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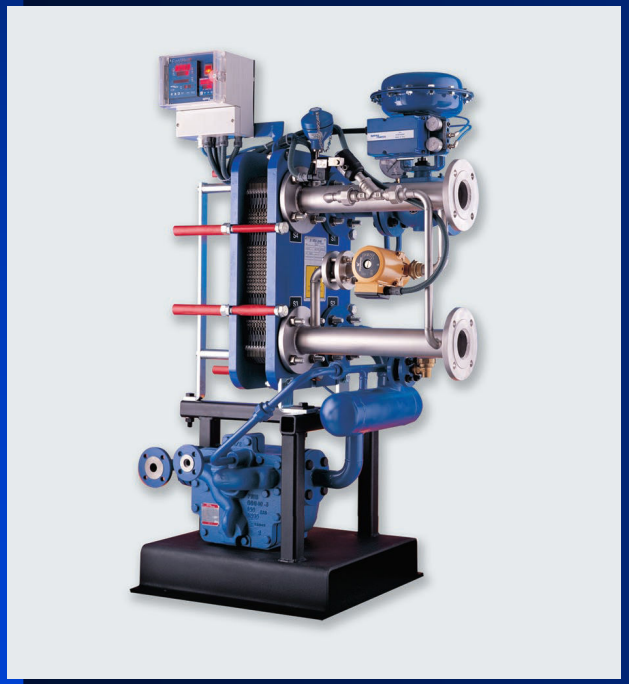
David Cronin-Ohio Valley Area Manager

Heat Transfer, Controls & Instrumentation, Metering.

Heat Exchangers



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Selection Issues

- Maximum design Capacity
- Steam Supply pressure
- Materials of construction
- Space and access
- Controls/Communication
- Steam Quality
- Load TURNDOWN
- Condensate quality & system Issues
- Maintenance of ALL components
- Maximum Pressure Drop allowed
- Water Quality-TDS, hardness, chlorides

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Selection Issues

- Maximum design Capacity
- Steam Supply pressure
- Materials of construction
- Space and access
- Controls/Communication
- Steam Quality
- Load **TURNDOWN**
- Condensate quality & system Issues
- Maintenance of ALL components

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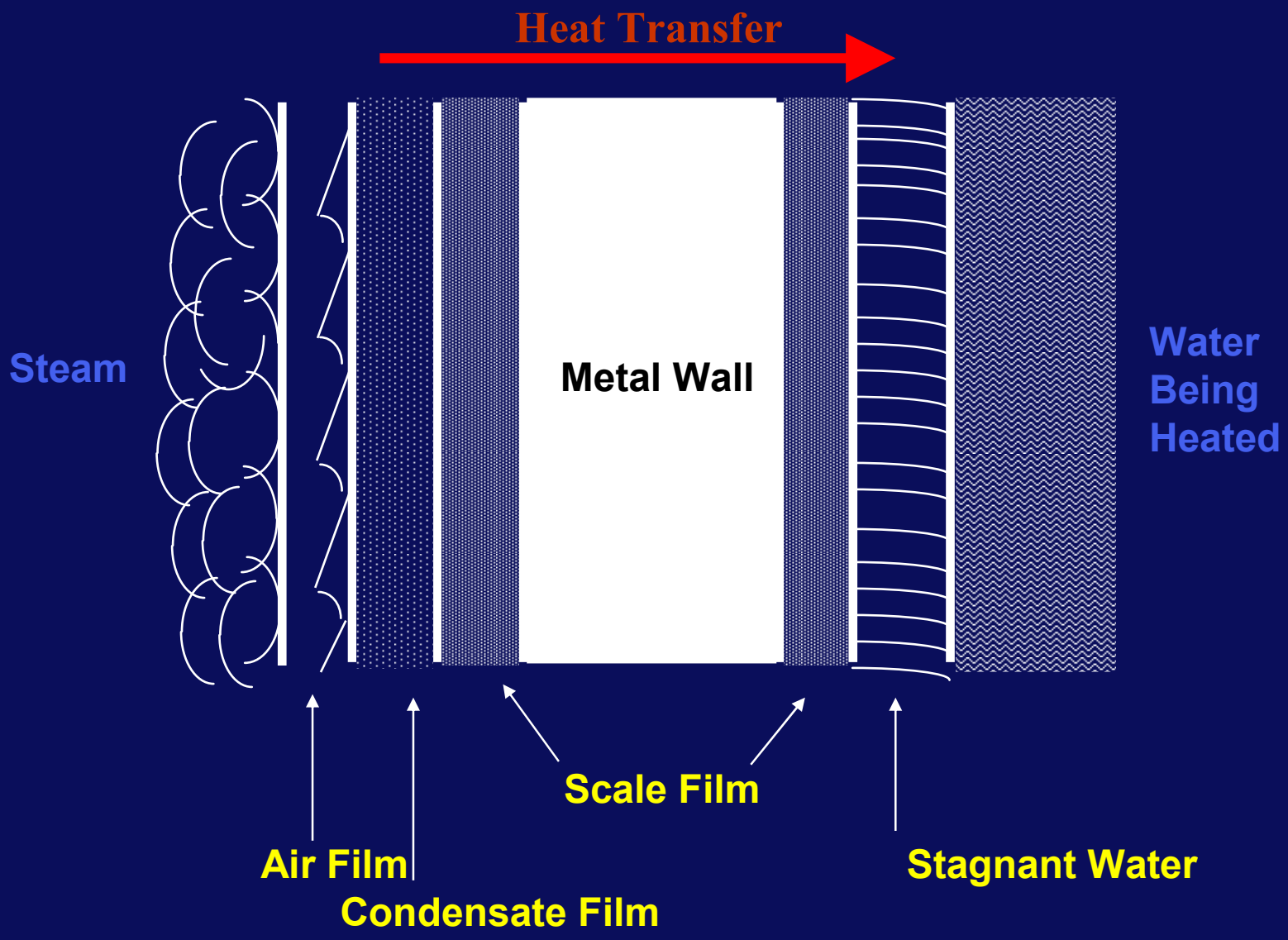
Heat Transfer Q = "U" x A x DT



a. **Systems That Use Hot Water Storage Tanks.** If a facility uses hot water storage tanks, raise the water temperature of all domestic hot water storage tanks to a minimum of 140 degrees Fahrenheit (°F) to prevent growth of *Legionella*. A master thermostatic mixing valve assembly must be installed on the discharge side to reduce water temperature to 130°F before distribution, with a maximum decrement in water temperature of 10°F (120°F) at the tap. ***NOTE:*** *The facility needs to consider the presence and operational requirements of any anti-scald devices when determining if 120°F to 129°F at the tap is feasible. If at least 120°F is not feasible at the tap, consider the periodic (at least annually) evaluation of the water distribution system for Legionella or the implementation of preventive measures to inhibit Legionella growth (e.g., hyperchlorination) or Legionella transmission to patients (e.g., point-of-use filters).*

b. **Systems That Use Instantaneous Hot Water Heaters**

(1) If the facility has an instantaneous hot water heater that feeds instantly heated water directly into a circulating distribution system, then the water can be discharged into the circulating distribution system at 130°F without the need of a mixing valve. The maximum decrement in water temperature at the tap shall be 10°F (120°F). ***NOTE:*** *The facility needs to consider the presence and operational requirements of any anti-scald devices when determining if 120°F to 129°F at the tap is feasible. If at least 120°F is not feasible at the tap, consider the periodic (at least annually) evaluation of the water distribution system for Legionella or the implementation of preventive measures to inhibit Legionella growth (e.g., hyperchlorination) or Legionella transmission to patients (e.g., point-of-use filters).*

(2) If the facility has an instantaneous hot water heater that is configured to feed into a storage tank before the water enters the circulating distribution system, then raise the water temperature to a minimum of 140°F in the storage tank and distribute the hot water as described above (Att. A, subpar. 1a). It is encouraged that facilities that use instantaneous hot water heaters select systems that feed directly into circulating distribution systems to avoid the use of storage tanks and to conserve energy.

