# THROUGH-THE-TUBE (TTT) PLUGGING USING CPI/PERMA (CPI) POP-A-PLUGS® (PAP)

CPI plugs are part of the PAP Tube Plugging System. Unlike other tube plug designs, and under the proper conditions, CPI plugs can be passed through the length of a straight heat exchanger tube and successfully installed at the far end of the tube without having direct access to both tube ends. This procedure outlines the information required to evaluating a heat exchanger for TTT plugging, limitations of the technique, and installation process.

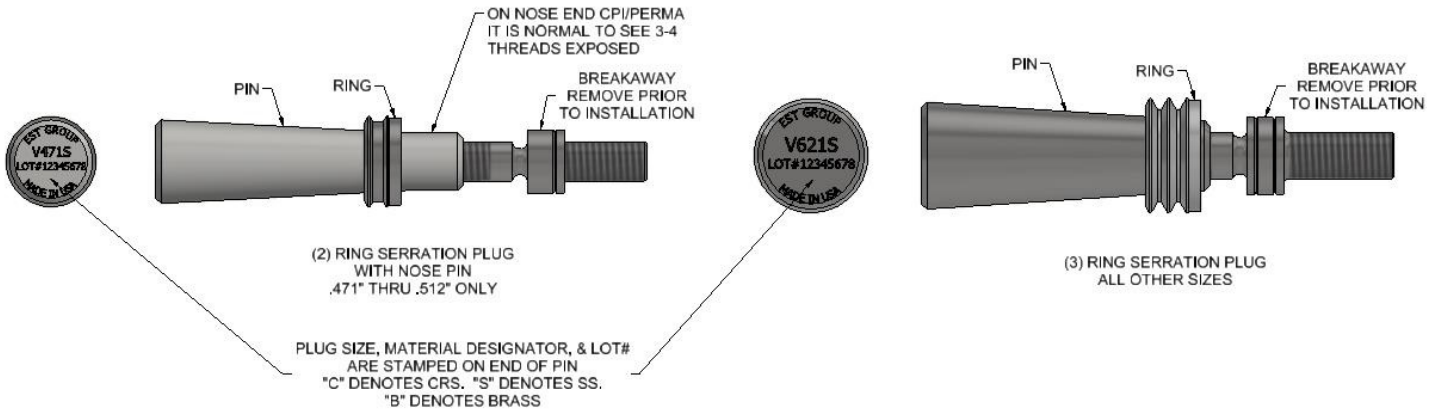


**FIGURE 1: ASSEMBLED PLUGS**

***WARNING! IN ORDER TO SUCCESSFULLY INSTALL CPI PLUGS BY PASSING THEM TTT, THE OPERATOR MUST CAREFULLY FOLLOW THIS PLUGGING PROCEDURE AND POSSESS A CLEAR UNDERSTANDING OF HOW TO INSTALL CPI PLUGS AT THE NEAR END BEFORE ATTEMPTING TTT PLUGGING.***

## EVALUATING THE APPLICATION - INFORMATION REQUIRED

1. **Tube Size.**
   - What is the actual tube ID?

2. **The tube-to-tubesheet connection.**
   - Is the tube-to-sheet connection expanded, welded, or both? If the tube is expanded, the length of the expanded area is required to determine the position where the plug will be installed within the tube. If the tube is seal welded to the tubesheet then the weld material at the near tube end will need to be removed by lightly reaming with a tapered reamer.

