
ASME
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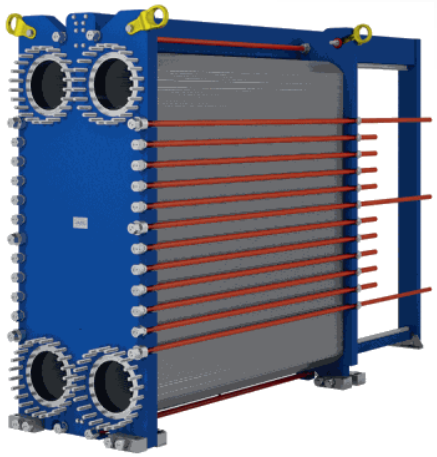

# Historic Introduction of Plate Heat Exchanger Rules into ASME and National Board Codes

Michael Pischke
GE Power

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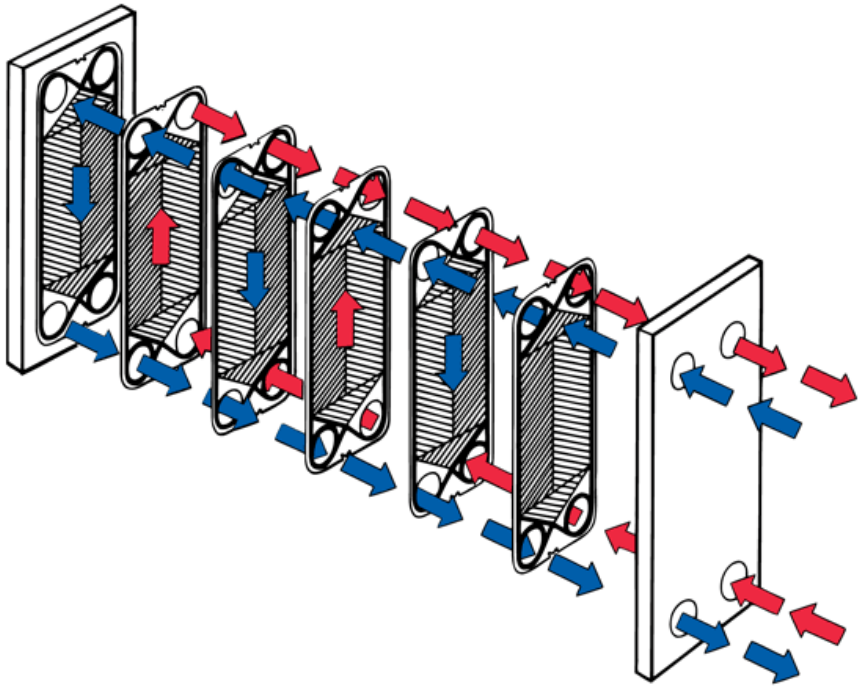
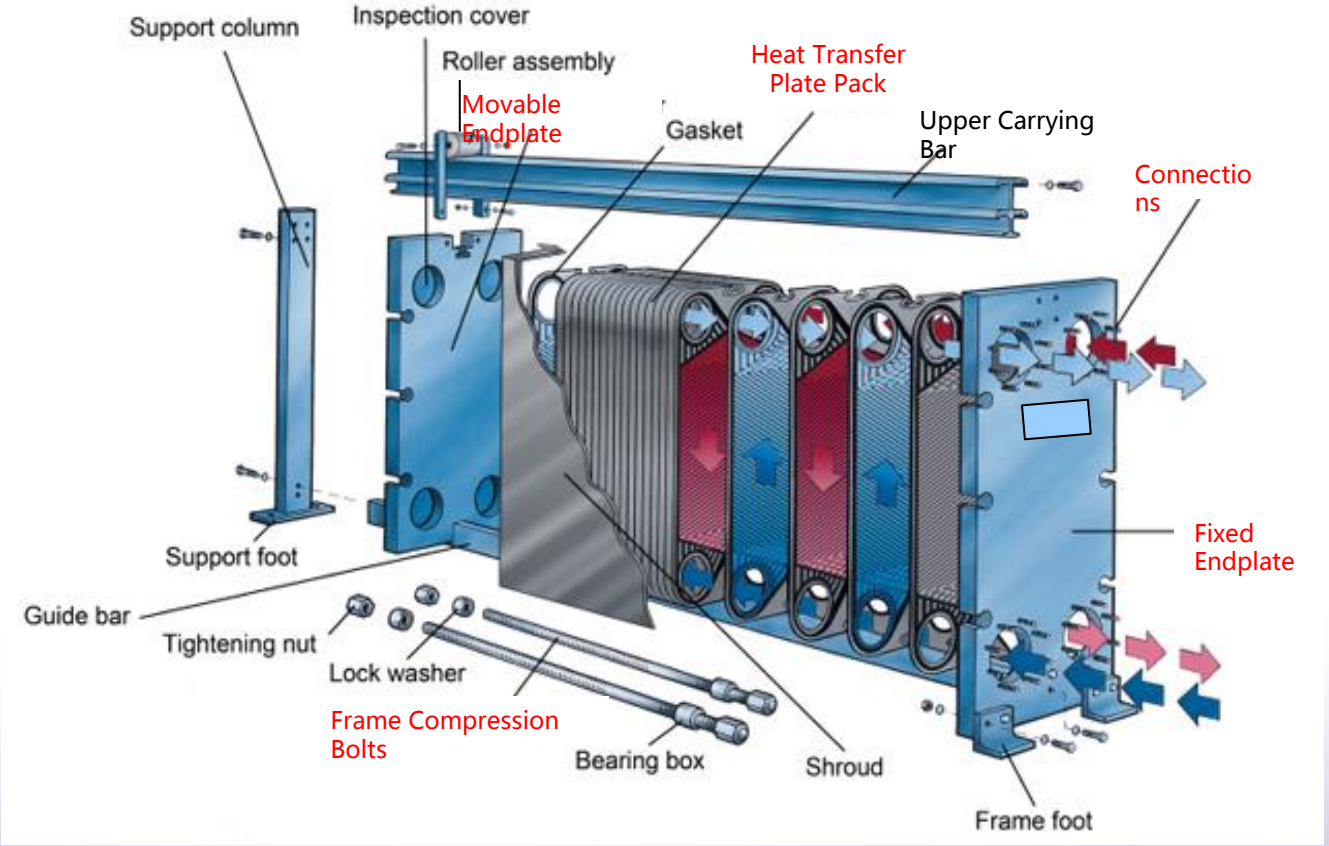
# Discussion Topics

- Plate Heat Exchangers (PHE's): Components & Operating Principle
- The History of PHE Technology
- Various Designs
- Applications
- Elements of the ASME Section VIII-1 Appendix 45

