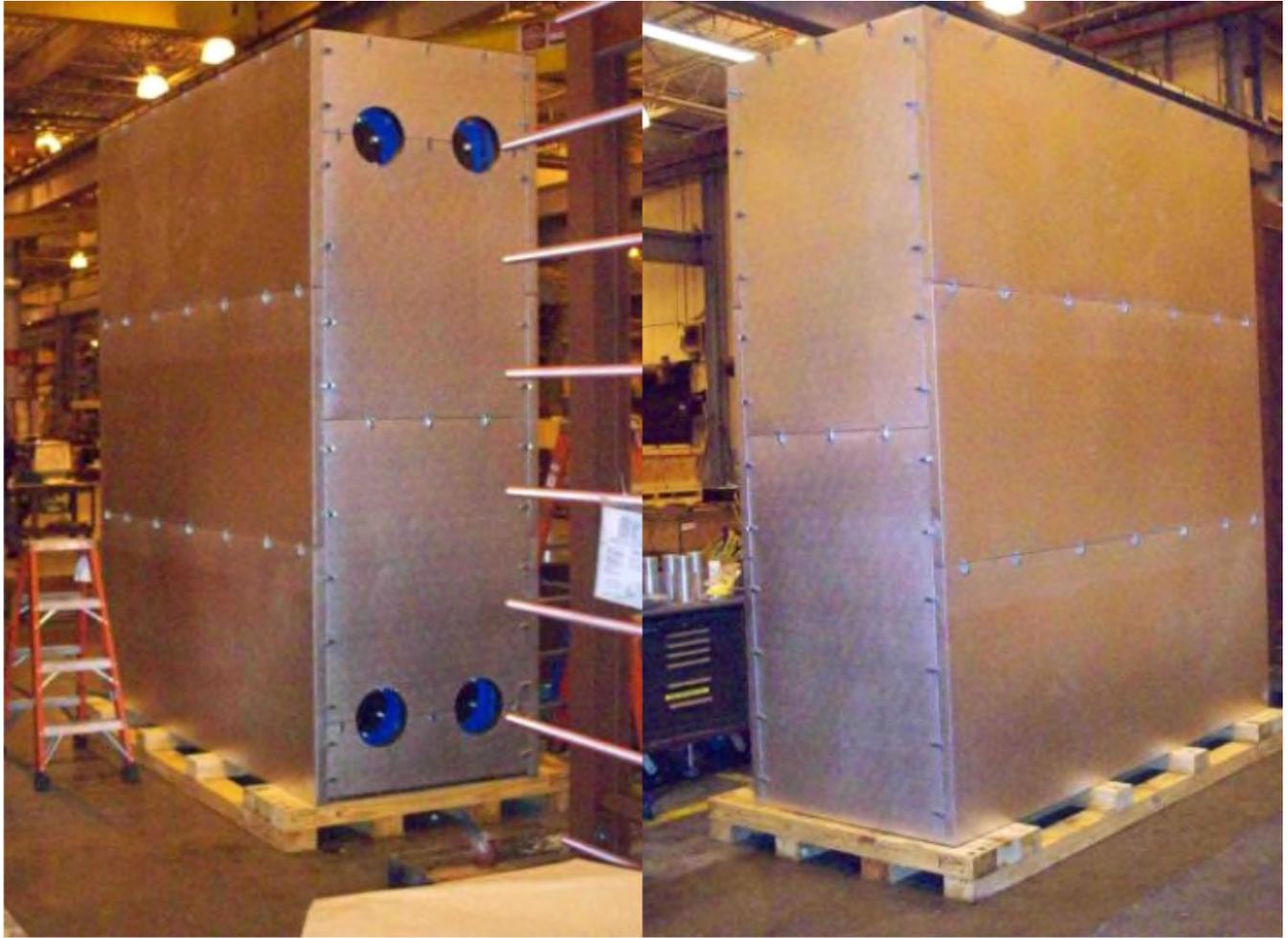


Figure 56: Insulation Jacket

14. SPARE PARTS, IDENTIFICATION AND ORDERING

14.1. Identification of Spare Parts

Each spare part of the APV GPHE is allocated a unique item number.

For gaskets and plates see item numbers on APV GPHE plate arrangement diagram.