***NOTE: CPI PLUGS SHOULD NEVER BE INSTALLED IN THE TRANSITION ZONE BETWEEN EXPANDED AND UNEXPANDED AREA OF THE TUBE.***

**Questions?** Contact EST Group Customer Service at any of the following locations.

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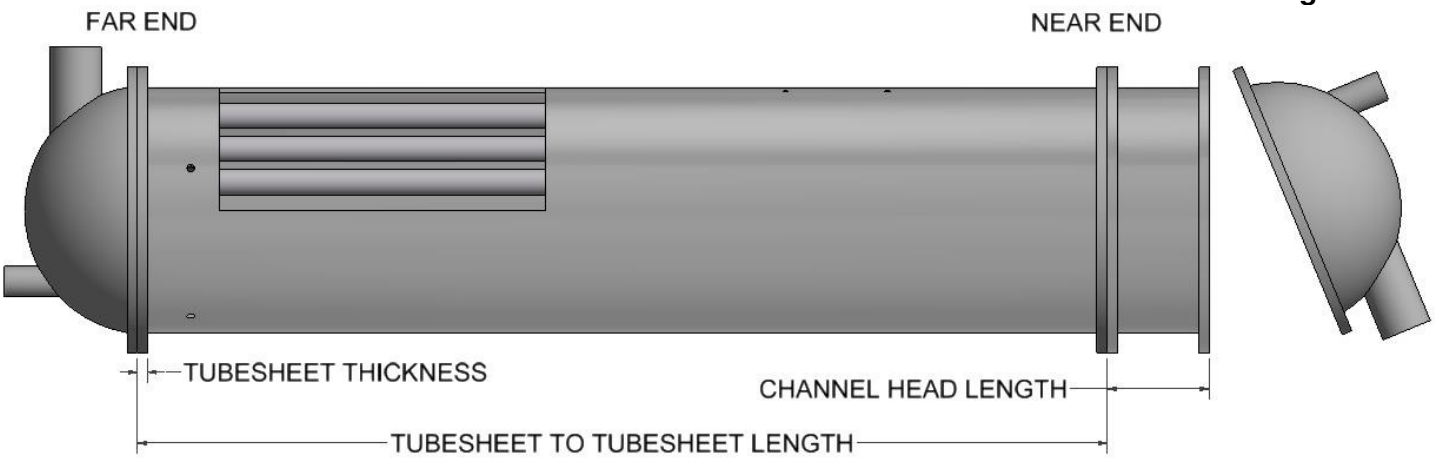



**FIGURE 2: SIMPLIFIED VIEW OF A STRAIGHT TUBE HEAT EXCHANGER**

3. **Tubesheet-to-tubesheet length**
   - What is the distance from the outer face of the near tubesheet to the outer face of`` the far tubesheet?

4. **Tubesheet Thickness**
   - What is the thickness of the far end tubesheet?

5. **Channel Head Length**
   - Is there a channel head present at the near end? If so, what is the length of the channel head?

6. **Existing Obstructions**
   - Are there any obstructions (division plates, stud bolts, limited clearance overhead, etc.) that may interfere with any of the PAP System equipment? Do any of the obstructions require that the Pull Rod & Tube sections be a specific length?

## LIMITATIONS OF THIS TECHNIQUE

While the TTT plugging technique has proven to be both effective and reliable means for plugging tubes, several external factors can limit its success. These factors should be recognized and understood prior to starting.

1. **Condition of the Tubes**
   - The tubes to be plugged must be clean and free of any deposits. Deposits within the tubes can prevent the proper plug size from fitting through the tube to the far end of the heat exchanger. EST recommends hydroblasting and/or the use of aggressive tube cleaning brushes to clean the tubes. Some deposits may require chemical cleaning. Hard deposits that cannot be removed by hydroblasting, brushing, or chemical cleaning may require either drilling or rodding.

2. **Damaged Tubes**
   - Tubes that are extremely bowed, bent, or have failed as a result of tube denting, implosion or other tube ID altering factor may not allow the plug to be passed through the tube to the far end.

## PRIOR TO PLUGGING

1. Clean the tube(s) thoroughly.
2. If the service of the heat exchanger permits, pierce the wall of the tube(s) in a location just beyond the tubesheet. The puncture should be cleanly through the tube wall.

## DETERMINING THE PROPER CPI PLUG SIZE

CPI plugs and plug installation equipment will be selected based upon the tube ID. Actual tube measurements are best. Ideally the measurements should be taken at two locations, 90 degrees apart, at a point about 1" (25.4 mm) deep within the tube end. Further, a number of tubes in both the inlet and outlet pass should be measured. If actual tube measurements are not available then the tube data (tube OD and wall thickness, or gage) may be obtained from the heat exchanger data sheet provided by the manufacturer. The tube data and the sizing guide shown in Appendix 1 may be used to determine the suggested CPI Plug size. ***Note: A careful evaluation of the repair history for the heat exchanger is also advised. If the tube bundle and/or tubes have been replaced, the actual tube size may vary considerably from the tube size indicated on the heat exchanger datasheet.***

## CALCULATE INSTALLATION DEPTH FOR FAR END PLUG

The CPI Plug must be installed into the tubesheet area of the tube only. EST recommends that the plug be positioned in the middle of the rolled area of the far end tube or the middle of the tubesheet if the tube is not rolled. To determine the proper **Installation Depth,** subtract one half of the far end tube roll length from the tubesheet-to-tubesheet length. Refer to Figure 2.

