

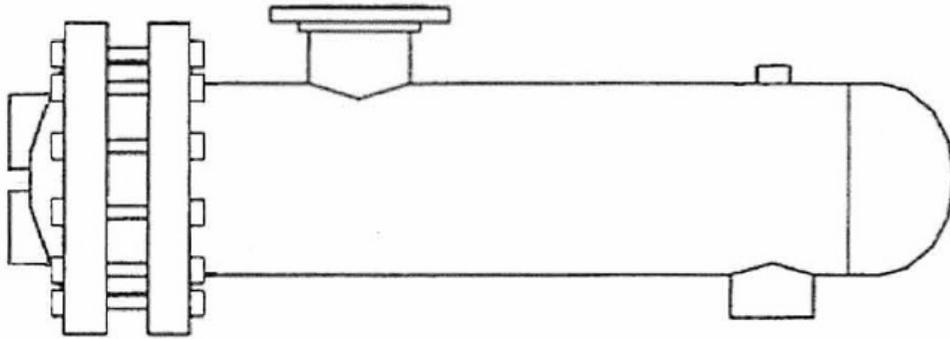
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Power Plus International

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Installation, Operation, & Maintenance Instructions
For Shell & Tube Heat Exchangers



Manufactured For:

Serial Number(s):

Order Number:

Power Plus International

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Introduction

This manual will cover Shell & Tube type heat exchangers, of "U-Tube," "Fixed Tube Sheet," "Floating Rear Tube Sheet," and "Double Tube" design. The Heat Exchanger discussed in this manual has been carefully assembled and factory tested to provide years of trouble-free service. In order to assure the service intended, the following information is provided to enable proper Installation, Operation, and Maintenance of the Heat Exchanger.

Storage

If the heat exchanger cannot be installed immediately upon receipt at the job site, please be advised of certain necessary precautions to prevent deterioration during storage. Responsibility for integrity of the heat exchanger is to be assumed by the User. Power Plus International, Inc. will not be responsible for damage, corrosion, or other wear & tear of equipment during storage.

- Upon receipt of the heat exchanger, inspect for shipping damage. If damage is evident, inspect for possible contamination and replace protective covers as needed. If damage is extensive, notify the Freight Carrier and Power Plus immediately.
- Remove any accumulations of dirt, water, ice, or snow and wipe dry before moving the exchanger into indoor storage. Take precautions to prevent rusting or contamination. Open drain plugs to remove any moisture, then reseal.
- Store under cover in a climate controlled area, if possible. An ideal storage environment is a dry, low humidity area that is sealed to prevent entry of blowing dust, rain, or snow. Inspect the heat exchanger frequently while it is in storage.

Installation

Location — The heat exchanger should be located in a clean, open area, with sufficient clearance at the head of the heat exchanger to remove the tube bundle. In the case of Fixed Tube Sheet units, allow room on both ends of the unit to remove the heads for inspection and tube cleaning. In the case of Floating Rear Tube Sheet units, allow sufficient space at the stationary head end to remove the tube bundle, and sufficient space at the floating head end to permit removal of the shell cover and/or floating head cover.

The foundation of the heat exchanger should be adequate so that the unit will not settle and cause piping strains. Foundation bolts should be set to allow for settling inaccuracies. In concrete footings, pipe sleeves at least one size larger than the bolt diameter slipped over the bolt and cast in place are best for this purpose, as they allow the bolt center to be adjusted after the foundation has set. Foundation bolts should be loosened at one end of the unit to allow for free expansion and contraction of the heat exchanger shell. Slotted holes are provided for this purpose. Exchangers should be set level and square so that pipe connections can be made without forcing.

Fittings & Piping — Provide valves and bypasses in the piping system so that both the shell-side and the tube-side may be bypassed to permit isolation of the unit for inspection and repairs. Long radius elbows should be used in lieu of standard elbows wherever possible, because of their superior flow characteristics.