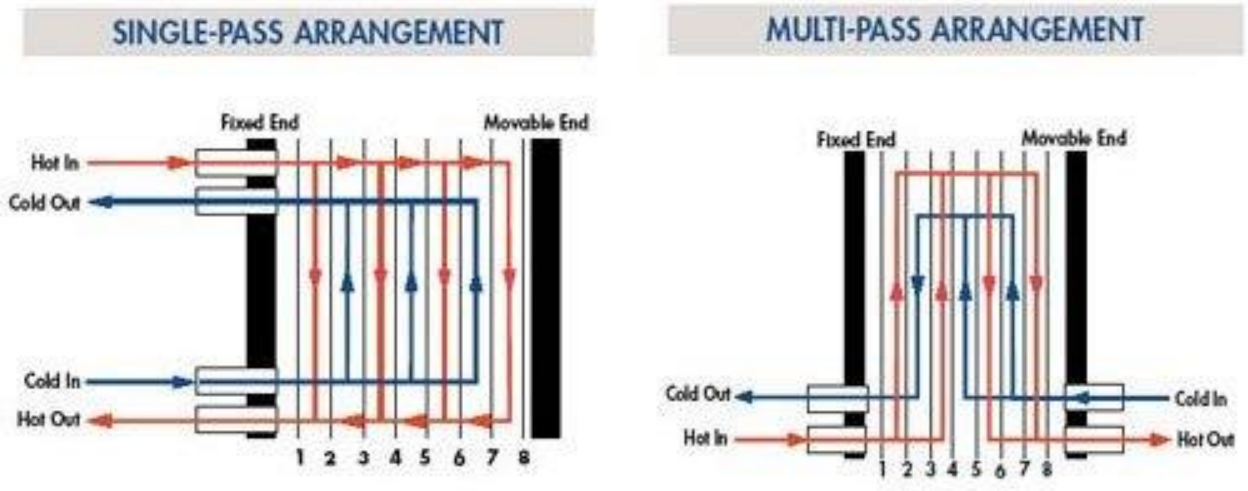


# PHE'S: COMPONENTS AND OPERATING PRINCIPLE

# Main Components



# Operating Principle

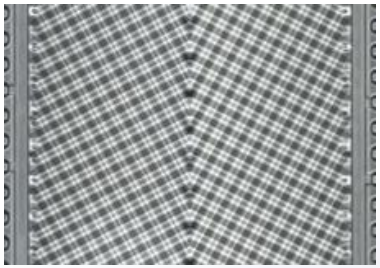


# Heat Transfer Plates

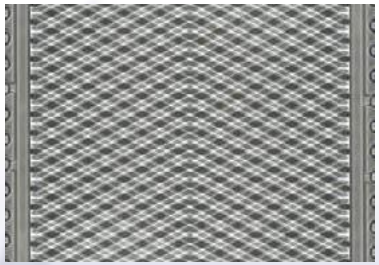
L: Low theta

H: High theta

L + L = L channels



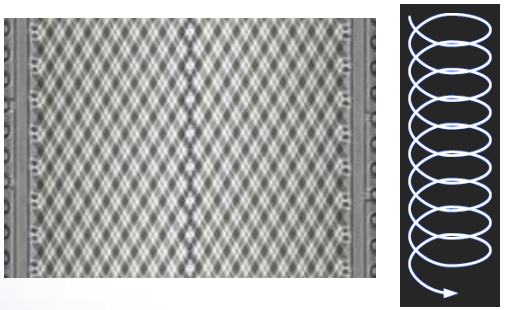
L + H = M channels



H + H = H channels

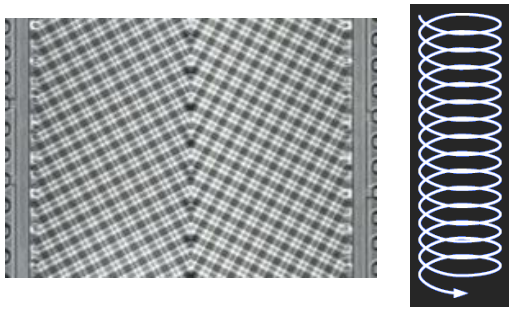
# Plate Combinations Dictate Flow Rates & Heat Tranfer