On some APV GPHE plates, the last four digits of the item number are also stamped near one end of the plate. On some gaskets, the part number may be molded on the gasket. Plate punch code and plate inversion – right and left are shown in **Figure 57**.

Plate handling is checked by which lower port will allow flow into the channel. For the right hand plate, the right hand lower port allows flow to enter or exit the channel.

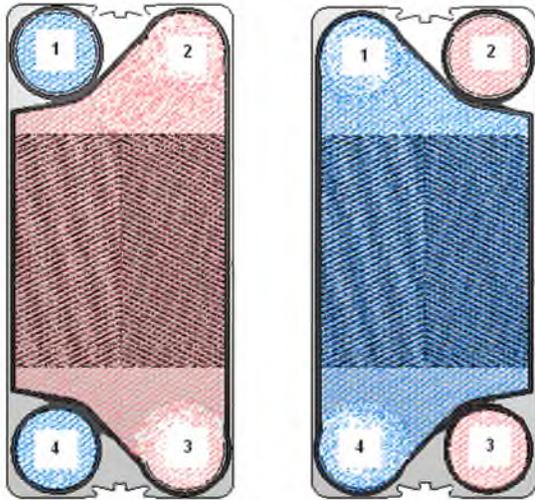


Figure 57: Right and left hand plate

15. TROUBLESHOOTING

TROUBLESHOOTING PLATE HEAT EXCHANGERS		
PROBLEM	POSSIBLE CAUSES	SUGGESTED SOLUTIONS
Reduced heat transfer	<ol style="list-style-type: none"> 1. The inlet temperature or flow rates do not correspond to the original design. 2. Plate surfaces have become fouled on either the product or service side. 3. Freeze-up. 	<p>Correct temperatures or flow rates to design conditions.</p> <p>Open the GPHE and clean the plates or clean the plates (without opening) by circulating a suitable cleaning agent or reverse flush to dislodge debris.</p>
Increased pressure drops or reduced flow rate	<ol style="list-style-type: none"> 1. Plate surfaces have become fouled on either the product or service side. 2. Debris is blocking the flow channels. 	<p>Open the GPHE and clean the plates (see Section 12.0). Screens or filters must be installed to prevent debris from entering the equipment. Reverse flush to dislodge debris.</p>
Visible leakage	<ol style="list-style-type: none"> 1. Operating pressure exceeds the rating of the heat exchanger. 2. The GPHE is not tightened adequately for the operating conditions. 3. Sealing surfaces of plates or gaskets maybe damaged or dirty. 4. Chemical attack on the gaskets. 	<p>Reduce the operating pressure to the rating of the GPHE. If the equipment continues to leak after the pressure is reduced, the plates or gaskets might be damaged, or gaskets aged and may require replacement.</p> <p>Tighten the GPHE further in increments of 0.001 in. (0.025mm) per plate, checking for further leakage each time. Do not tighten below the minimum</p>

		<p>dimensions given in the customer drawing. If leaks continue, see paragraph below.</p> <p>Open the GPHE and inspect the plates and gaskets. There must not be any cuts, cracks, debris, or flat spots on the gaskets. Glue free gaskets must not have any debris under the gasket. The plates must be clean and free of heavy scratches or dents on both sides.</p> <p>Replace all defective parts.</p> <p>Identify the source of chemical attack and correct by either eliminating the corrosive agent or changing the gasket material.</p>
<p>Cross-contamination</p>	<ol style="list-style-type: none"> 1. Cracks in one or more plates. These may be caused by fatigue resulting from pressure. 2. Holes in the plates caused by corrosion. 	<p>Open the GPHE and inspect the plates. Replace the defective parts. Identify the source of pressure fluctuations and correct.</p> <p>Dye penetrant or alternative in situ testing may be required to identify cracks in the plates. If this is the case, contact your SPX FLOW representative. Identify the source of corrosion and correct by either eliminating the corrosive agent or changing the plate material.</p>

16. APPENDICES

APPENDIX 16.1 – Multi-piece Gaskets

APPENDIX 16.2 – Preventative Maintenance Checklist

APPENDIX 16.1 – Multi-piece Gaskets

Flow Gaskets

Flow gaskets, used on the flow plate and seal plate, are typically manufactured as single piece gaskets. There are occasions where multi-piece flow gaskets are required where the multi-piece configuration is typically used with welded plate pairs. The fluid on the welded side is typically more aggressive than the fluid on the gasketed side of a welded plate pair. The multi-piece flow gasket is comprised of three pieces which are the main section and two corner sections (**Figure 58**). The main section will contain the less aggressive fluid on the gasketed side and the corner sections contain the more aggressive fluid on the welded side.