When not integral with the exchanger nozzles, thermometer well and pressure gauge connections should be provided in all piping to and from the unit, and located as close to the unit as possible. Vent valves should be provided so units can be purged to prevent vapor or gas binding. Special consideration must be given to discharge of hazardous or toxic fluids. Drain connections should not be piped to a common closed manifold.

In all installations, care should be taken to eliminate or minimize transmissions of fluid pulsations and mechanical vibrations of the heat exchanger. Quick-opening and closing valves controlling fluids to or from the heat exchanger may cause water or steam hammer, which can cause serious damage to the heat exchanger.

Cleanliness Provisions — All heat exchanger openings should be inspected for foreign material. Protective plugs and covers should not be removed until just prior to installation. The entire system should be cleaned before starting operation. Under some conditions, the use of strainers in the piping may be required. Convenient means should be provided for cleaning the unit as suggested in the Maintenance section.

Operation of Heat Exchanger

Design & Operating Conditions — Equipment must not be operated at conditions which exceed those specified on the name plate(s).

Bolted Joints — Heat exchangers are pressure tested at Power Plus's facility in accordance with ASME Code requirements. However, normal relaxing of the gasketed joints may occur in the interval between testing and installation at the job site. Therefore, all external bolted joints should be properly retightened (see diagram on page 8) after installation, and again after the unit has been heated. This is to prevent leaks and gasket blowout.

Operation Procedures — Before placing any heat exchanger in operation, reference should be made to the exchanger drawing(s), specification sheet(s), and name plate(s) for any special instructions. Local safety and health regulations must be considered. Improper start-up or shut-down sequences, particularly of Fixed Tube Sheet and Double Tube units, may cause leaking of the tube-to-tube sheet and/or bolted flange joints.

Start-Up Operation — When placing a unit in operation, open all vent connections and start to circulate the cold media only. Be sure the cold side of the unit is entirely filled with fluid before closing the vents. The hot media should then be introduced gradually until all passages are completely filled with liquid or vapor, whichever the case may be. Then close the vents and slowly bring the unit(s) up to temperature.

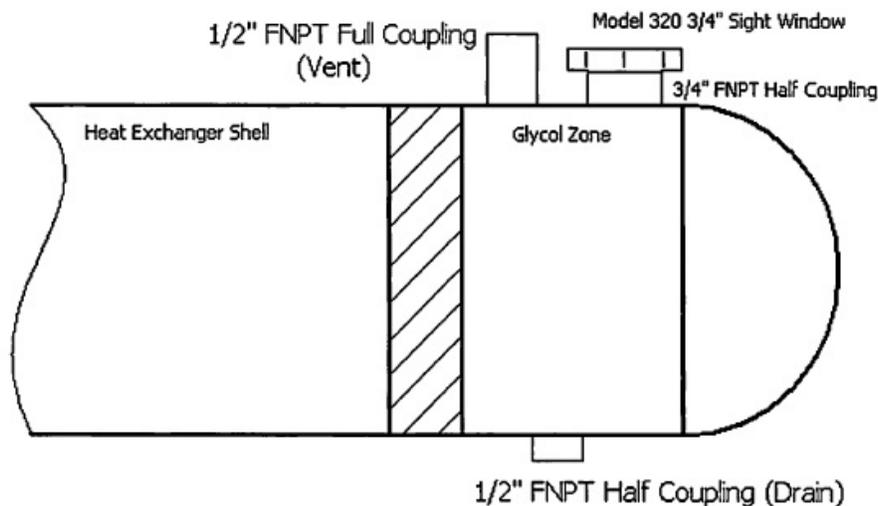
Start operation gradually. Do not subject the heat exchanger to sudden temperature fluctuations. Hot fluid must not be suddenly introduced when the unit is cold, or vice-versa. This could damage the exchanger and void the warranty.

For Fixed Tube Sheet units, fluids must be introduced in a manner to minimize differential expansion between the shell & the tubes.

For Double Tube units, see the following page for Special Instructions.