Low turbulence
& pressure drop



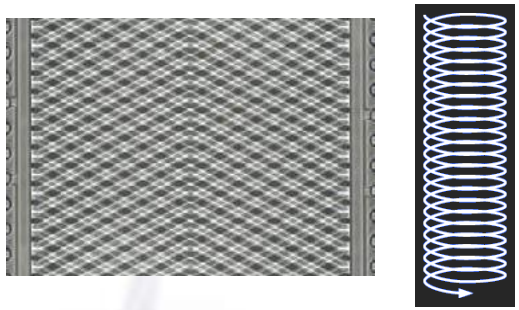
L + L = L channels

Medium turbulence
& pressure drop

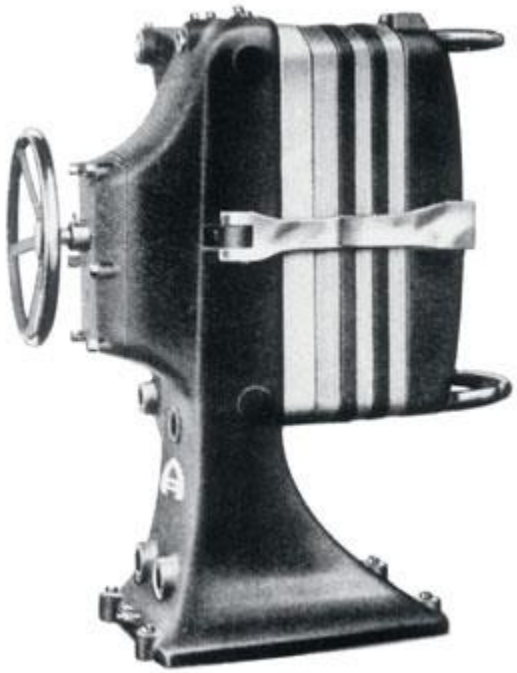


L + H = M channels

High turbulence
& pressure drop

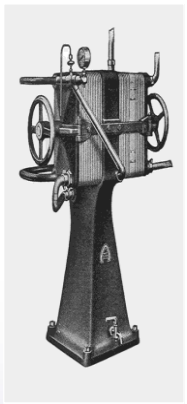


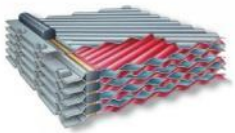
H + H = H channels

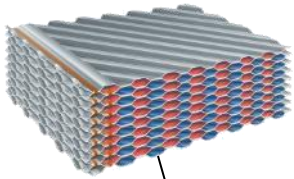


# HISTORY OF PHE TECHNOLOGY

# Timeline of PHE Technology







The First Gasketed PHE

Herring Bone Pattern

Brazed

Semi Welded

Fully Welded

Fusion Brazed

1923

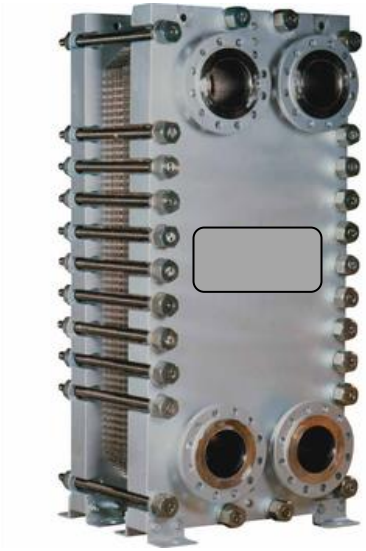
1960

1977

1980

1994

2003

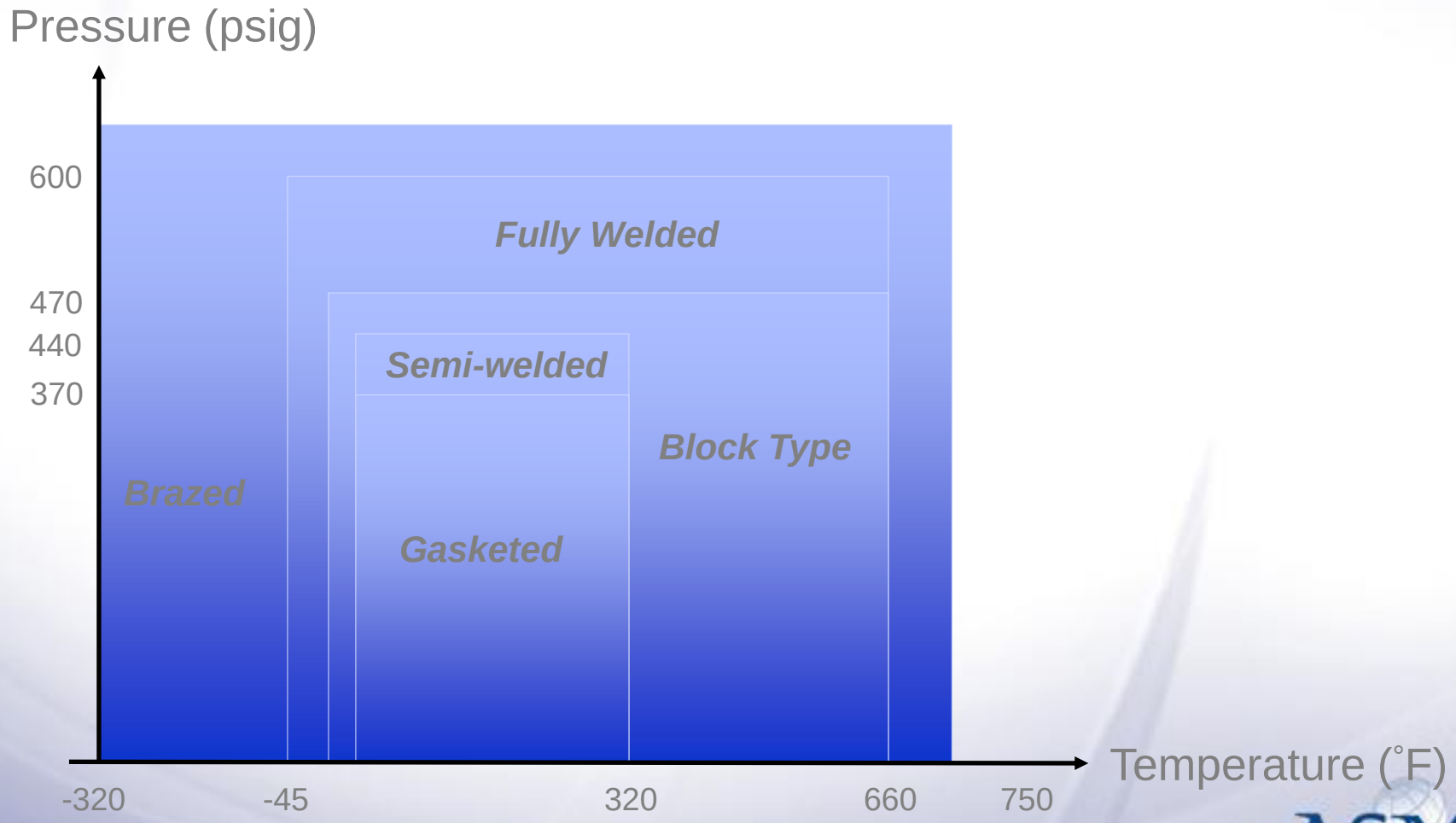


# VARIOUS PHE DESIGNS

# Basic PHE Design Categories

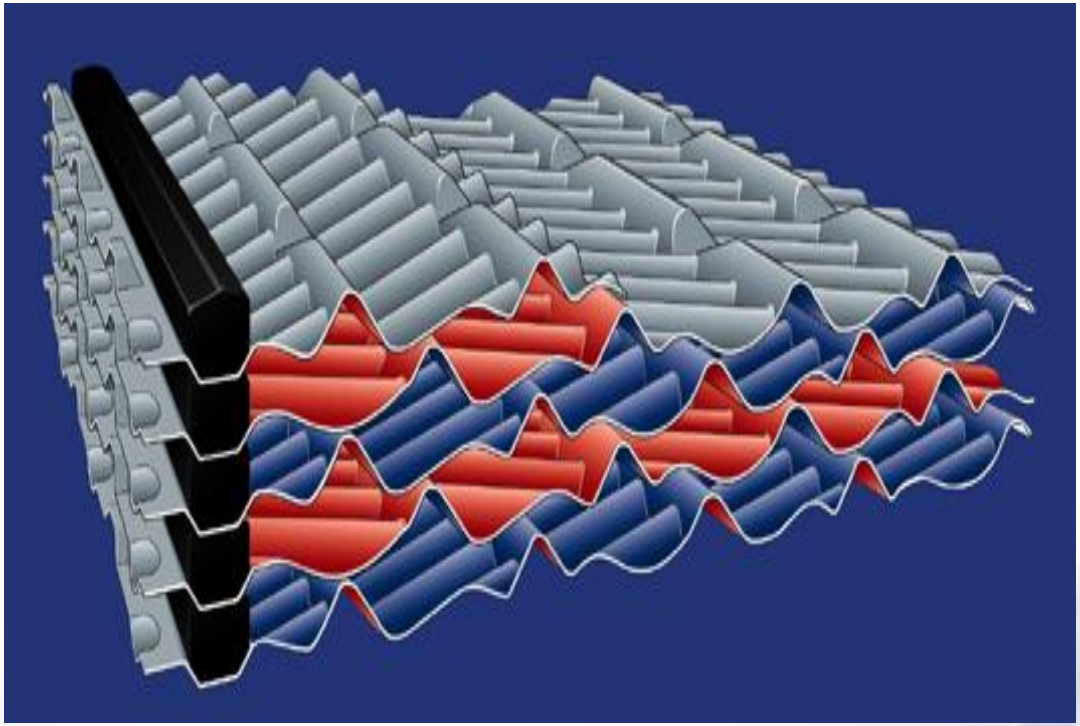
- Gasketed
- Semi-Welded
- Fully Welded
- Block Type
- Brazed