Steam Supply Quality

- LP steam carries more Btu's, increases efficiencies.
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- LP steam typically requires PRV's to generate from HP.
- PRV's require space and give more to maintain.
- LP steam requires large pipes.
- LP condensate is difficult to drain from HX.

- HP steam requires no PRV's and smaller pipe.
- HP steam makes HX, conditioning, & control equipment smaller.
- Installation less expensive with HP steam.

- We can combine the benefits from both systems !

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Methods of Control

Constant Pressure with float & thermostatic steam trap- “Wild loop”

Constant Pressure with float & thermostatic steam trap in conjunction with mixing valve

Constant Pressure with control of the heating surface

Control “Mass” flow of steam with discharge temperature of the Secondary Side

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Typical HX ???-Open System

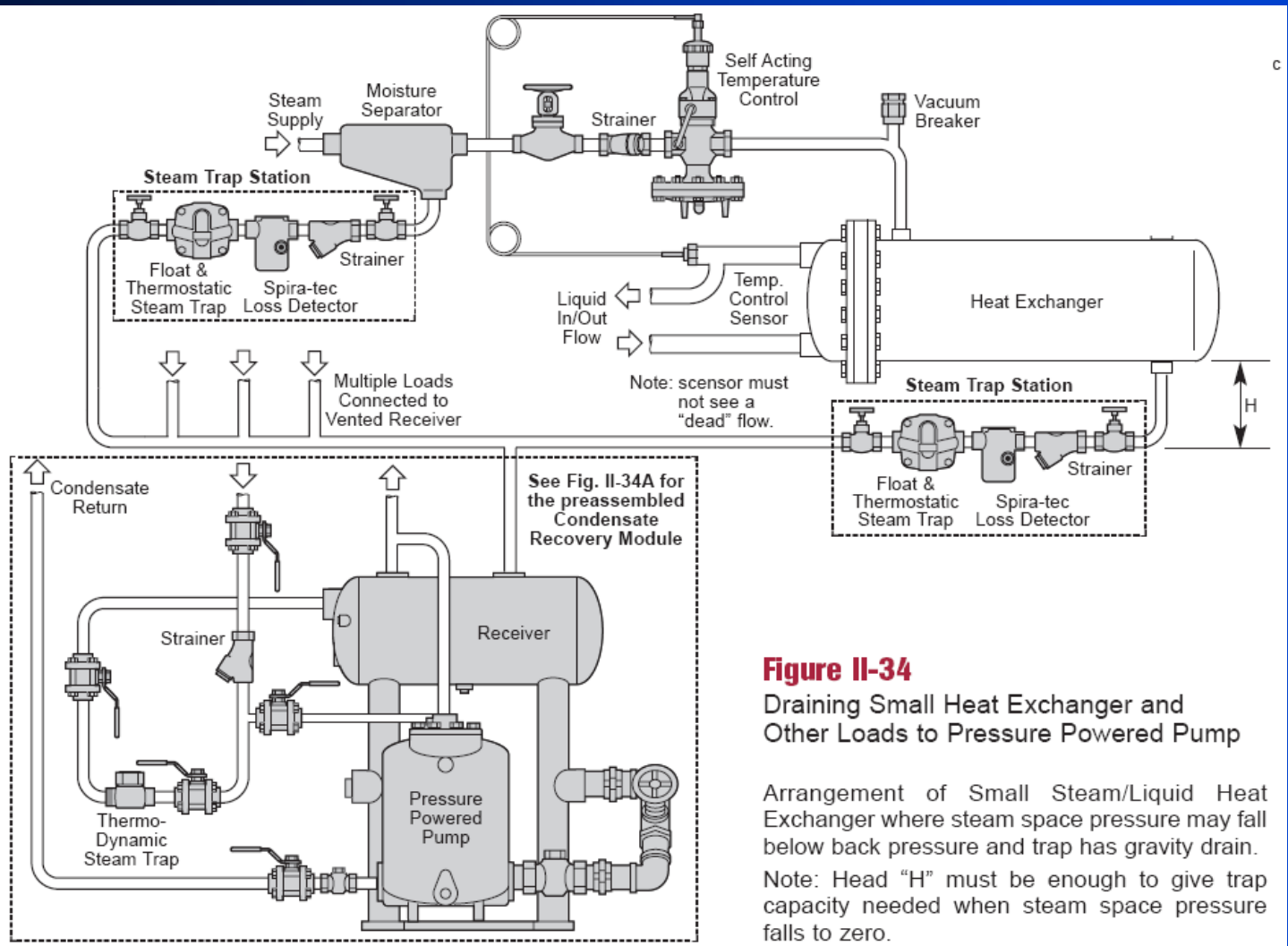

Figure II-34
Draining Small Heat Exchanger and Other Loads to Pressure Powered Pump

Arrangement of Small Steam/Liquid Heat Exchanger where steam space pressure may fall below back pressure and trap has gravity drain.

Note: Head "H" must be enough to give trap capacity needed when steam space pressure falls to zero.

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Steam and Condensate Quality

- Vacuum breakers introduce air !!!!
- Reverses Heat Transfer !!!!
- Wastes steam !!!!
- Increases duty cycles of heat transfer equipment !!!!
- Increases duty cycles of Control equipment !!!!
- Barriers heat transfer, reduces heating efficiency !!!!
- Reduces equipment capability to handle load changes !!!!
- Corrodes (oxygen pitting) Heat Transfer Equipment !!!!
- Generates Carbonic Acid !!!!
- Erodes Heat Transfer Equipment !!!!
- Corrodes/erodes Condensate System !!!!
- Increases Chemical requirements !!!!

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“STALL” Issues

Definition: The point at which the necessary pressure differential across the trap is below the point at which condensate can be removed from the heat exchanger.