End Gaskets

End gaskets can be single piece or multi-piece. The typical reasons for using multi-piece end gaskets are:

- Cost – the main section of the gasket can be a less costly material for the less aggressive fluid and the corner sections are more costly material for the more aggressive fluid
- Plate models available in various lengths, e.g.C063, C110, C134, C158 and C205

The number of pieces for the multi-piece end gasket is dependent on the plate model and / or gasket material being used. Viton and Parator end gaskets are typically five-piece sections comprised of the main section (**Figure 59**) and four corner sections (**Figure 60**).

The end gaskets for plate models with various lengths are typically created by one of two methods. The first method is a two-piece end gasket where two flow gaskets are cut in half vertically. The right hand half and the left hand half create the end gasket (**Figure 61**). In the second method one of the plate models will only be available in a single piece end gasket. The other plate lengths will use the single piece end gaskets and cut accordingly to create the multi-piece end gasket (**Figure 62**). The end gasket will be a two-piece end gasket for plate lengths shorter than the single-piece end gasket. The end gasket will be a four-piece end gasket for plate lengths longer than the single-piece end gasket. The four-piece end gasket will be comprised of the two end sections and two side extension pieces.

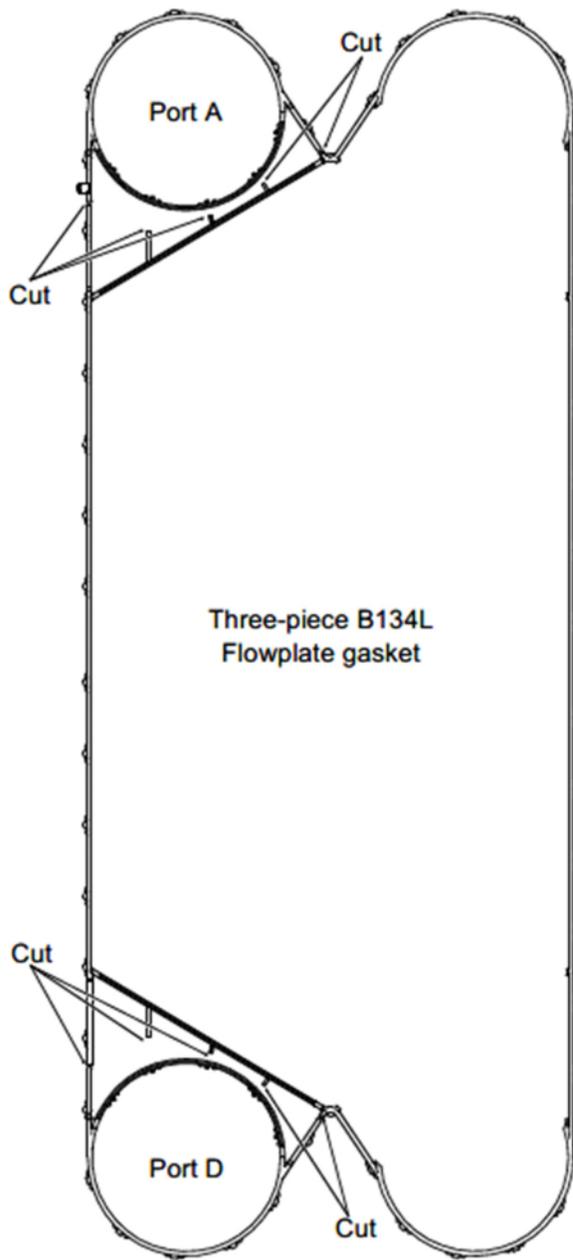


Figure 58: Multi-piece flow gasket

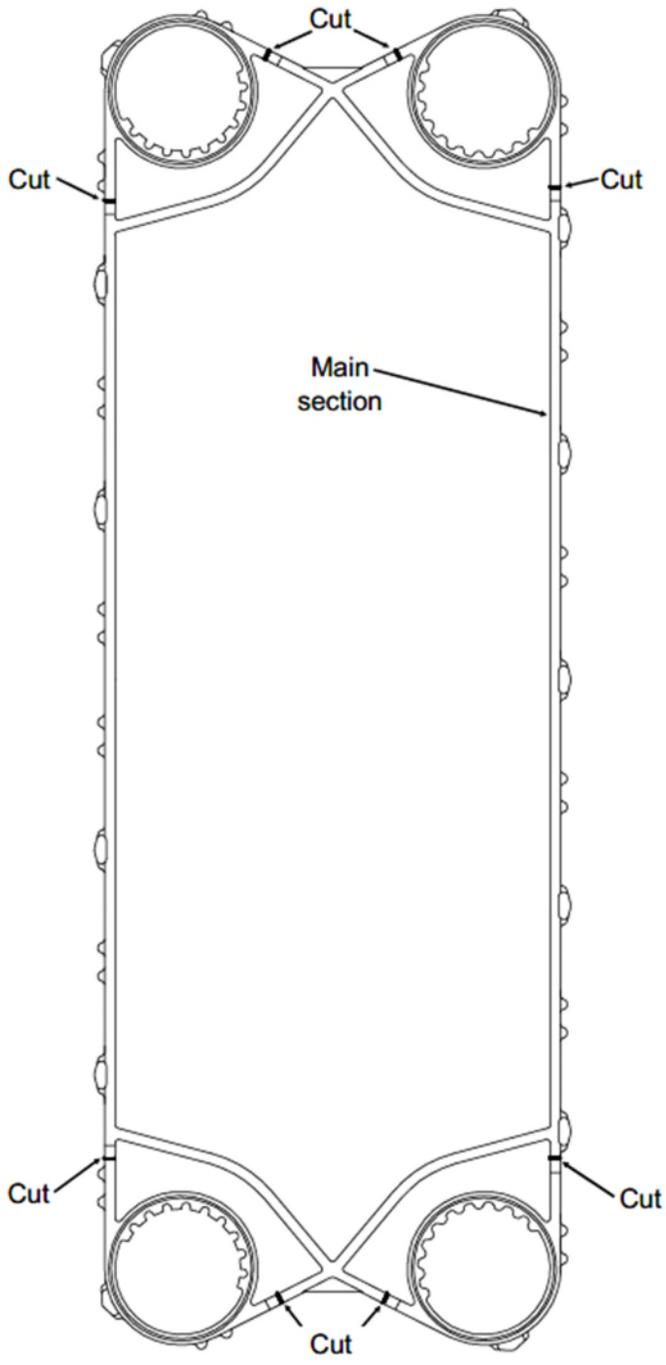


Figure 59: Gasket main section

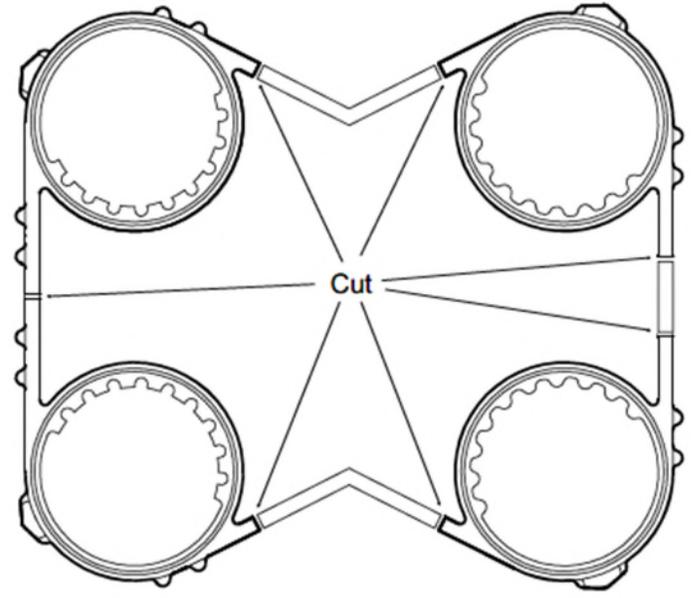


Figure 60: Gasket corner sections