# Pressure and Temperature Limits

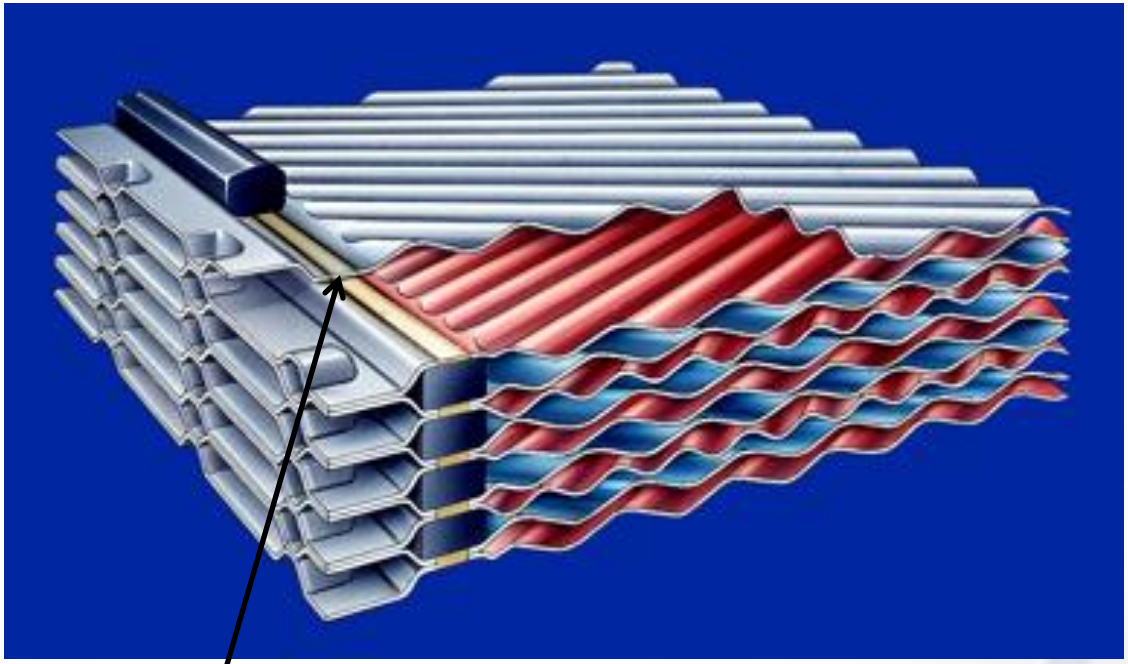


# Gasketed & Semi-Welded PHE Designs

# Gasketed Heat Transfer Plates



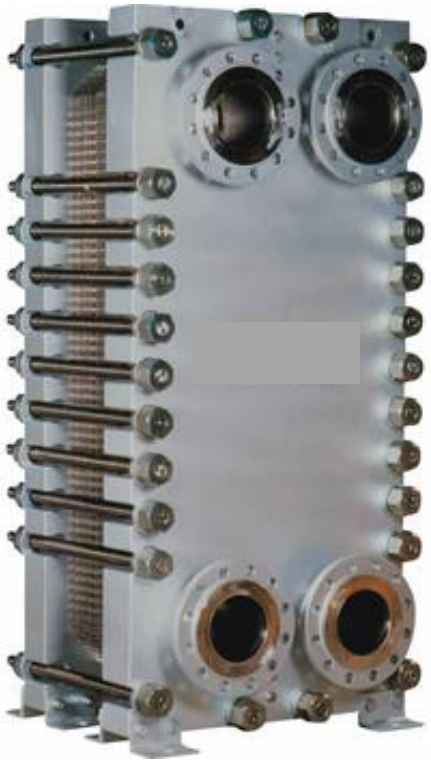
# Semi-Welded Heat Transfer Plates



Lap Joint Laser Welded

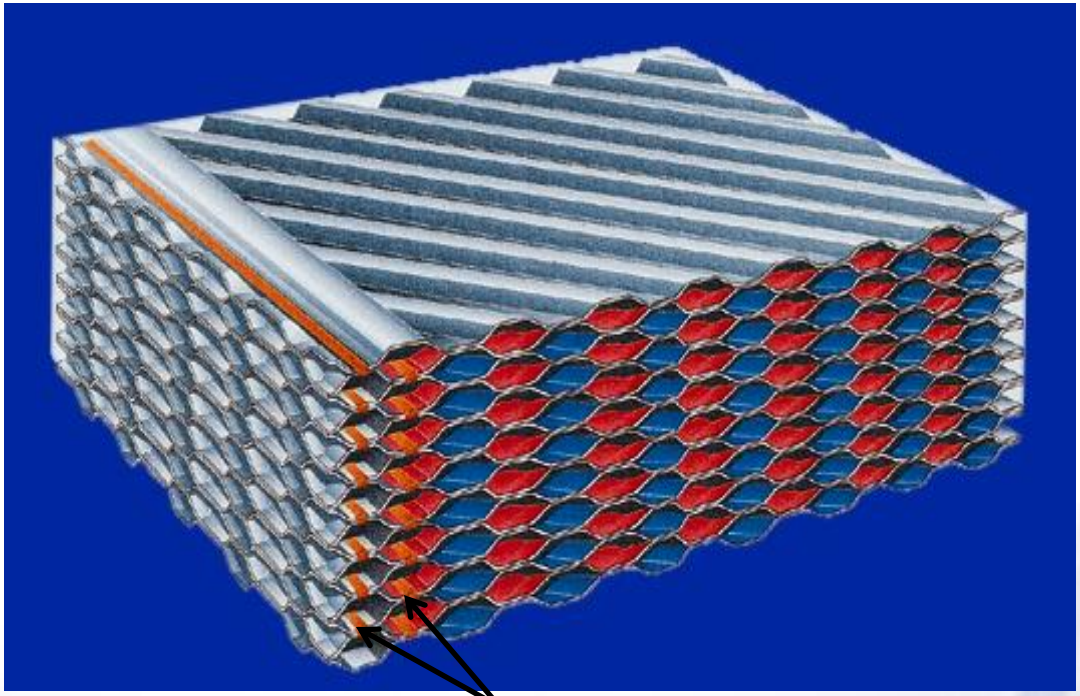
# Characteristics of a Gasketed & Semi-Welded Design

- Modular
- Expandable and Contractible
- Replaceable Parts
- Use of Non-Metallic Heat Transfer Plates
- May be Disassembled for Installation