- **Poor Control !!!!**
- **Slow response to load changes !!!!**
- **Noise !!!!**
- **Waterhammer !!!!**
- **Leaking Gaskets !!!!**
- **Damaged / Failed Equipment !!!!**
- **Increased Maintenance !!!!**
- **Premature failure due to thermal Cycling**

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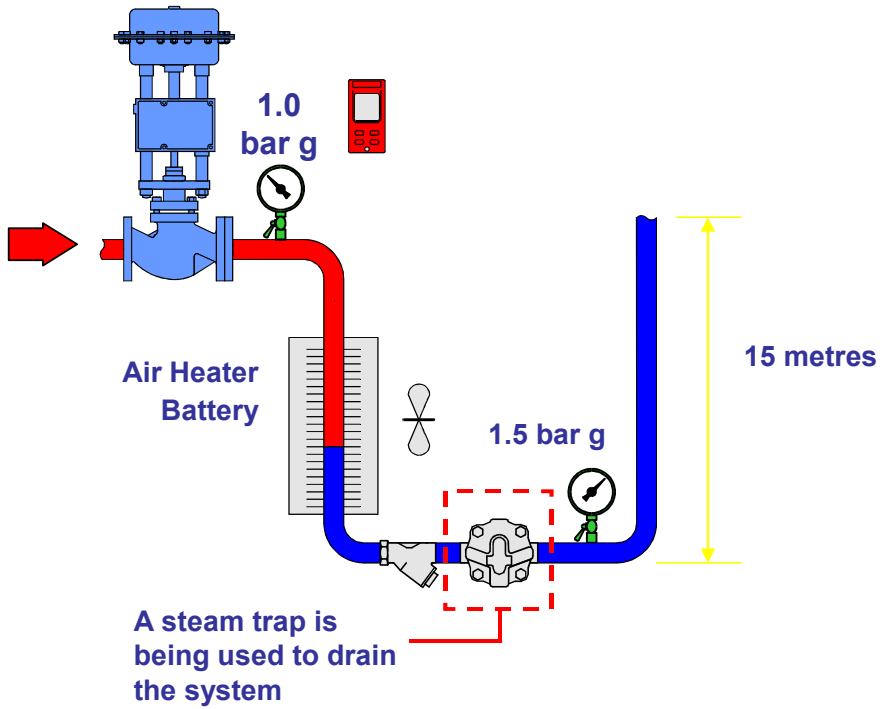
Loss of Positive Differential Pressure

Stall due to elevated return line

APT range



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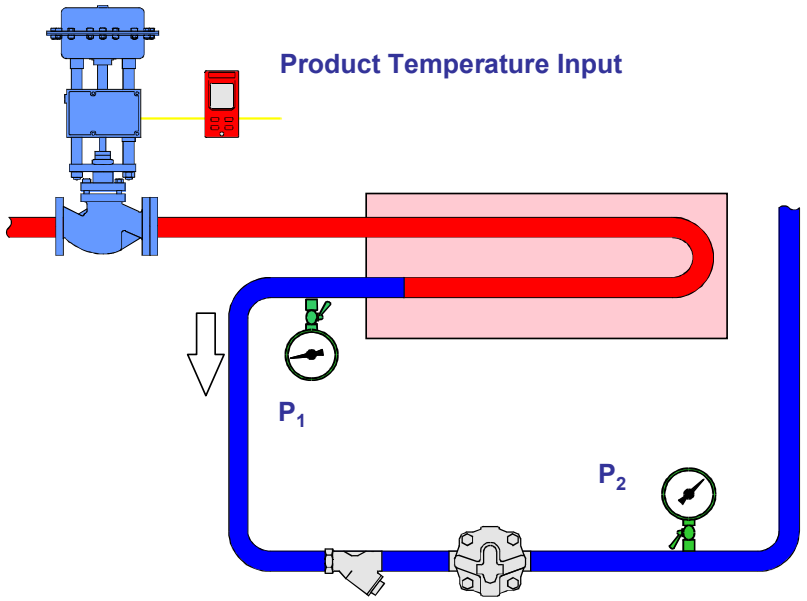
Condensate backing up into heat exchanger-loss of “A”

Stall conditions

APT range



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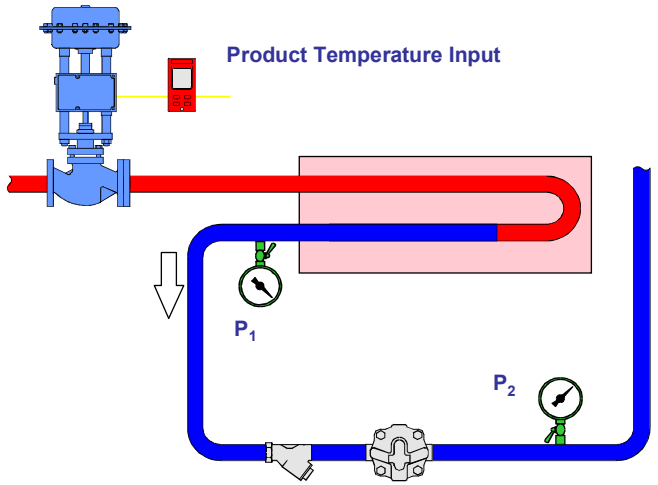
Temperature Control Valve Opens and positive differential pressure is increased.

Stall conditions

APT range



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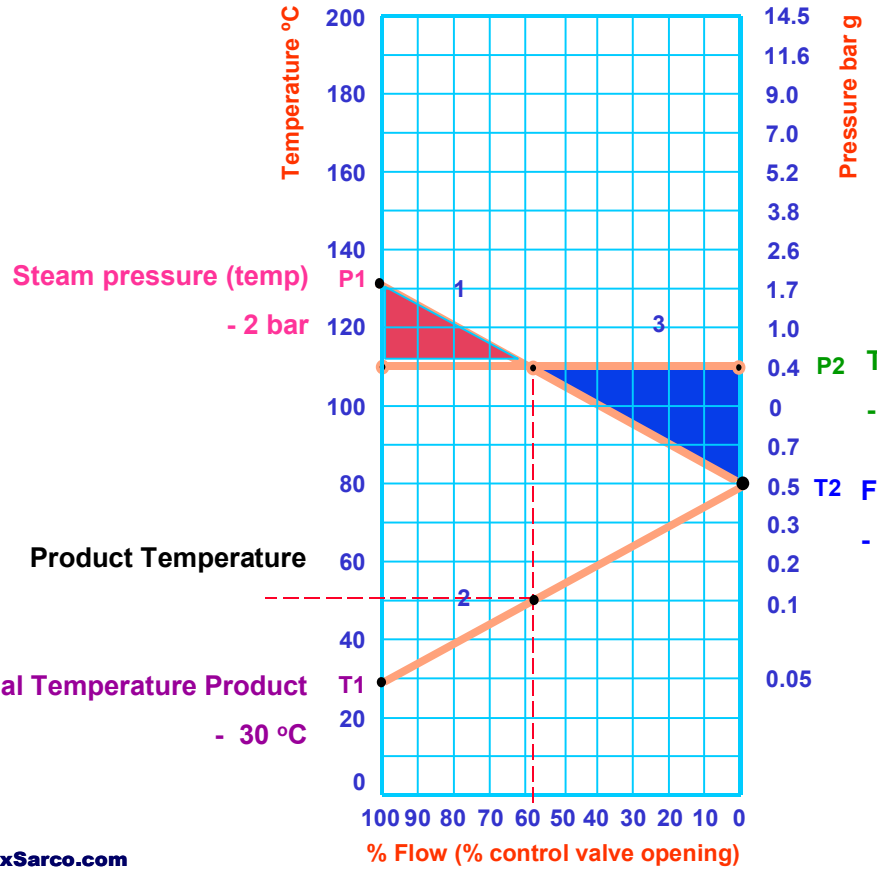
“Stall Chart”

Variable inlet temperature stall chart

APT range



Steam pressure (temp)