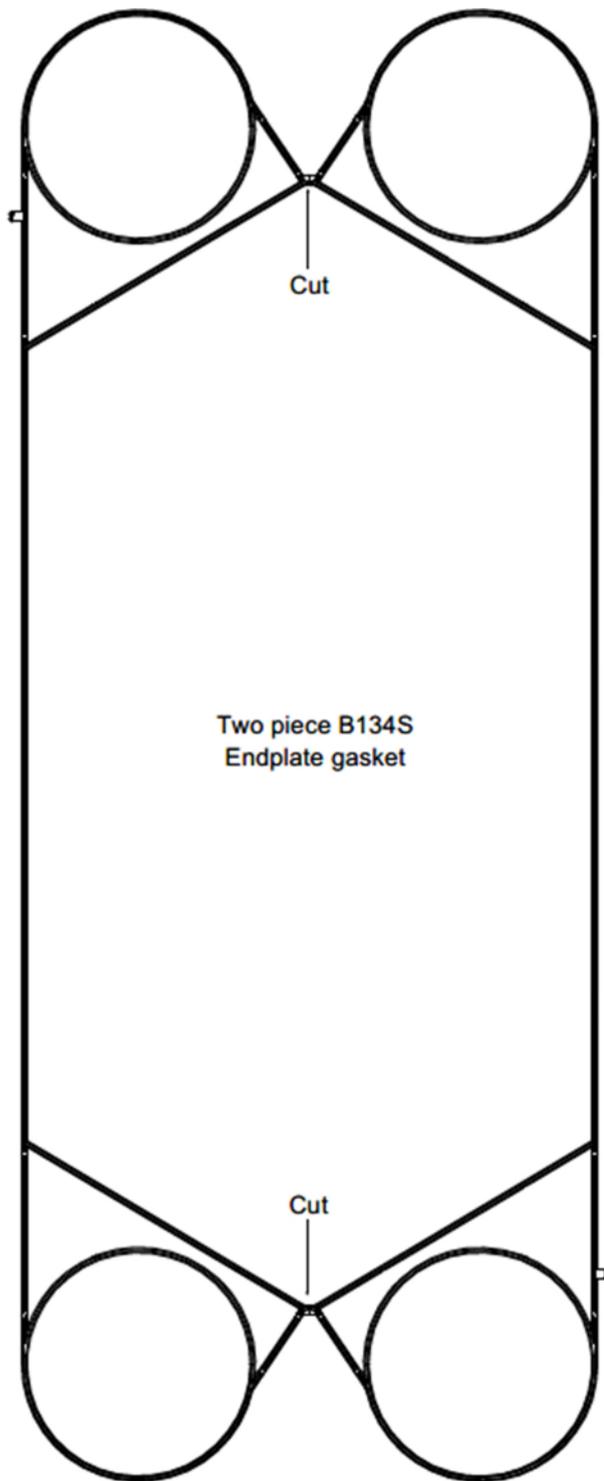


Figure 61: Two-piece end gasket

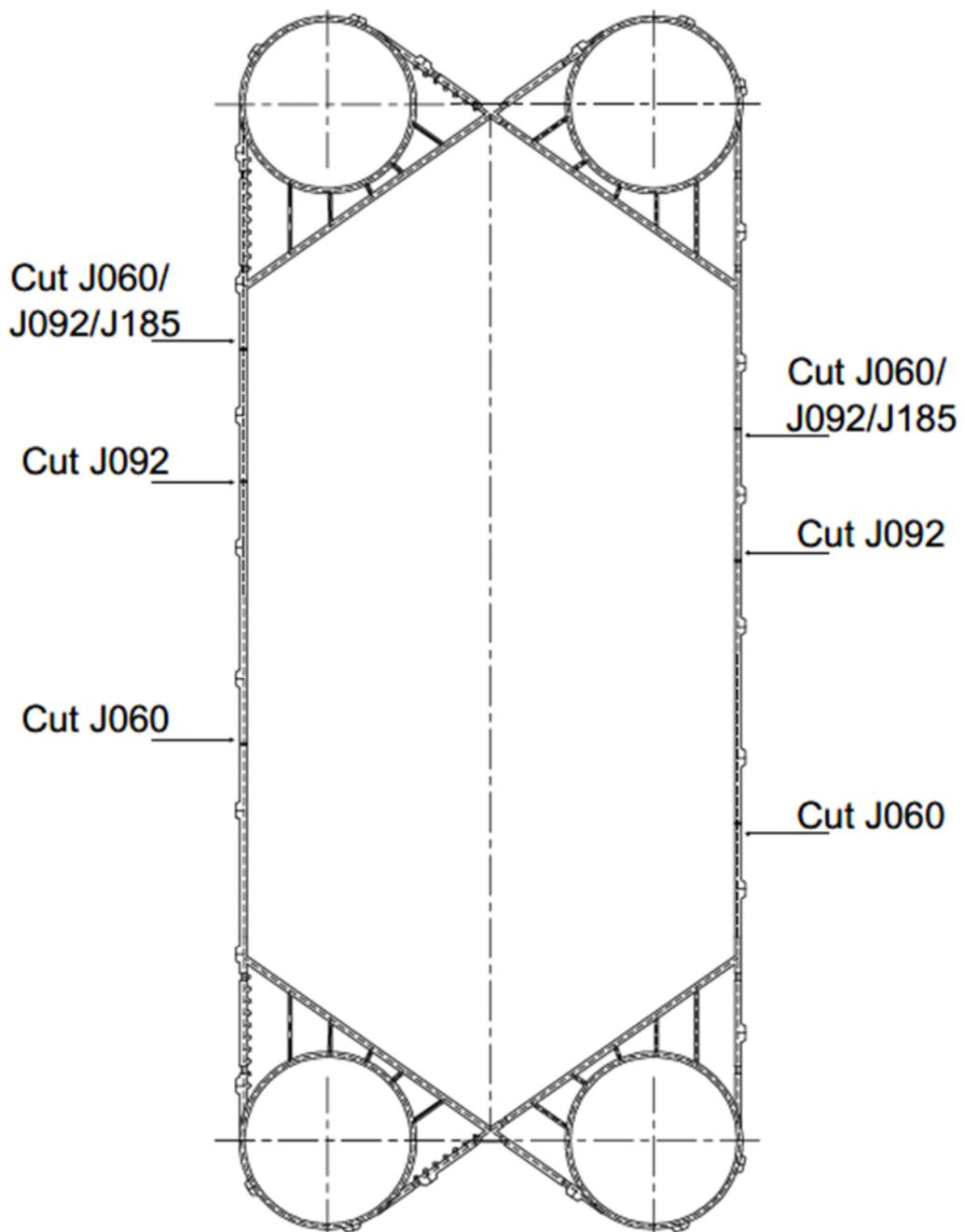
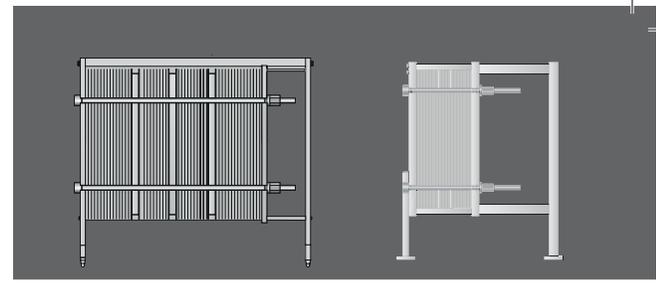


Figure 62: Multi-piece end gasket

APPENDIX 16.2 – Preventative Maintenance Checklist



Preventative Maintenance Checklist

PLATE HEAT EXCHANGERS

Implementation of a preventive maintenance plan keeps SPX FLOW products running at optimal levels and protects your product investment. Use the below checklist to schedule regular product inspections and part replacements using SPX FLOW genuine spares to extend your products lifecycle.