Recommended Procedure for Flooding Intermediate Zone with Glycol in Double Tube Safety Heaters

1. With Heat Exchanger completely assembled, remove 'A' and 3/4" MPT plugs from sight indicator and vent connections. These connections should be at the highest point in relation to the heat exchanger shell.
2. Fill the 3/4" FNPT connection with 100% Ethylene Glycol. The 3/4" connection acts as a vent.
3. Let stand 30 minutes.
4. Install sight window in the 3/4" FNPT connection. Then top off with glycol through the "A" connection. Vent remaining air by gradually turning on the hot-side media. Once all air has vented out, and glycol begins to bubble out, tighten 1/2" FNPT connection and plug. Then gradually introduce the cold-side media, and bring the unit(s) up to temperature.



Shut-Down Operation - For U-Tube and Floating Rear Tube Sheet units, flow of the hot media should be gradually shut off first. If it is necessary to stop the circulation of the cold media, the circulation of the hot media should be stopped also, through bypassing or other means. For Fixed Tube Sheet and Double Tube units, the unit should be shut down in a manner to minimize the differential expansion between the shell & tubes.

Drain all fluids when shutting down to eliminate the possibility of freezing and/or corrosion. To guard against water hammer, condensate should be drained from units using vapors during start-up or shut-down.

For Fixed Tube Sheet units, the tube-side may require blowing out with air to minimize water retention after drainage.

*****Caution*****

Steam and/or water hammer can cause serious damage to the tubes of any heat exchanger. A careful consideration of the following points before an installation is made can prevent costly repairs which may be required due to hammer.

- A vacuum breaker and/or vent should be used in accordance with the type of system being installed.
- The proper trap for a steam system installed should be used.
- The trap and the condensate return line to the trap should be properly sized for the total capacity of the unit(s).
- The trap should be sized for the differential pressure across the trap, not the inlet pressure to the steam controller.
- A properly sized relief valve must be installed on the heated water side to protect the heat exchanger(s) from possible damage due to volumetric expansion.
- In the case of steam as the heating medium, the steam trap should be manually by-passed until the exchanger is switched to automatic operation. Water hammer often results when a large quantity of steam is allowed to condense rapidly in an enclosure. This usually happens when the demand for hot water ends and the steam control valve closes, but there is still substantial steam left in the exchanger. As this steam condenses, the pressure drops (often to full vacuum). This prevents condensate from leaving the shell and sometimes siphons in condensate from a line beyond the trap. Now, when steam valve opens again and admits steam to the shell, the rapid condensation, as it strikes the cold condensate left in the shell, causes streams of water to rise, hitting the top of the shell and bouncing onto the top of the tubes.

Maintenance of Heat Exchanger

***Important: Follow the recommended procedure for operation. Quick start-up and shut-down is a major cause of heat exchanger damage.**

Inspection of Unit — At regular intervals and as frequently as experience indicates, an examination should be made of the interior and the exterior of the heat exchanger. Neglect in keeping all tubes clean may result in complete stoppage of flow through some tubes, causing severe thermal strain, leaking tube joints, or structural damage to other components. When sacrificial anodes are provided, they should be inspected at regular intervals to determine whether they should be cleaned or replaced.

Indications of Fouling — Exchangers subject to fouling or scaling should be cleaned periodically. A light sludge or scale coating on tubes greatly reduces their efficiency. A marked increase in pressure drop and/or reduction in performance usually indicates cleaning is necessary. The unit should first be checked for air or vapor binding to confirm that this is not the cause for reduction in performance. Because difficulty of cleaning increases rapidly as scale or deposit thickness increases, intervals between cleaning should not be excessive.

Disassembly for Inspection and/or Cleaning — Before disassembly, the user must make sure that the unit has been depressurized, vented and drained, and all hazardous material purged or neutralized.