- 2 bar

Product Temperature

Initial Temperature Product

- 30 °C

Air Heater Application

P2 Total back pressure

- 0.4 bar

T2 Final Temperature product

- 80 °C

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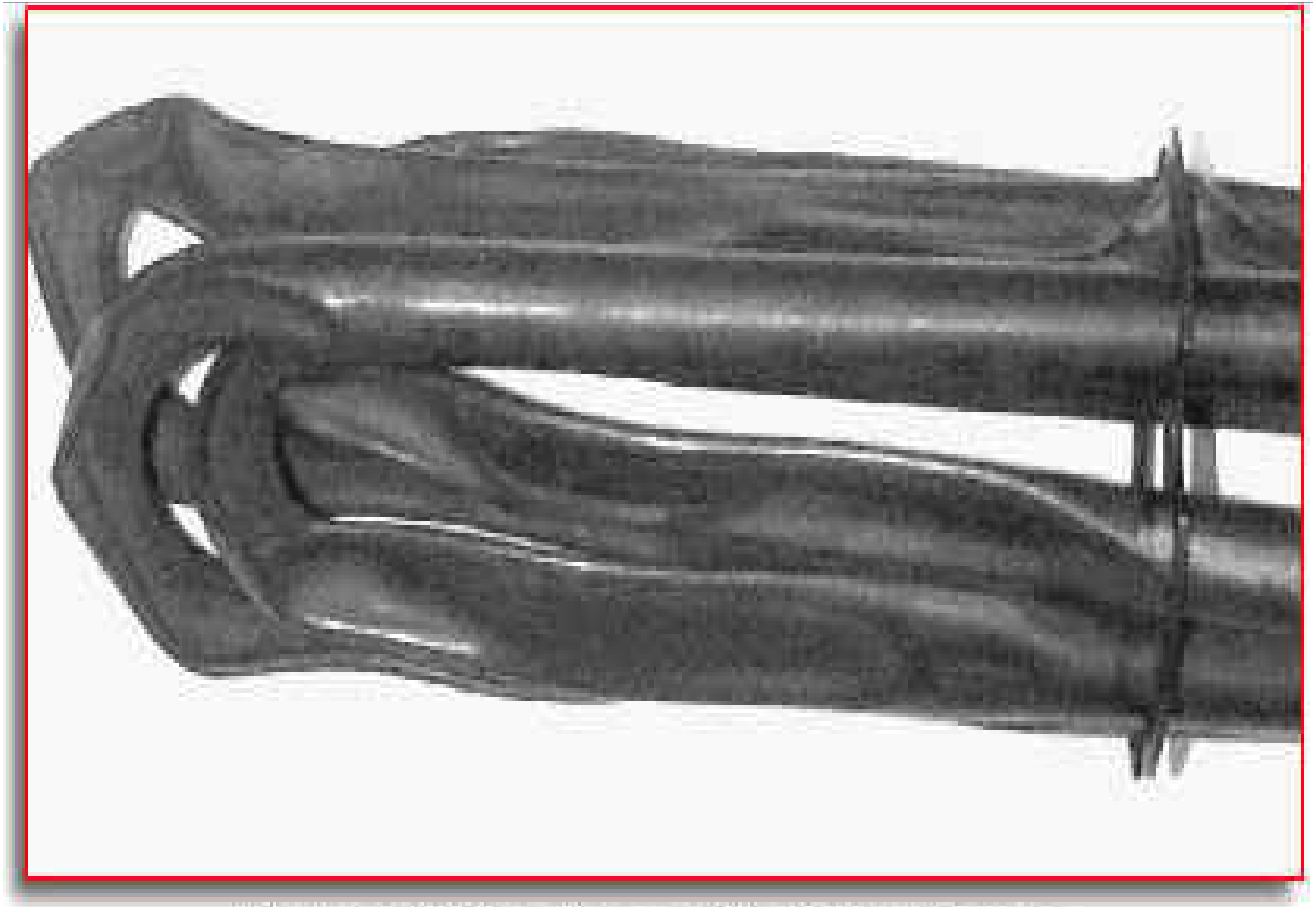

Picture of Tubes Damaged by Water Hammer

Typical Heat Exchanger Types Used

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- Shell and Tube-most common
- Plate and Frame
- Plate and Shell

Shell & Tube Heat Exchanger

- Horizontal or Vertical Installations
- Lowest “U” value of the 3 types
- “Withdrawal” distance equal to length of heat exchanger
- Lowest Cost in low to medium flowrates
- Simple Design
- Steam should be installed in the shell side
- Lowest Pressure Drop on Product Side

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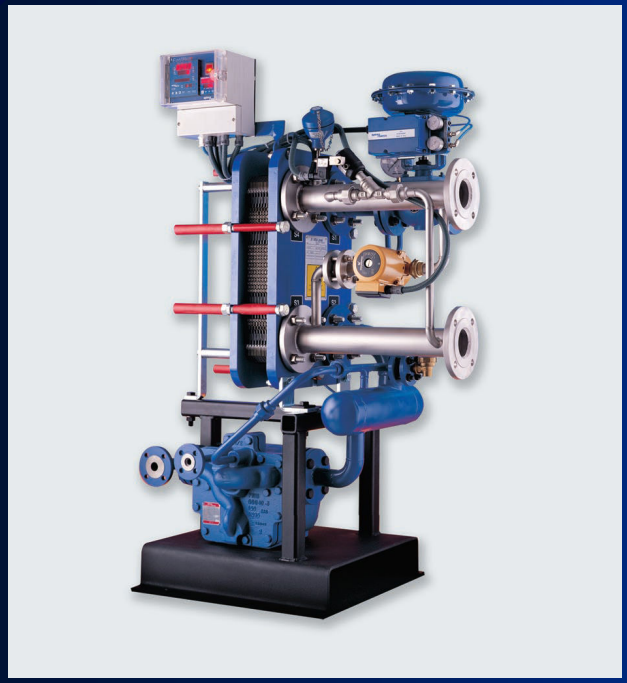
Plate & Frame Heat Exchanger



- Very High “U” Value
- Ability to increase/decrease area with process changes
- Stainless steel is standard in gasketed models
- Small Footprint and floor space
- No Withdrawal distances required
- Install new plate pack WITHOUT pipe disruptions
- Long history of use in the process industries
- History of failure in steam systems due to “Stall”
- Perception that they do not work in steam systems

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Plate & Shell

- Very High “U” Values
- Typically used for high flowrates
- Not susceptible to thermal cycling
- Long History in the OPC Market
- Repairable Units relatively expensive
- Sealed units can be cost effective in high flow conditions
- Higher Pressure drop on process side