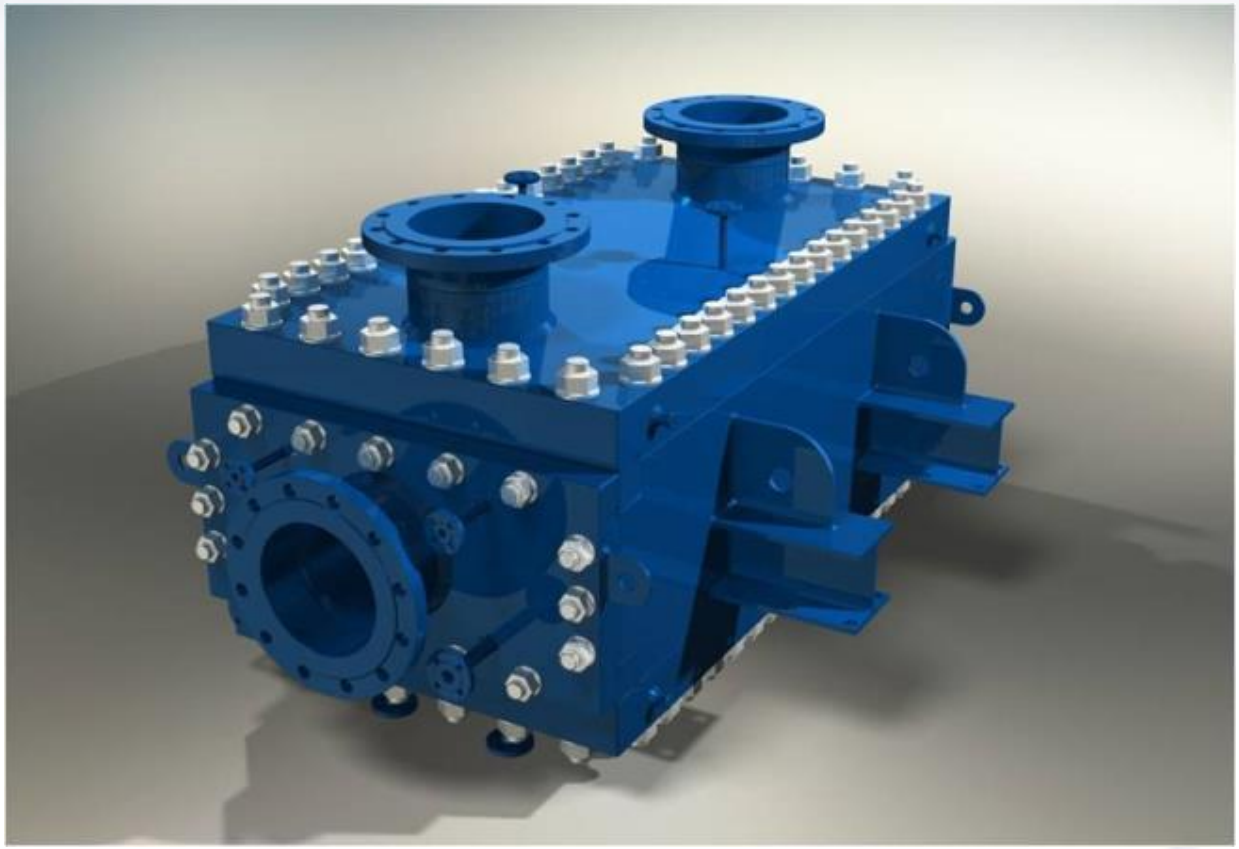


# FULLY WELDED HEAT TRANSFER PLATE DESIGNS

# Fully Welded Heat Transfer Plates

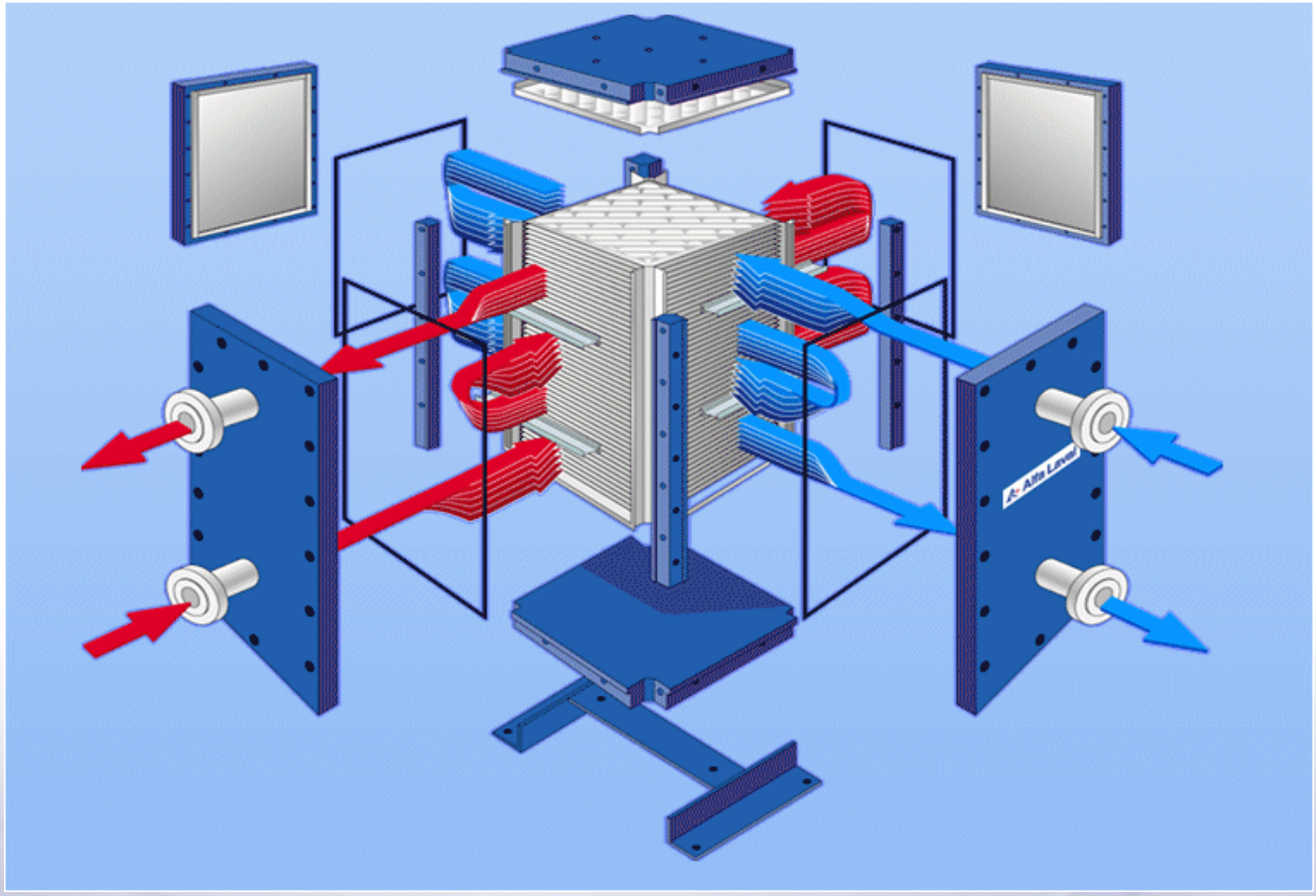


Lap Joint Laser Welded



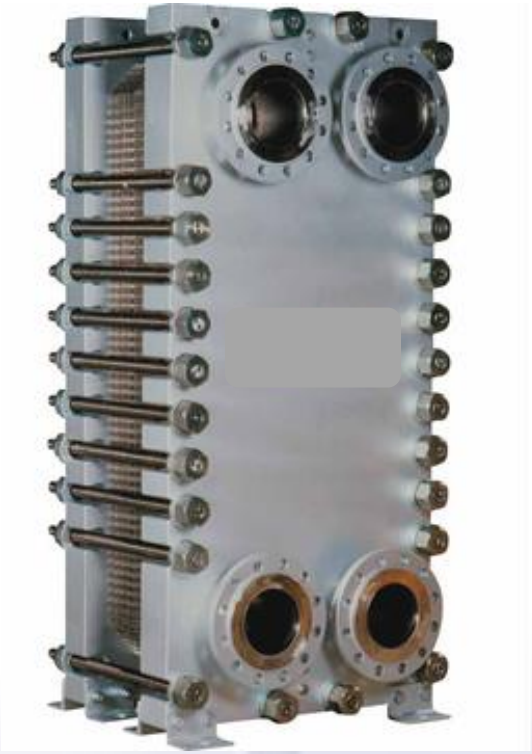
# BLOCK TYPE HEAT EXCHANGER

# Block Type Heat Exchanger



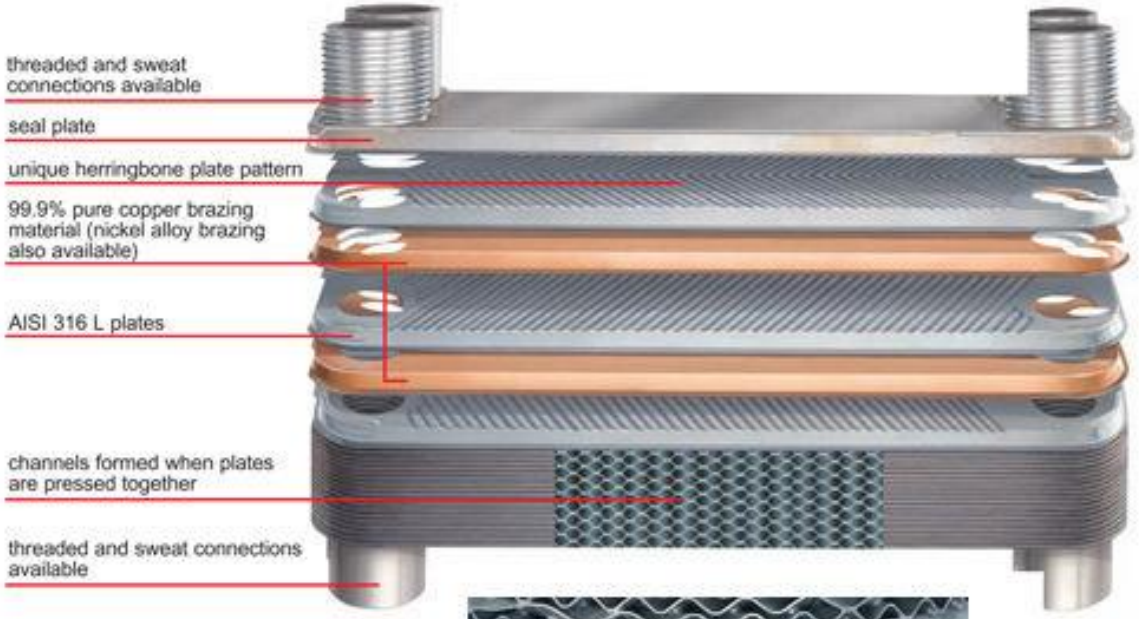
# Characteristics of Fully Welded

- Higher Temperatures & Pressures
- No Gaskets to Replace
- Avoids Gasket Fluid Permeation
- More Difficult to Alter/Repair



# BRAZED PLATE HEAT EXCHANGERS (BHE'S)

# BHE Assembly



# Copper Brazed BHE Cut Away

# Characteristics of the BHE

- Compact
- Largest Range of Temps and Pressure
- Robust Design
- Must Clean in Place
- Disposable

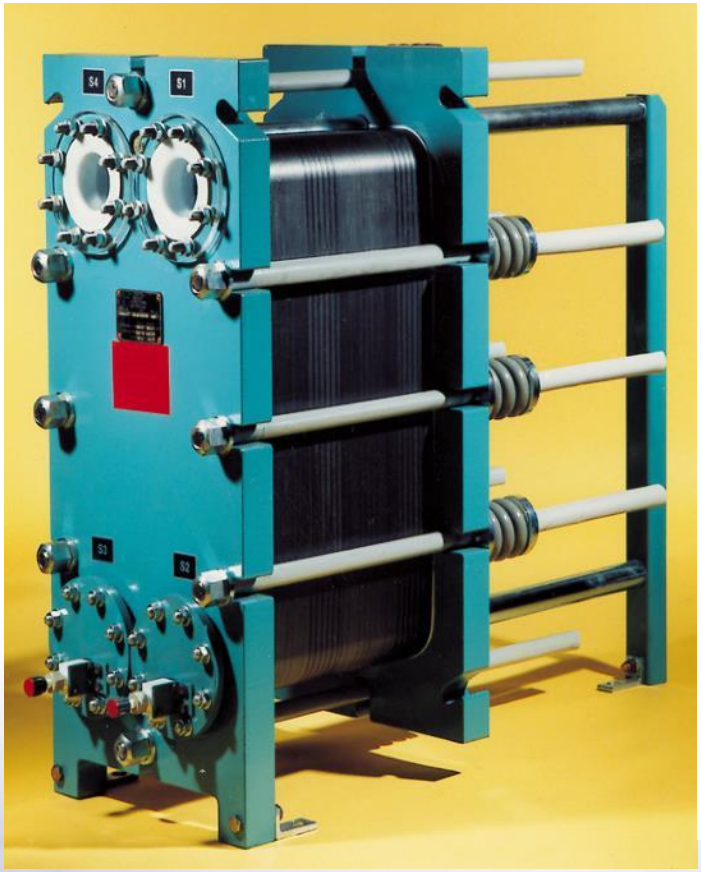
Chemical/Petrochemical/LNG
HVAC
Maritime
Dairy
Food
Pharmaceutical