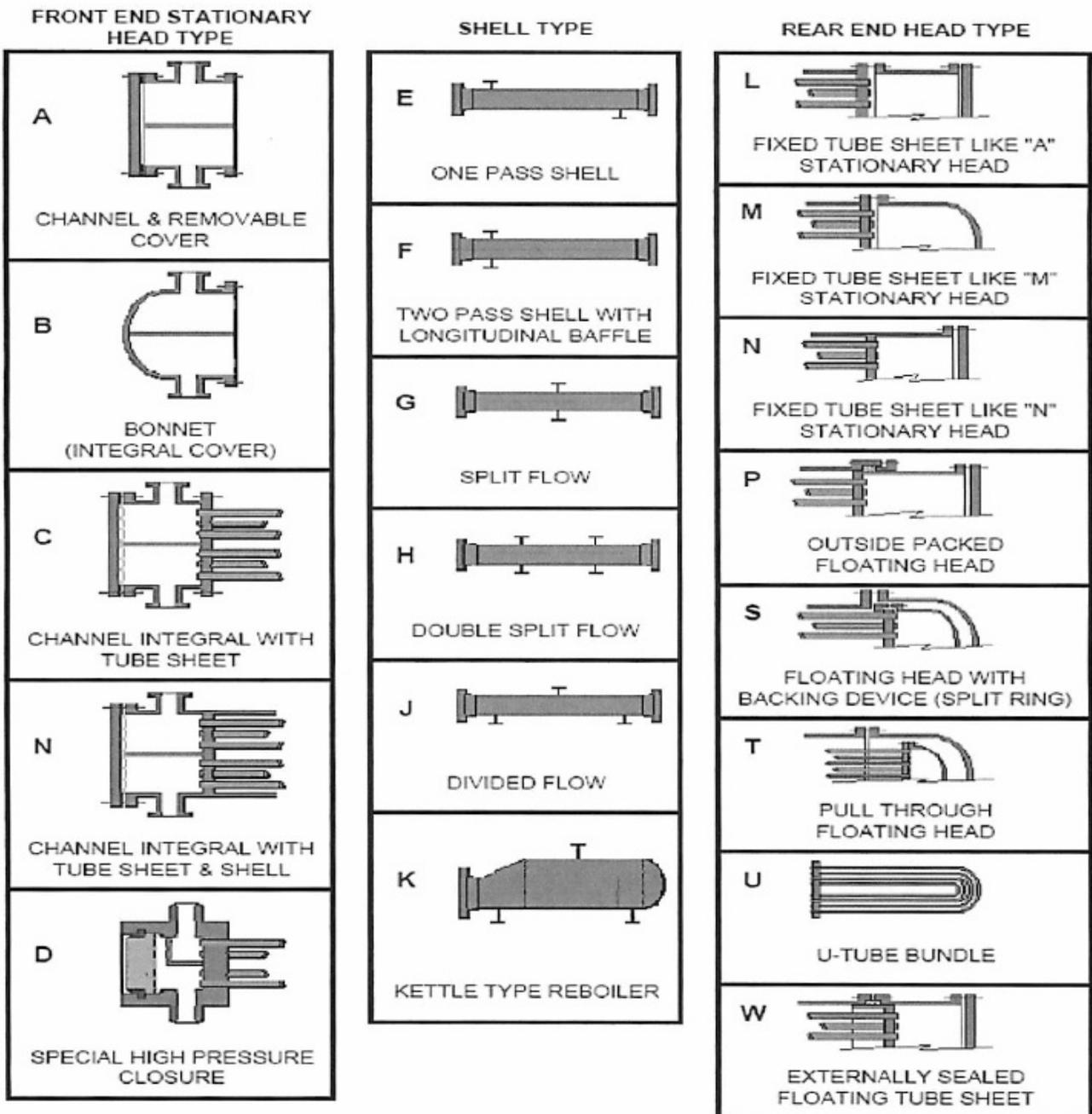
To inspect the inside of the tubes and also make them accessible for cleaning, use the following procedures, and reference the chart below.