Closed Loop Drainage

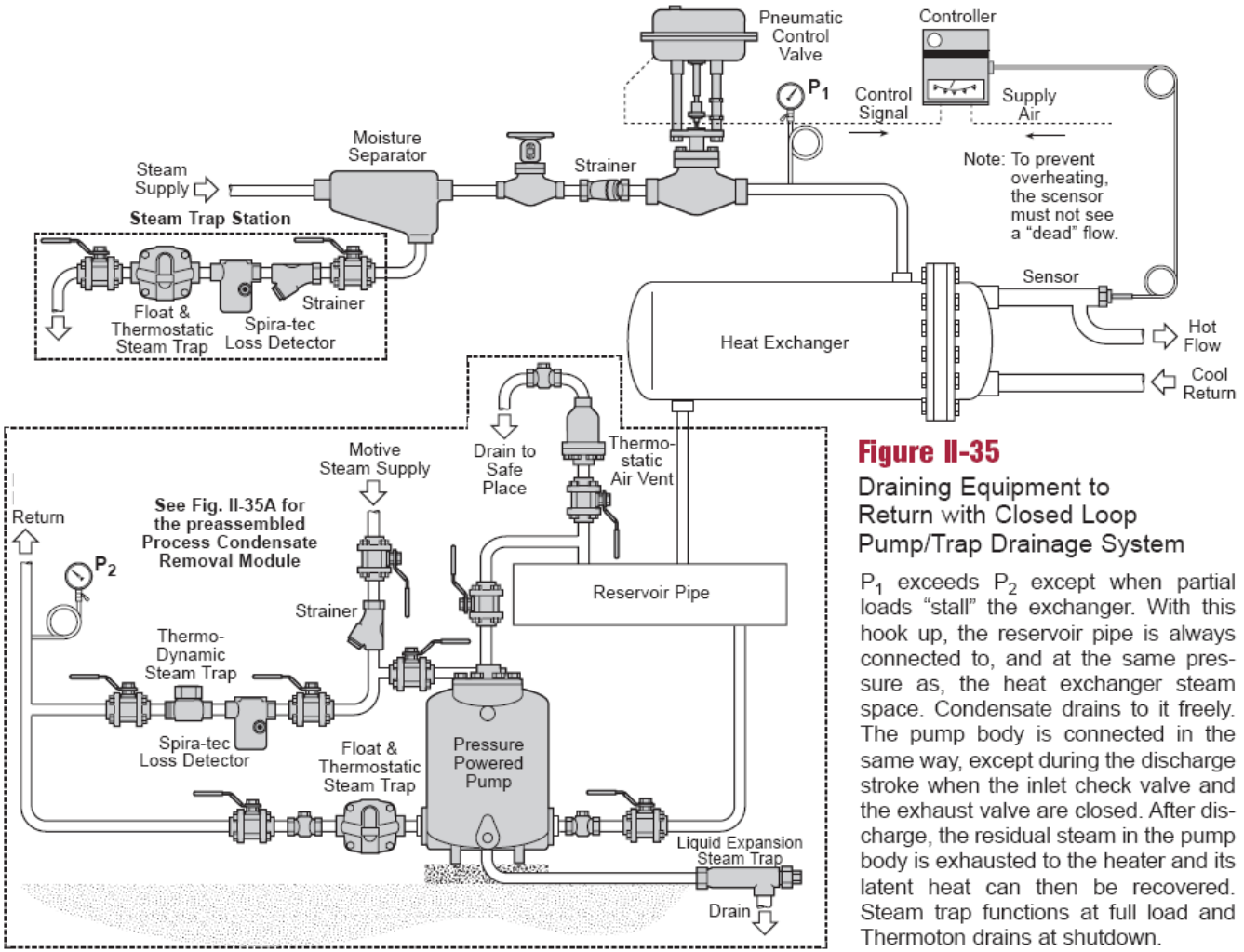

Figure II-35

Draining Equipment to Return with Closed Loop Pump/Trap Drainage System

P_1 exceeds P_2 except when partial loads "stall" the exchanger. With this hook up, the reservoir pipe is always connected to, and at the same pressure as, the heat exchanger steam space. Condensate drains to it freely. The pump body is connected in the same way, except during the discharge stroke when the inlet check valve and the exhaust valve are closed. After discharge, the residual steam in the pump body is exhausted to the heater and its latent heat can then be recovered. Steam trap functions at full load and Thermoton drains at shutdown.

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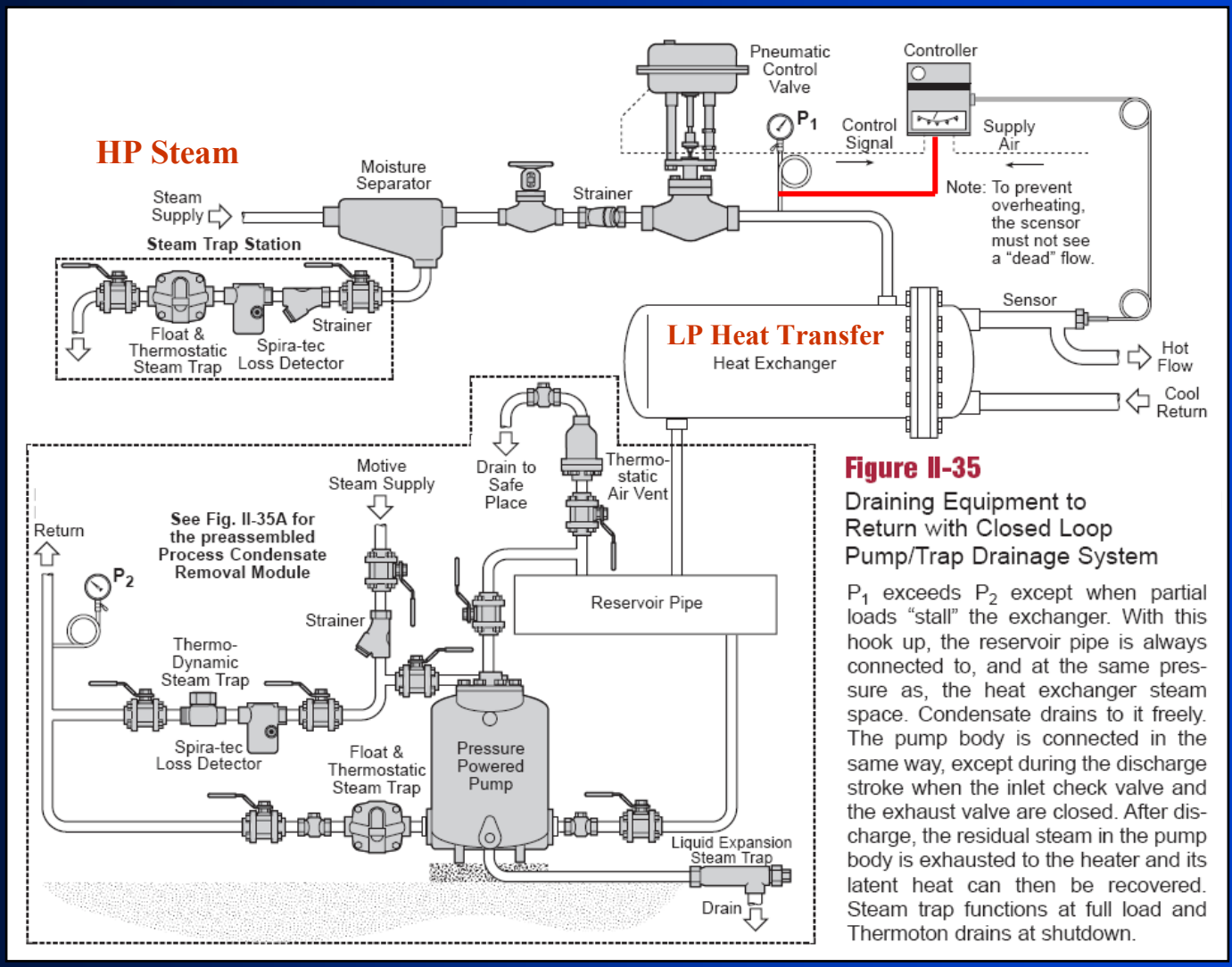
Closed Loop Drainage +