Distillation/Ethanol
Lube Oil Coolers
Power Generation
Mining
Natural Gas
Ultrapure Water

# APPLICATIONS

# Chemical/Petrochemical/LNG

# Strong Acid: Non-Metallic Heat Transfer Plates



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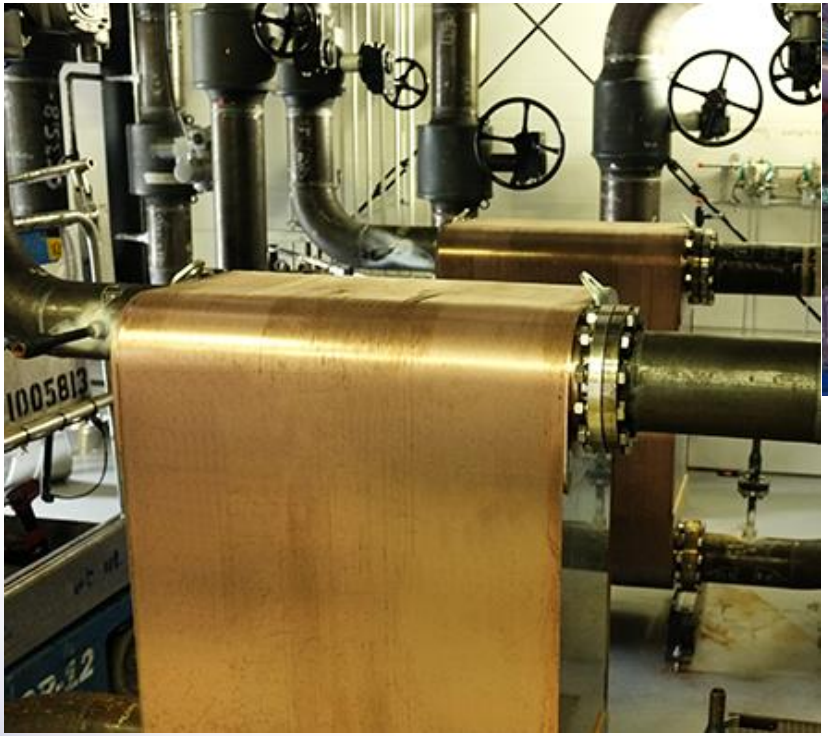
# HVAC Applications



# Maritime Applications

# Power Generation

Chilled Water Economizer

Lube Oil Cooler

# Distillation: Evaporators/Condensers

# Ultrapure Water

# Sanitary: Dairy & Brewery

## MANDATORY APPENDIX 45
## PLATE HEAT EXCHANGERS

(17)

### 45-1 SCOPE

The rules of this Appendix cover the minimum requirements for design, fabrication, assembly, inspection, testing, and documentation of gasketed, semiwelded, welded, and brazed plate heat exchangers (PHEs).

These rules cover the common types of PHEs and their elements but are not intended to limit the configurations or details to those illustrated or otherwise described herein. Designs that differ from those covered in this Appendix, as well as other types of PHEs, shall be in accordance with U-2(g).

### 45-2 MATERIALS OF CONSTRUCTION

All pressure-containing parts shall be constructed using materials permitted by this Division. Metallic and nonmetallic materials not permitted by this Division may be used specifically for heat transfer plates within the PHE, provided there is an applicable Code Case published for the limited use of this material as heat transfer plates within a plate pack.

### 45-3 TERMINOLOGY

#### 45-3.1 GENERAL

*brazed plate heat exchanger (PHE)*: an assembly consisting of fully brazed heat transfer plates. The heat transfer plates are stacked on top of each other and brazed together. The nozzles can be located on any fixed endplate.

*fully welded plate heat exchanger (PHE)*: an assembly consisting of fully welded heat transfer plates and its supporting frame. The frame provides structural support and pressure containment and consists of two fixed endplates and, if applicable, frame compression bolts. The frame may be fully bolted, fully welded, or a combination of bolted and welded. The heat transfer plates are fully welded to form a plate pack, and one or more plate packs can be assembled in the frame. The nozzles or connections can be located on the top, bottom, front, side, or back endplates.

*gasketed or semiwelded plate heat exchanger (PHE)*: an assembly of components consisting of gasketed or semiwelded heat transfer plates and its supporting frame. The gaskets provide periphery sealing between the compressed heat transfer plates or between the semiwelded plate pairs. The gaskets also provide additional sealing between adjacent heat transfer plates to prevent intermixing of the operating fluids. The frame provides structural support and pressure containment and consists of the fixed endplate, movable endplate, upper carrying bar, lower guide bar, support column, and frame compression bolts. The gasketed or semiwelded gasketed heat transfer plates are compressed between the fixed endplate and movable endplate by the frame compression bolts. The heat transfer plates and movable endplate are supported by the upper carrying bar and aligned with the lower guide bar. The support column provides structural support for the upper carrying bar and lower guide bar. The nozzles or connections can be located on the fixed endplate, movable endplate, or connection plate; see Figure 45-3.1-1.

#### 45-3.2 DEFINITIONS OF GASKETED OR SEMIWELDED PHE COMPONENTS

*connection plate*: an intermediary "endplate" located in the plate pack that permits additional nozzles, additional fluids, and redirection of flow patterns.

*divider plate*: a plate that changes the direction of the flow of the fluid in a two-pass or larger heat exchanger. Also called a turning plate.

*fixed endplate*: a fixed plate that provides pressure containment and locations for the nozzles or connections; it may or may not come with feet.

*frame*: a general term that describes structural support and pressure-containment components. The components may consist of a fixed endplate, a movable endplate, upper carrying and lower guide bars, a support column, and frame compression bolts.

*frame compression bolt*: a bolt assembly used to compress the fixed endplate, movable endplate, and heat transfer plates to affect a pressure seal.

*gasket*: a sealing element between single plates or semiwelded plate pairs.

*heat transfer plate*: a thin corrugated plate that makes up the plate pack and is in contact with the process fluids.

*movable endplate*: a movable plate that provides pressure containment and locations for the nozzles or connections.