1. Stationary Head End

- Type A, C, D, & N — Remove cover plate only
- Type B — Remove entire bonnet

2. Rear Head End

- Type L, N, & P — Remove cover plate only
- Type M — Remove entire bonnet
- Type S or T — Remove shell cover and floating head cover
- Type W — Remove channel cover plate or entire bonnet



Removal and Handling — When removing tube bundles from exchangers, care should be taken to assure that improper handling does not damage them. The tube bundle should never be supported on the tubes but should rest on the parts designed to carry it, e.g. the tube sheets, baffles, or tube supports.

To avoid possible damage during removal from the shell, a pulling device should be attached to eyebolts screwed into the tube sheet. If the tube sheet does not have tapped holes for eyebolts, steel rods or cables inserted through tubes and attached to bearing plates may be used.

Do not handle tube bundles with hooks or other tools which might damage the tubes. They should be moved about on cradles, dollies, or skids. Horizontal tube bundles should be lifted by means of suitable slings. Baffles and support plates can be easily damaged by dragging a bundle over a rough surface.

Cleaning Tube Bundles — The heat transfer surfaces of heat exchangers should be kept reasonably clean to assure satisfactory performance. Provide convenient means as necessary for cleaning at regular intervals. The method selected must be the responsibility of the owner. It may be beneficial to employ the use of a qualified organization that provides heat exchanger cleaning services. These organizations can check the nature of the deposits, furnish proper solvents and/or acidic solutions containing inhibitors, and provide equipment and personnel for a complete cleaning service.

Cleaning Methods:

- Circulating hot wash oil or light distillate through the tubes or shell at high velocity may effectively remove sludge or similar soft deposits.
- Soft salt deposits may be washed out by circulating hot fresh water.
- Commercially available cleaning compounds may be used for removing sludge, scale, or coke. This is in the event hot water or wash oil, described above, is ineffective.
- High pressure water jet cleaning
- Chemical cleaning is now being extensively practiced in the removal of various scales and foreign materials. Consult a qualified cleaning organization that can provide a complete equipment and piping cleaning solution.
- If none of the above methods are effective, scrapers, rotating wire brushes, and/or other mechanical means may be used for removing hard scale, coke, or other deposits.

Cleaning Precautions:

- Tubes should not be cleaned by blowing steam through individual tubes. This overheats tubes, and results in severe expansion strain, deformation, and possible leaky tube joints.
- When mechanically cleaning a tube bundle, tubes should not be hammered on to remove hard scale. If scrapers are being used, make sure the scrapers are not sharp enough to damage the tubes.
- Cleaning compounds must be compatible with the metallurgy of the heat exchanger.
- If scaling or other fouling is expected, provisions in the piping could be made to allow connections for flushing out or chemical circulation cleaning. In large plants, it may be profitable to have a tank of cleaning fluid available for periodic flushing of shells and/or tubes. Makers of commercial cleaning products would be able to advise in this respect. Small units that can be easily removed from the line and small tube bundles can be sent to organizations that do such cleaning on their premises.

Tube Expanding — To tighten a loose tube-to-tube sheet joint, use a suitable roller type expander. Do not roll tubes that are not leaking as this needlessly thins the tube wall, and work hardens the metal which makes it brittle. Care should be taken to ensure that tubes are not over expanded.

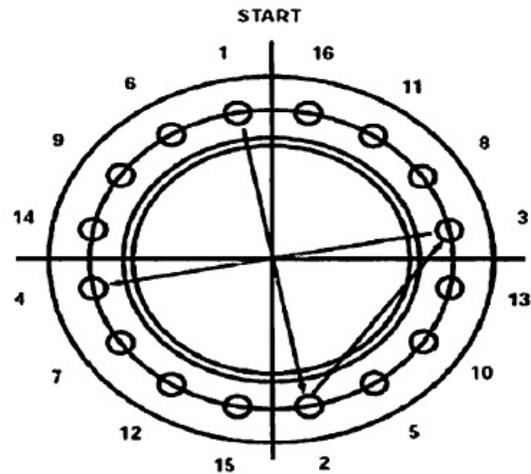
Gasket Replacement — Gaskets and gasket surfaces should be thoroughly cleaned and should be free of scratches and other defects. Gaskets should be accurately positioned before re-tightening bolts. It is recommended that when a heat exchanger is dismantled for any reason, it be re-assembled with new gaskets. Attempting to re-use gaskets could damage the contact surfaces of the heat exchanger. Any leakage at a gasketed joint should be rectified and not permitted to persist as it may result in damage to the heat exchanger.