	MAINTENANCE FREQUENCY*					POSSIBLE CAUSES	POSSIBLE SOLUTIONS	SOLVE WITH 
	DAILY (150 HRS)	WEEKLY (150-300 HRS)	MONTHLY (300-500 HRS)	EVERY 3 MONTHS (500-1000 HRS)	EVERY 6 MONTHS (3,000 HRS)			
GASKETS	Inspect gaskets for deterioration and cracking. Pull gasket tab, should not tear, be brittle or be hard.		X			<ul style="list-style-type: none"> Elastomer degradation happens overtime, can be normal or caused by the product or excessive heat. 	<ul style="list-style-type: none"> Replace the elastomer material with Genuine SPX FLOW gaskets to withstand chemical attack or excessive processing temperatures. 	
	Inspect gaskets for deterioration and hardening.		X			<ul style="list-style-type: none"> Leaking at low temps or at startup. Fingernail test the gasket- press thumbnail into gasket to make an impression. If impression stays in the gasket, it needs to be replaced. If it goes away, the gasket has enough elasticity for continued use. 	<ul style="list-style-type: none"> Elastomers used at relatively high temperatures tend to harden and their sealing performance at low temperatures will deteriorate. Because of this, it is essential to avoid cold start-ups at high pressures. Replace gasket material with Genuine SPX FLOW gaskets. 	
	Inspect gaskets for proper fit in plate gasket grooves.			X		<ul style="list-style-type: none"> Pressure and temperature spikes can cause sealing gaskets to expand or contract. 	<ul style="list-style-type: none"> Pressure must change slowly in plate heat exchangers, as plates breathe during pressure changes and may cause movement or flexing. Shock cooling may cause sudden contraction of sealing gaskets. 	
	Store gaskets in proper environment.			X		<ul style="list-style-type: none"> Gasket materials can dry out and become brittle is exposed to certain environments. 	<ul style="list-style-type: none"> It is recommended to store gaskets in a black or opaque plastic bag, sealed to prevent the ingress of air, moisture, contaminants and UV radiation. Store away from sunlight and ozone producing equipment such as welders and electric motors. 	
	Estimated Gasket Storage Life					<ul style="list-style-type: none"> Nitrile: 3 years, EPDM: 5 years 		
PLATES	Inspect plate pack for leaks.		X			<ul style="list-style-type: none"> Leaks can be caused by Improper gasket installation, not enough plate tightening, or normal gasket degradation. 	<ul style="list-style-type: none"> Reinstall gaskets into plate gasket grooves. Tighten plate pack one turn. Do not over-tighten, as over-tightening can cause plate damage. Replace gaskets. 	
	Regularly inspect and test plates for integrity (no pin holes or cracks)				X	<ul style="list-style-type: none"> Use approved testing procedures to regularly test the integrity of the heat transfer plates. SPX FLOW can provide approved testing processes. Working fluids can cause gaskets swelling, and plate deformation, which in turn can cause leaking. 	<ul style="list-style-type: none"> Replace plates immediately if leaking is detected. Under normal operation and process material, the average life of a plate is expected to be 7-8 years. 	
	Estimated Plate Life					<ul style="list-style-type: none"> Normal usage: 7-8 years 		
MOVING PARTS	Flatness of Head				X	<ul style="list-style-type: none"> Over time due to constant force or corrosion, the Head can bow. 	<ul style="list-style-type: none"> Check the Head for flatness. If there is deflection, replacement is recommended. Over time, deflection can increase the probability of the plate pack not sealing. 	
	Flatness of Follower				X	<ul style="list-style-type: none"> Over time due to constant force or corrosion, the Head can bow. 	<ul style="list-style-type: none"> Check the Follower for flatness. If there is deflection, replacement is recommended. Over time, deflection can increase the probability of the plate pack not sealing. 	
	Inspect tie bars for wear.				X	<ul style="list-style-type: none"> Tie bars are heavily loaded and need to be regularly lubricated. 	<ul style="list-style-type: none"> Lubricate tie bars with Never-Seez to maintain free movement. 	
	Piping Loads				X	<ul style="list-style-type: none"> Unless otherwise specified, the nozzle loads on industrial units are designed to meet API specifications. If there are consistent loads present that exceed these specs, they can force the frame out of alignment which can cause leaks, damage plates and/or frame components. 	<ul style="list-style-type: none"> If excessive piping loads are found, action must be taken by owner to reduce these loads or risk potential catastrophic damage to the heat exchanger. SPX FLOW Engineering can confirm the nozzle loading specifications for each APV heat exchanger. 	
	Top Bar				X	<ul style="list-style-type: none"> The plates are hung on and supported by the Top Bar. It is critical the Top Bar is straight and not warped. If there is warping or deflection, the potential for the plate pack to not consistently seal is significantly increased. A warped Top Bar can also cause misalignment of the plate pack which may damage the plates. 	<ul style="list-style-type: none"> If a warped tie bar is found, it should to be replaced as soon as possible. 	