# ELEMENTS OF MANDATORY PHE APPENDIX 45

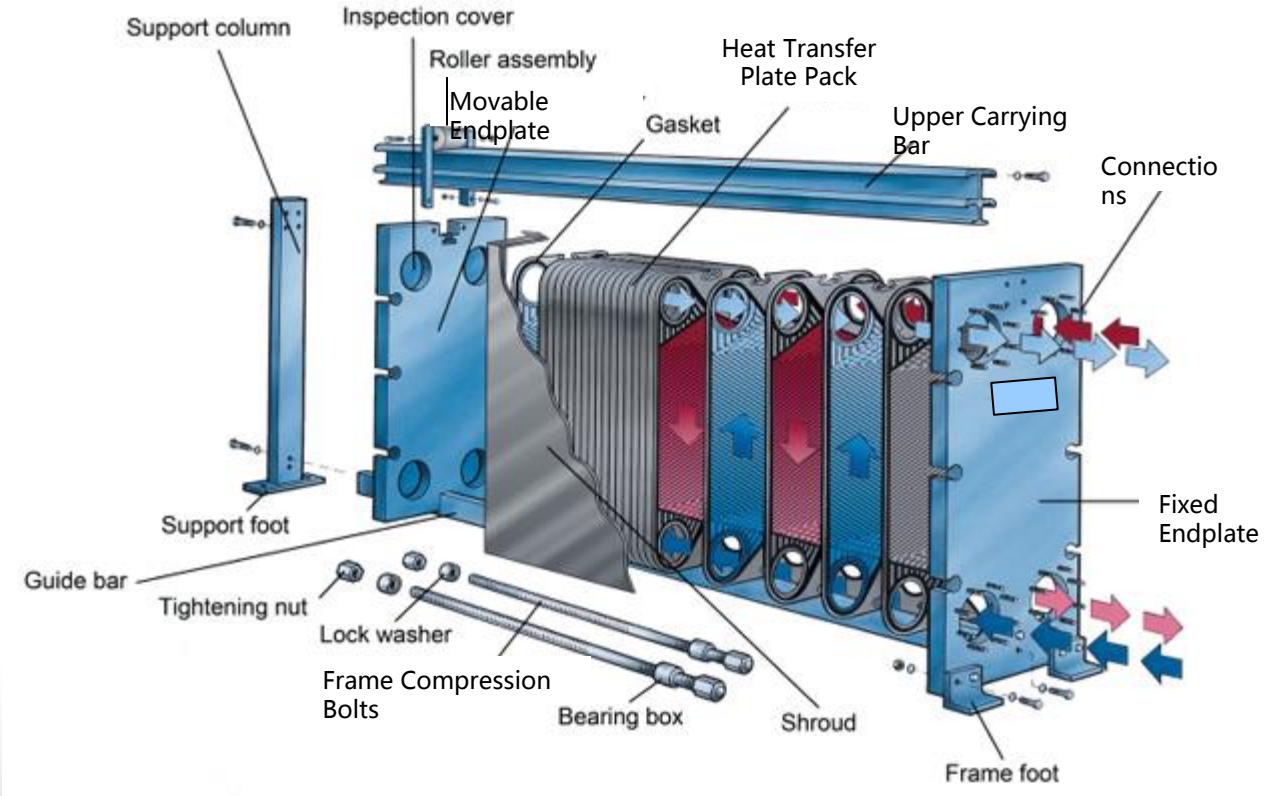


ASME SETTING THE STANDARD

# Key Elements of Appendix 45

- Definitions & Terminology
- Design
- Materials
- Pressure Testing
- Documentation

# Definitions & Terminology



# Design

- Fixed & Moveable Endplates Designed to U-2(g)
- Gasketed Plate Packs - 1.3x MAWP
- Fully Welded – UG-101 Proof Test
- Brazed – UG-101 Proof Test
- All Other Pressure Parts to Div. 1

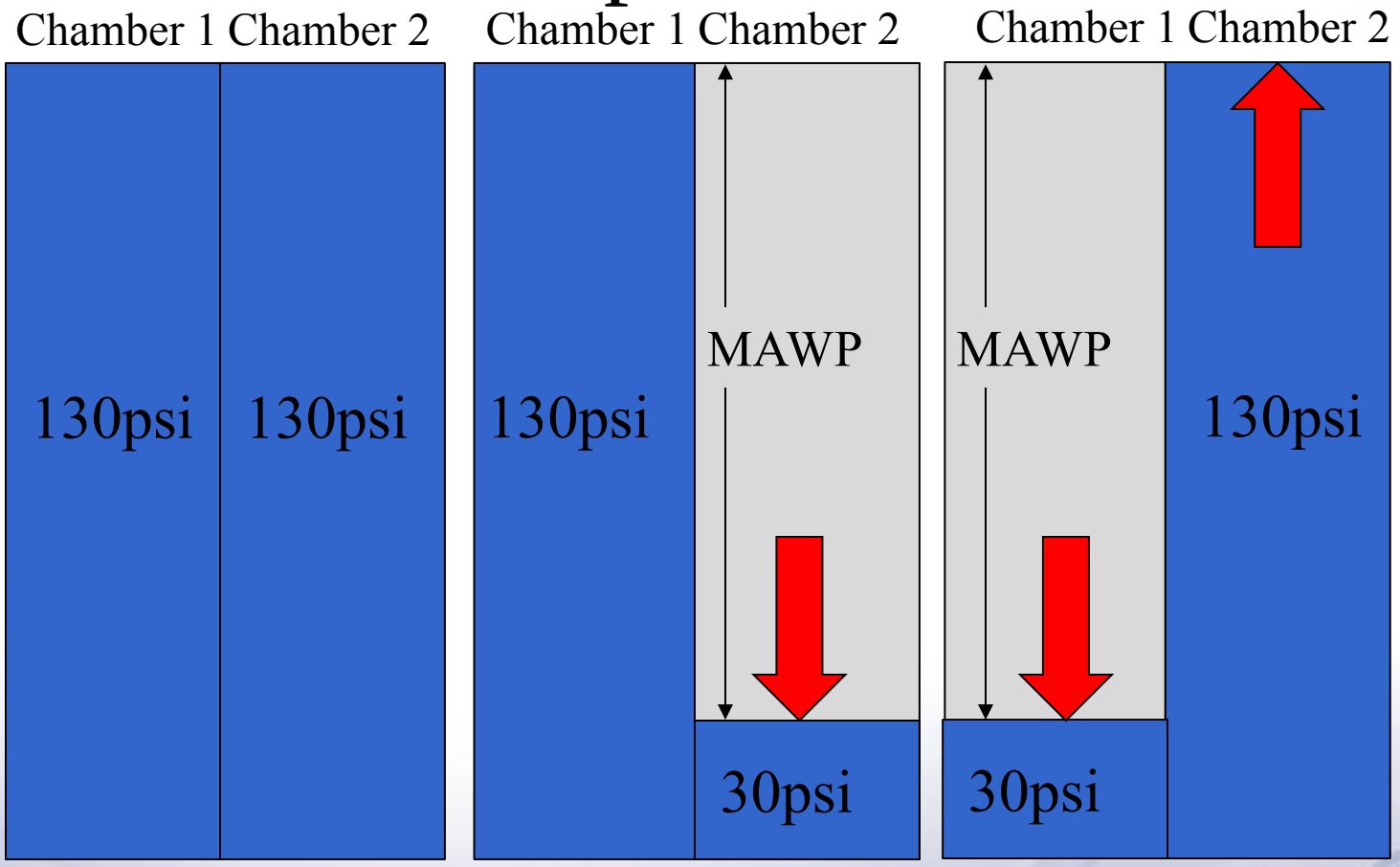
# Materials

- Endplates & Bolts Must Meet ASME Section II or CC
- Heat Transfer Plates May Use a Special Limited Code Case
- Nozzles & Fittings Must Meet ASME Section II
- Nozzle Liners are Exempt

# Pressure Testing

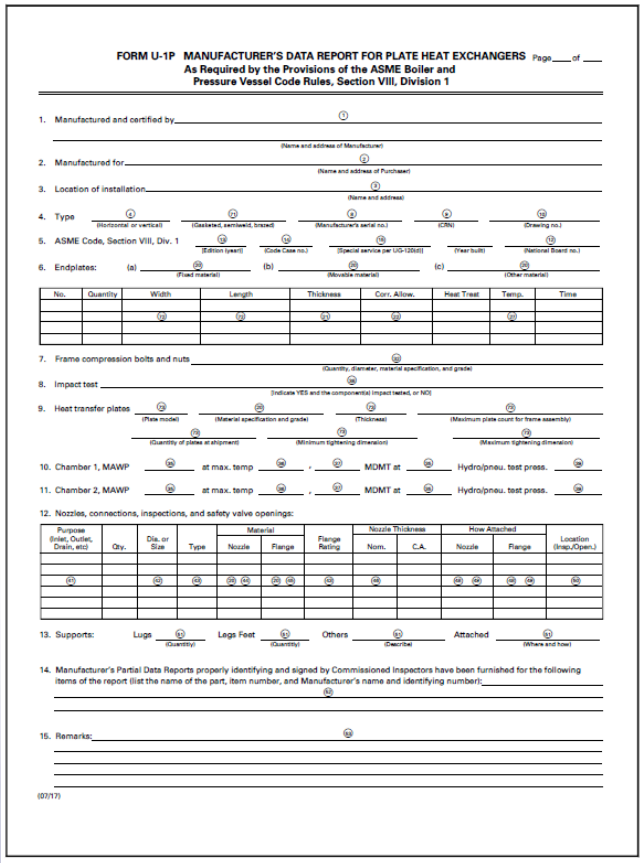
- In accordance with UG-99 or UG-100
  - The Vessel Must be Tested to 1.3x MAWP for Hydro (1.1x Pneumatic)
  - The Internal Heat Transfer Plates Must be Tested to at Least MAWP