Spare & Replacement Parts — Spare or replacement parts can be obtained for heat exchangers by reference to the part required and to the serial number of the exchanger. Consideration should be given to stocking parts which would reduce inconvenient shutdowns while waiting for replacements from the factory. Because some gaskets are made to order with a long lead-time, it may be desirable to have them on hand.

In situations where a shut-down for cleaning and/or repairs cannot be conveniently arranged, a standby heat exchanger connected in parallel, or a complete replacement tube bundle on hand, is recommended.

Bolting — It is important that all bolted joints be tightened uniformly and in a diametrically staggered pattern, as illustrated below. Consult the factory for bolt sizes not listed. Bolts should be torqued incrementally to 30%, 60% and then 100% of the appropriate torque.

Nominal Bolt Size	Torque in Ft/lbs
1/2"	40
5/8"	75
3/4"	125
7/8"	200
1"	310
1-1/8"	450
1-1/4"	650
1-3/8"	850
1-1/2"	1000
1-5/8"	1400
1-3/4"	1900
1-7/8"	2500
2"	2800



Power Plus International

GENERAL

Unless otherwise agreed upon in writing by an officer of Power Plus International, Inc. and the purchaser, the following paragraphs will be applicable.

PERFORMANCE

The purchaser shall furnish Power Plus with all information necessary for a clear understanding of the product's requirements, including any special requirements. The purchaser shall be responsible for any information, dimensions, drawings, sketches, templates, and/or specifications given to Power Plus for fabrication purposes.

Power Plus shall guarantee thermal performance and mechanical design of our heat transfer equipment or other fabrications when operated at the design conditions specified by the purchaser, or as shown on the specification sheet furnished by Power Plus. This guarantee shall extend for a period of twelve (12) months after shipping date.

DEFECTIVE PARTS

Power Plus International, Inc. shall repair or replace, F.O.B. Hamden, CT., any part(s) proven to be defective due to our workmanship and/or materials, within the guarantee period. Finished materials and accessories purchased from other manufacturers, including but not limited to tubing, etc., are under warranty only to the extent of the original manufacturer's warranty to Power Plus International, Inc.

FOULING, CORROSION & VIBRATION

Power Plus assumes no responsibility for excess fouling of the manufactured part by any foreign substance nor for the deterioration of any part or parts of the equipment due to corrosion, erosion, flow-induced vibration or any other causes after leaving Power Plus's premises.

ALTERATIONS & BACK CHARGES

The purchaser shall not alter the products in any way without the express written consent of an Officer of Power Plus. Should the part be altered in anyway this guarantee shall be considered null and void. Unauthorized back-charges for repair, etc. of equipment manufactured by Power Plus International, Inc. will not be accepted unless the scope and method of the repair and the exact cost are pre-approved in writing by an Officer of Power Plus.

LIMITS OF LIABILITY

The liability of Power Plus International, Inc. with respect to the manufacture, sale, delivery, installation, repair, technical direction, or use of any equipment and/or services furnished shall not exceed the selling price of the equipment or part as to which such liability is asserted.

Power Plus International Inc. shall not be liable for special, incidental, and/or consequential damages, including but not limited to damage or loss of and to other property and/or equipment, loss of profits or revenues, loss of use of other property or equipment, or claims of customer's of the buyer for interruption in the buyer's or the buyer's customer's operations.

This limitation of liability is independent of any guarantee provisions and will apply regardless of what remedies the buyer may be entitled to pursue.