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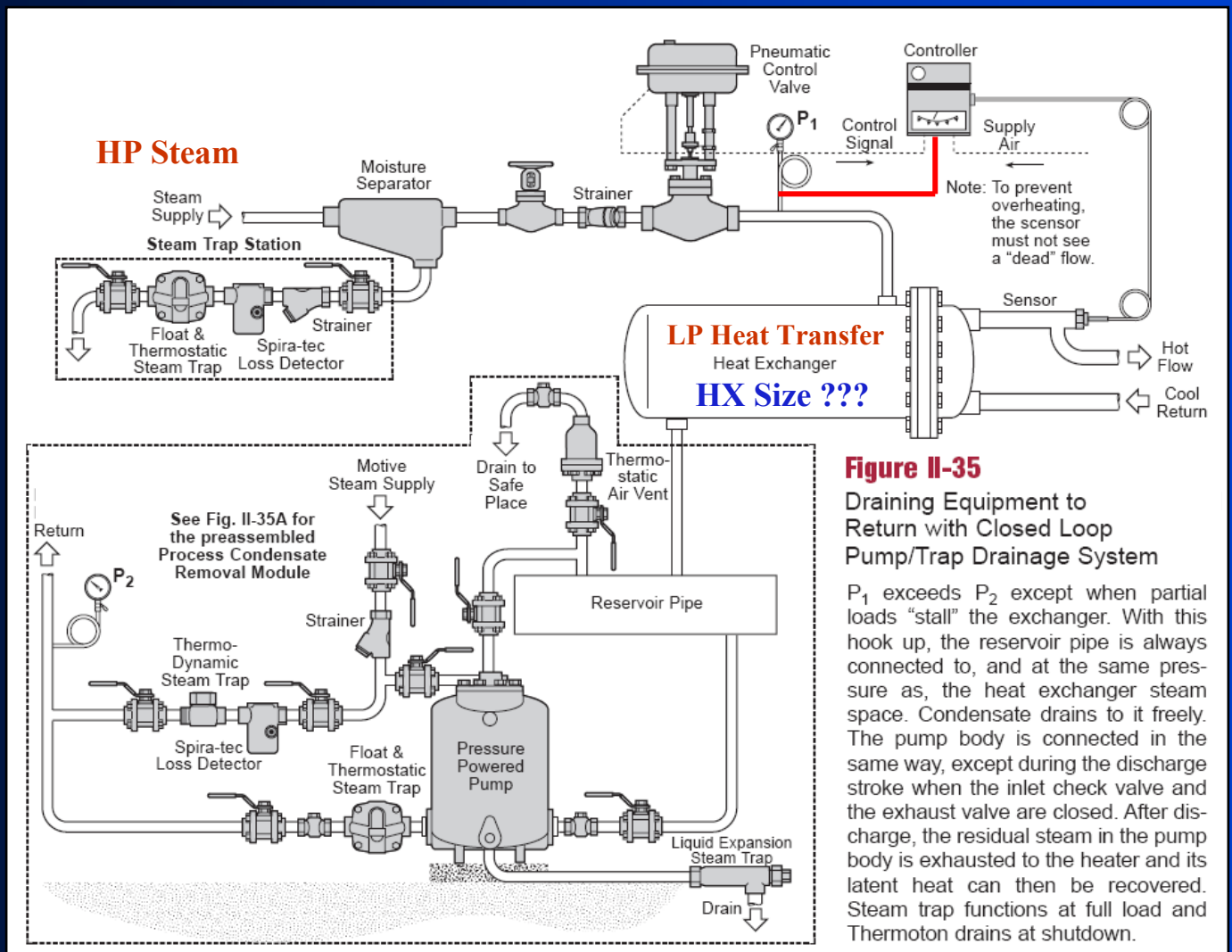

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Plate & Frame HX

- Smaller Footprint
- Large Surface Area's for LP Transfer.
- NO Tube Withdrawal space req'd
- Easier to maintain
- Some Flexibility with capacity
- Stainless wetted parts as standard
- Higher efficiency
- Better control Accuracy
- More responsive

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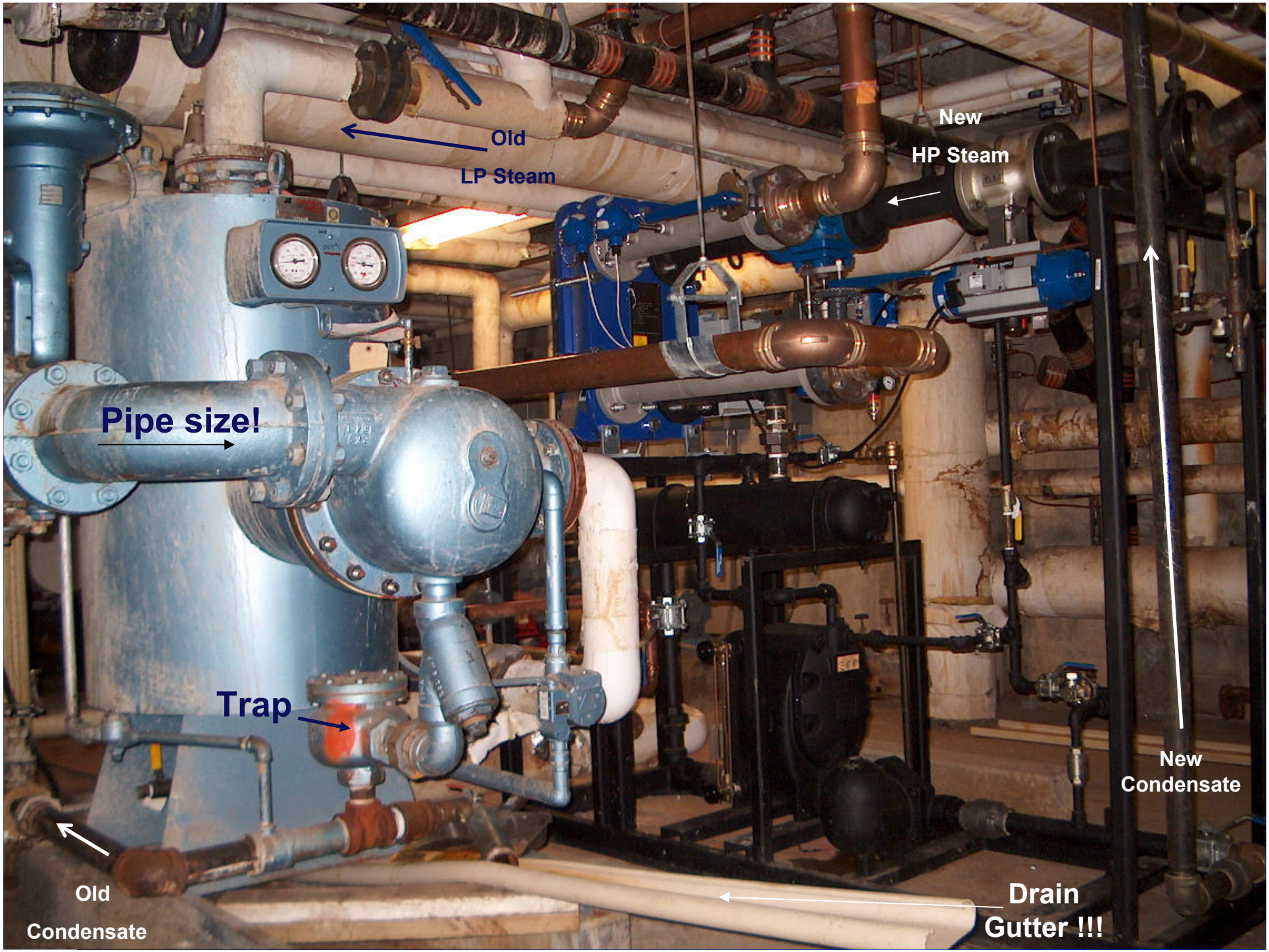
Old
LP Steam
New
HP Steam
Pipe size!
Trap
New
Condensate
Old
Condensate
Drain
Gutter !!!