# Pressure Testing Example: MAWP = 100psi



# Finally-Documentation

## Form U-1P



FORM U-1P MANUFACTURER'S DATA REPORT FOR PLATE HEAT EXCHANGERS Page ___ of ___
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by ①
(Name and address of Manufacturer)
2. Manufactured for ②
(Name and address of Purchaser)
3. Location of installation ③
(Name and address)
4. Type ④ (Horizontal or vertical) ⑦ (Gasketed, semiwelded, brazed) ⑧ (Manufacturer's serial no.) ⑨ (CRN) ⑩ (Drawing no.)
5. ASME Code, Section VIII, Div. 1 ⑪ (Edition (year)) ⑫ (Code Case no.) ⑬ (Special service per UG-125(d)) ⑭ (Year built) ⑮ (National Board no.)
6. Endplates: (a) ⑯ (Fixed material) (b) ⑰ (Movable material) (c) ⑱ (Other material)

| No. | Quantity | Width | Length | Thickness | Corr. Allow. | Heat Treat | Temp. | Time |
|---|---|---|---|---|---|---|---|---|
| | | ㉑ | ㉑ | ㉑ | ㉑ | | ㉑ | |

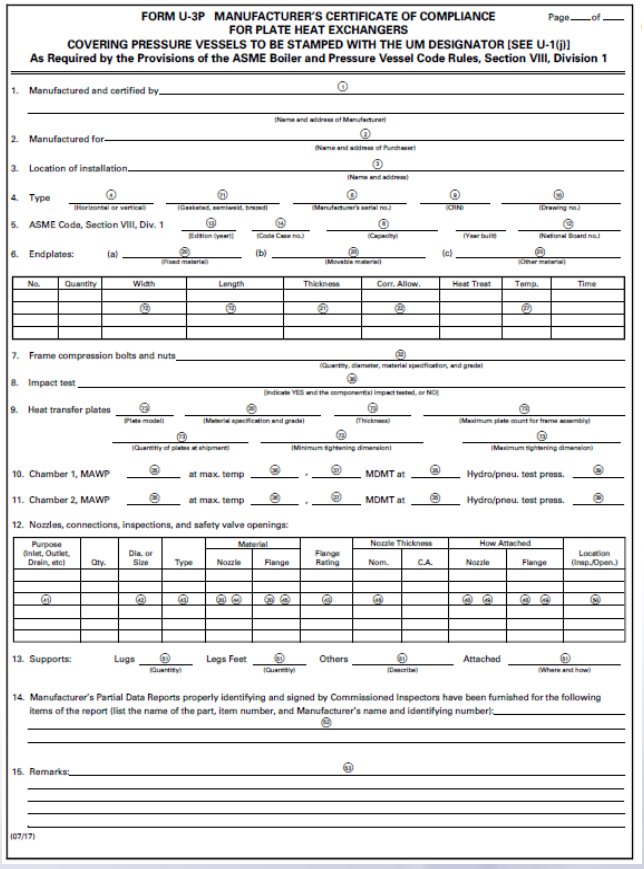
7. Frame compression bolts and nuts ㉒ (Quantity, diameter, material specification, and grade)
8. Impact test ㉓ (Indicate YES and the component(s) impact tested, or NO)
9. Heat transfer plates ㉔ (Plate model) ㉕ (Material specification and grade) ㉖ (Thickness) ㉗ (Maximum plate count for frame assembly) ㉘ (Quantity of plates at shipment) ㉙ (Minimum tightening dimension) ㉚ (Maximum tightening dimension)
10. Chamber 1, MAWP ㉛ at max. temp ㉜ / ㉝ MDMT at ㉞ Hydro/pneu. test press. ㉟
11. Chamber 2, MAWP ㊱ at max. temp ㊲ / ㊳ MDMT at ㊴ Hydro/pneu. test press. ㊵
12. Nozzles, connections, inspections, and safety valve openings:

| Purpose (Inlet, Outlet, Drain, etc) | Qty. | Dia. or Size | Type | Material: Nozzle | Material: Flange | Flange Rating | Nozzle Thickness: Nom. | Nozzle Thickness: C.A. | How Attached: Nozzle | How Attached: Flange | Location (Insp./Open.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ㊶ | | ㊷ | ㊸ | ㊹ ㊺ | ㊻ ㊼ | ㊽ | ㊾ | | ㊿ (51) | (52) (53) | (54) |

13. Supports: Lugs (55) (Quantity) Legs Feet (56) (Quantity) Others (57) (Describe) Attached (58) (Where and how)
14. Manufacturer's Partial Data Reports properly identifying and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of the part, item number, and Manufacturer's name and identifying number): (59)
15. Remarks: (60)

(07/17)

## Form U-3P



FORM U-3P MANUFACTURER'S CERTIFICATE OF COMPLIANCE FOR PLATE HEAT EXCHANGERS Page ___ of ___
COVERING PRESSURE VESSELS TO BE STAMPED WITH THE UM DESIGNATOR [SEE U-1(j)]
As Required by the Provisions of the ASME Boiler and Pressure Vessel Code Rules, Section VIII, Division 1

1. Manufactured and certified by ①
(Name and address of Manufacturer)
2. Manufactured for ②
(Name and address of Purchaser)
3. Location of installation ③
(Name and address)
4. Type ④ (Horizontal or vertical) ⑦ (Gasketed, semiwelded, brazed) ⑧ (Manufacturer's serial no.) ⑨ (CRN) ⑩ (Drawing no.)
5. ASME Code, Section VIII, Div. 1 ⑪ (Edition (year)) ⑫ (Code Case no.) ⑬ (Capacity) ⑭ (Year built) ⑮ (National Board no.)
6. Endplates: (a) ⑯ (Fixed material) (b) ⑰ (Movable material) (c) ⑱ (Other material)

| No. | Quantity | Width | Length | Thickness | Corr. Allow. | Heat Treat | Temp. | Time |
|---|---|---|---|---|---|---|---|---|
| | | ㉑ | ㉑ | ㉑ | ㉑ | | ㉑ | |

7. Frame compression bolts and nuts ㉒ (Quantity, diameter, material specification, and grade)
8. Impact test ㉓ (Indicate YES and the component(s) impact tested, or NO)
9. Heat transfer plates ㉔ (Plate model) ㉕ (Material specification and grade) ㉖ (Thickness) ㉗ (Maximum plate count for frame assembly) ㉘ (Quantity of plates at shipment) ㉙ (Minimum tightening dimension) ㉚ (Maximum tightening dimension)
10. Chamber 1, MAWP ㉛ at max. temp ㉜ / ㉝ MDMT at ㉞ Hydro/pneu. test press. ㉟
11. Chamber 2, MAWP ㊱ at max. temp ㊲ / ㊳ MDMT at ㊴ Hydro/pneu. test press. ㊵
12. Nozzles, connections, inspections, and safety valve openings:

| Purpose (Inlet, Outlet, Drain, etc) | Qty. | Dia. or Size | Type | Material: Nozzle | Material: Flange | Flange Rating | Nozzle Thickness: Nom. | Nozzle Thickness: C.A. | How Attached: Nozzle | How Attached: Flange | Location (Insp./Open.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ㊶ | | ㊷ | ㊸ | ㊹ ㊺ | ㊻ ㊼ | ㊽ | ㊾ | | ㊿ (51) | (52) (53) | (54) |

13. Supports: Lugs (55) (Quantity) Legs Feet (56) (Quantity) Others (57) (Describe) Attached (58) (Where and how)
14. Manufacturer's Partial Data Reports properly identifying and signed by Commissioned Inspectors have been furnished for the following items of the report (list the name of the part, item number, and Manufacturer's name and identifying number): (59)
15. Remarks: (60)

(07/17)

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# Thank You!