*Maintenance frequency is dependent up production hours, product/process conditions, and required regulatory inspection approvals. For more detailed repair information, download a copy of the required pump manual from the SPX FLOW website. Contact your local distributor for repair service and genuine SPX FLOW parts orders.

ADDITIONAL TECHNICAL INFORMATION

Gaskets:

- Gasket life
 - » The life of a gasket principally depends on operating temperatures, temperature variations and chemical influences.
 - » An increase in the temperature by 50° F (10° C) can reduce the life of the gasket by 50% and a reduction of the temperature by 50° F (10° C) can increase the life of the gasket by 50%.
- Sealing performance of aging gaskets:
 - » Since all gasket elastomers suffer from compression set with age and temperature, aging gaskets will eventually fail to properly seal.
 - » Elastomers used at relatively high temperatures tend to harden and their sealing performance at low temperatures will deteriorate. Because of this, it is essential to avoid cold start-ups at high pressures.
- Swelling of gaskets:
 - » Although, APV plates and gaskets are designed to withstand maximum design pressures and temperatures, certain working fluids or trace constituents of these fluids can attack the gaskets and cause sever swelling.
 - » Swelling may cause plate deformation.

Plate Life:

The life expectancy of APV plates is subject to many factors, including:

- The process duty the plate is performing
- Cleaning agents used in the cleaning process
- Design and operation of the overall system
- Operating outside the parameters stipulated by SPX FLOW / APV
- Use of oxidizing chemicals and other corrosive material
- Failure to properly maintain and monitor the condition of the plates

We believe with proper process system design, appropriate use and proper maintenance within the recommended plate compressed dimension, the estimated life of a plate could be 7-8 years. Plate pack integrity needs to be checked against a regular PM schedule. Plates that have pin holes, cracks, excessive fouling or scaling must be replaced immediately.

Frames:

- Tie bars are highly loaded. Grease the top bar and lubricate the tie bars with Never-Seez.
- Do not allow load on connections, especially on grids which have no strength to take pipe loads.

Shutdown:

- All liquids should be drained from the heat exchanger after shut down to prevent precipitation of products or scale build-up.
- In the case of corrosive fluids, it may also be necessary to flush with clean, non-corrosive water.

Pressure and Temperature Spikes:

- Pressure must change slowly in plate heat exchangers.
- Multi-section units breathe like a concertina during pressure spikes which cause leakage and plates or gaskets.
- Pressure changes may cause movement and/or flexing of the plate pack.
- Sudden changes in the operating pressure and temperatures should be avoided.
- Shock cooling of the heat exchanger may cause leakages due to sudden contraction of the sealing gaskets.

LOCATE YOUR LOCAL DISTRIBUTOR FOR CERTIFIED SERVICE AND GENUINE SPARE PARTS.



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3. Locate [Where to Buy](#) Button

WHERE TO BUY

Testing available from SPX FLOW:

- One testing process available is the Testex system. Testex consists of the detection of defective plates in the plate heat exchanger through Electrolytic Differential Analysis (EDA).
- EDA is used to determine if cross contamination is present. A consistent rise in the conductivity of the water indicates the presence of defective plates.

Testex features:

- The Testex range can pick up even the smallest of cracks
- Testing is carried out under pressure
- Utilizes state-of-the-art monitoring equipment
- Identifies the occurrence of cross contamination without the PHE being dismantled
- Adaptable to many models & sizes of PHE's
- Testing is completed without opening the plate pack

Based in Charlotte, North Carolina, SPX FLOW, Inc. (NYSE: FLOW) is a multi-industry manufacturing leader. For more information, please visit www.spxflow.com

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APV-Heat-Exchangers-Plate-Maintenance-Checklist-APV-1237-FLR-US

Version: 12/2020

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Identification Number: APV-1237-US



Installation, Operation and Maintenance Manual

MODELS: Gasketed PHE's

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