EASI-HEAT UNITS

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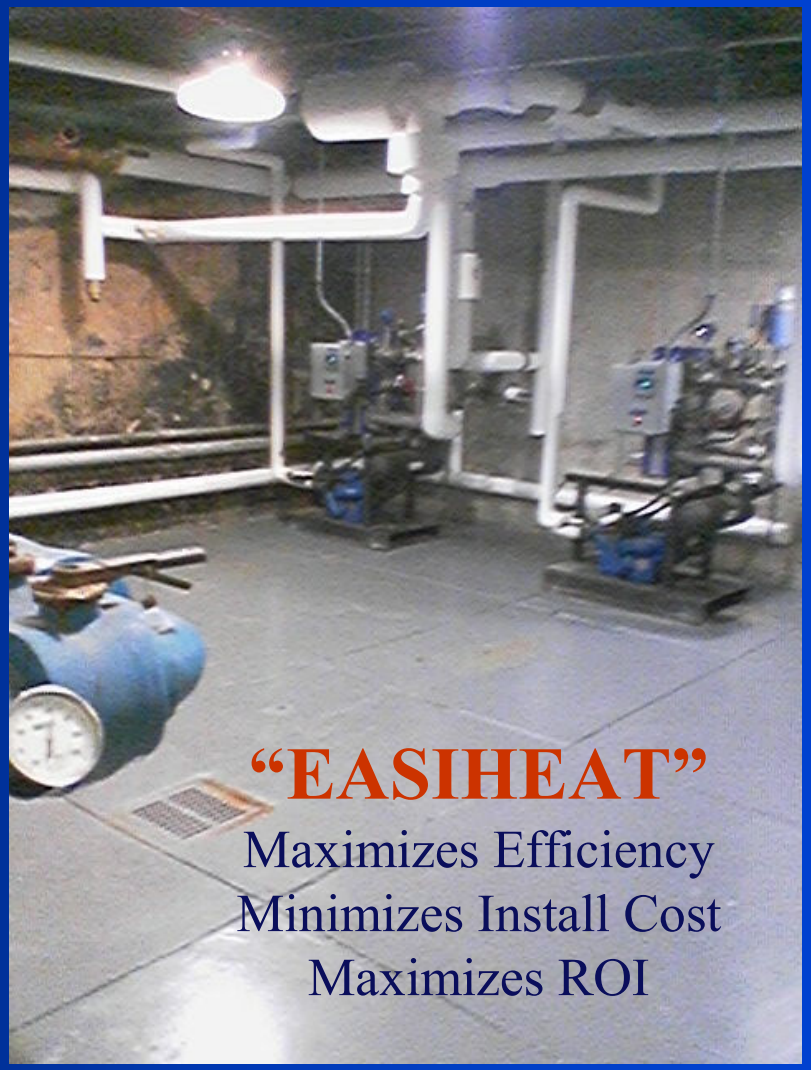
EASIHEAT UNITS



"EASIHEAT"

Maximizes Efficiency
Minimizes Install Cost
Maximizes ROI

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Natural Gas Technologies Centre Report

NGTC

CONFIDENTIAL

EASIHEAT
Final Report (#222906)
August 15, 2008

INFORMATION SHEET AND APPROVAL

1. Title and subtitle
Thermal performance of the EasiHeat compact heat exchanger.

2. Author(s)	3. Collaborator(s)	
Jean-François Bond, Eng., Ph. D.		
4. Date of report	5. Number of pages	6. Type of report
August 15, 2008	40	Final (v.1.3)

7. Project number	8. Type of project	9. Period covered
222906	Evaluation	October 2007 – August 2008

10. Abstract (limited to 200 words)

The performance of the EasiHeat compact steam-to-water heat exchanger was measured and compared to that of a standard, shell-and-tube heat exchanger. The RMS deviation from the target water temperature is about half for the EasiHeat what it is for the shell-and-tube. Temperature spikes observed upon flow increases or decreases have a magnitude of 8-9 °F with the EasiHeat, compared to 18-19 °F with the shell-and-tube with steam trap, another substantial advantage of the EasiHeat over the shell-and-tube.
The thermal efficiency of the EasiHeat averages 93.8% while that of the shell-and-tube with automatic pump trap (APT) averages 87.4%, a 6.4% efficiency advantage for the EasiHeat. For example, for the 6 MMBH model with 16h/day duty at current gas prices, this translates into yearly savings of $22,624; these savings are achieved at a purchase cost premium of $28,205. Our measurements establish the clear value of the EasiHeat product, in terms of providing a steady output water temperature, but especially as a very high efficiency product.

11. Keywords
Heat exchanger, water heater, plate, shell-and-tube, steam trap, efficiency.

12. Client (s)	13. Level of confidentiality
Spirax Sarco, EGD, Gaz Métro, Union Gas	Distribution limited to clients

14. Report distribution
6 copies: 1. Spirax Sarco: Marcus Bellot; 2. EGD: Bill Castellan; 3. Gaz Métro: Richard Béraud ; 4. Union Gas: Ruth Dekker; 5. NGTC: J. F. Bond; 6. NGTC: files

15. Authorization

Project Leader _____ J. F. Bond, Eng., Ph. D.

General Manager _____ Stéphane Brunet, Eng., M.A.Sc.

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The thermal efficiency of a Plate & Frame averages 93.8% while that of the shell-and-tube with automatic pump trap (APT) averages 87.4%, a 6.4% efficiency advantage for the Plate & Frame heat exchanger…

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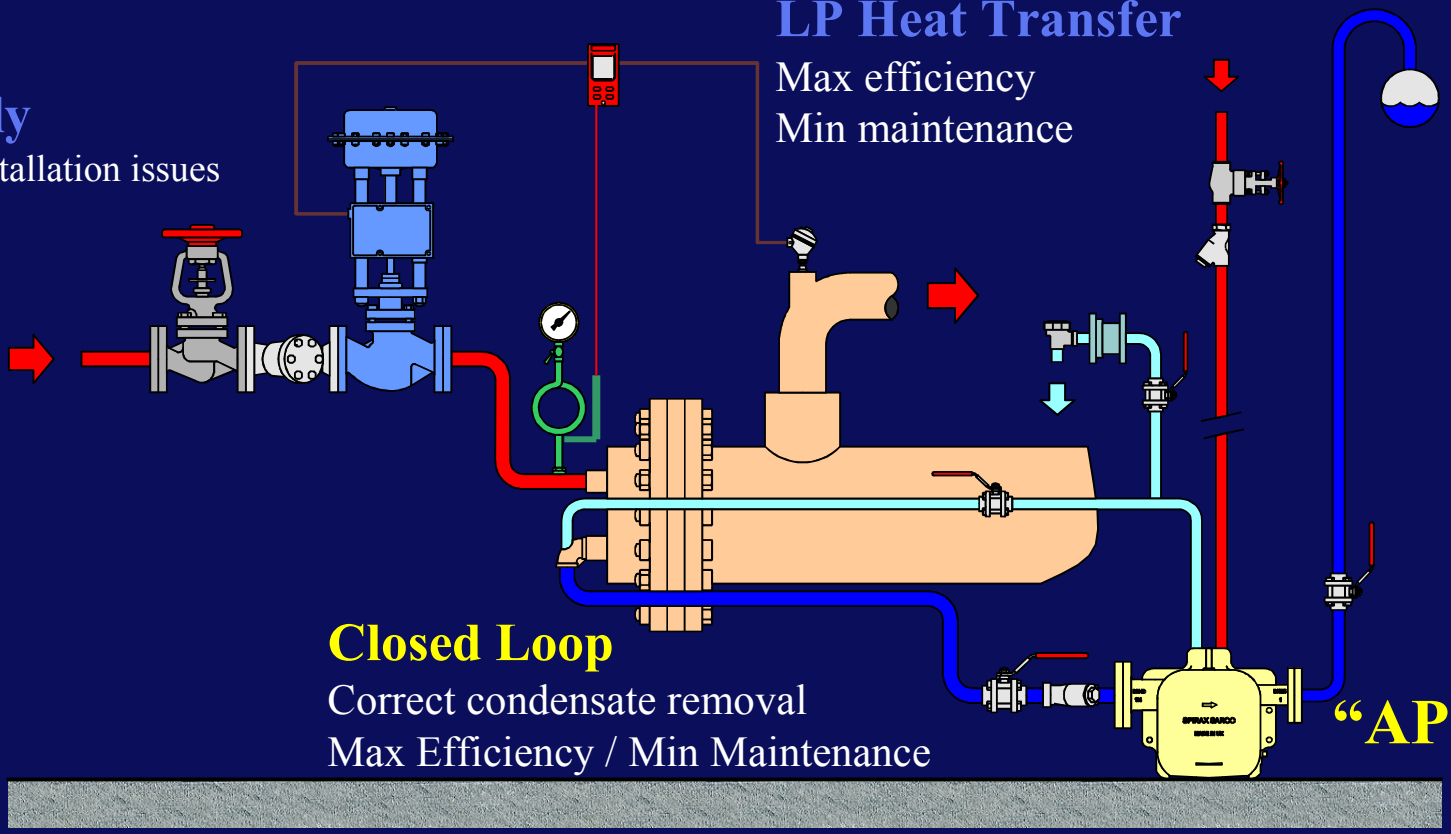
Summary – Heat Transfer

HP Supply
Minimizes Installation issues

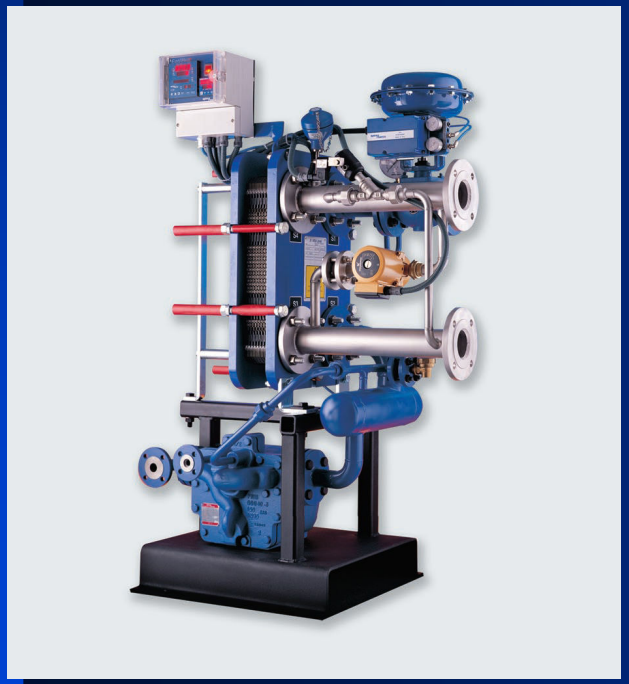
LP Heat Transfer
Max efficiency
Min maintenance



Closed Loop
Correct condensate removal
Max Efficiency / Min Maintenance

"APT"

Heat Exchangers



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Hot Water Heat Exchangers

- Instantaneous variable load capability
- Eliminates hot water storage and Legionella bacteria risk
- Accurate temperature control
- P&F construction designed for steam use

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THANK YOU !!!

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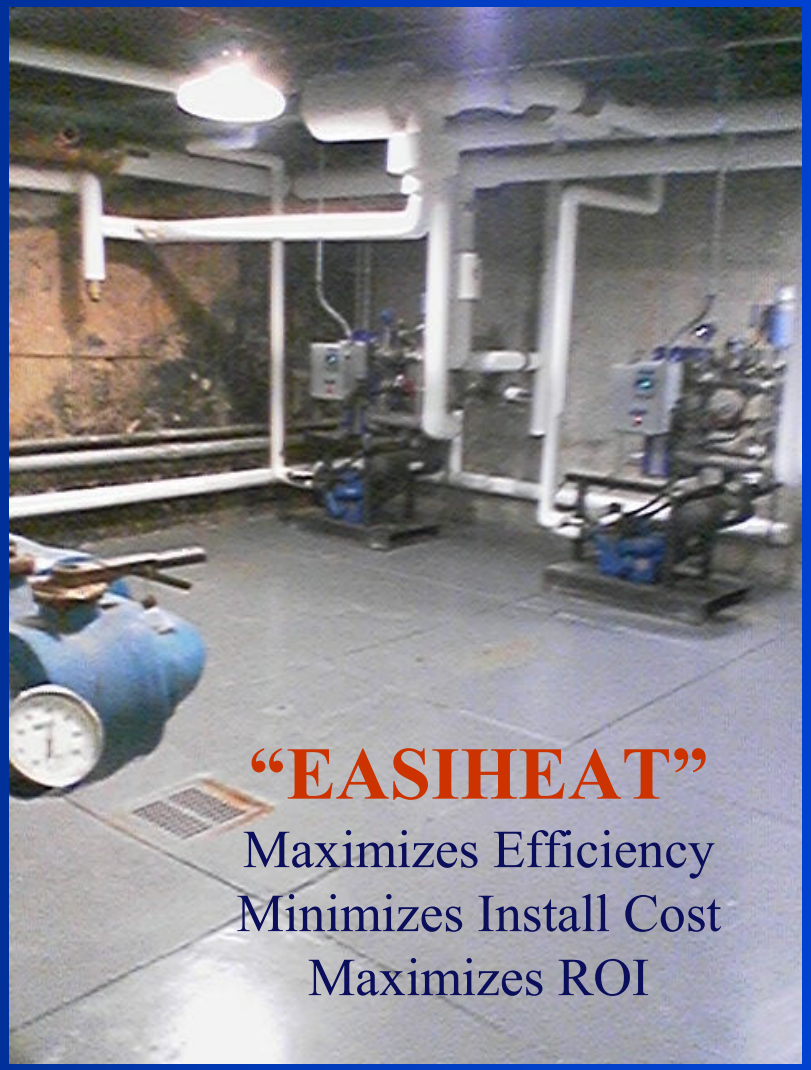
Questions ?????



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