*Example:* Tubesheet face to tubesheet face = 10 ft. = 120 in.
Far end tube roll length or Tubesheet thickness if unrolled = 4"
Installation Depth = 120" - [1/2 x 4"] = 118"
In this case the Installation Depth would be equal to 118"

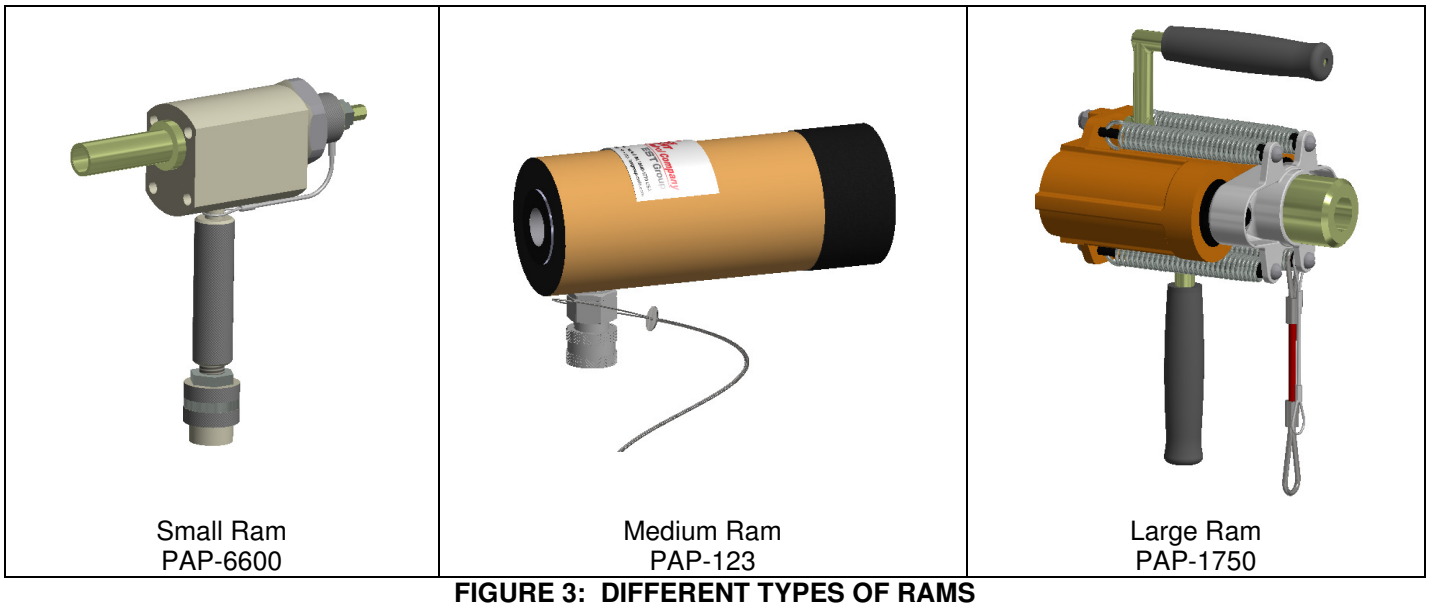
## REQUIRED INSTALLATION EQUIPMENT

CPI Plug installation hardware is dedicated to specific CPI Plug size(s) only. The following equipment is required:

1. A sufficient supply of CPI plugs in the proper size and plug material.

2. TTT Thread Adapter Kit(s) for the indicated plug size(s). Refer to the section titled TTT Adapter Kit for more information on the Adapter Kits.

3. A PAP System Ram Package based on the plug size and material being used.
   ***Note: V-1334 plug sizes and larger must be installed using the Medium Ram or Large Ram.***



Small Ram
PAP-6600

Medium Ram
PAP-123

Large Ram
PAP-1750

**FIGURE 3: DIFFERENT TYPES OF RAMS**

4. Air Regulator Assembly, Part Number REG-TTT.

5. A sufficient supply of Pull Rod & Tube Extensions to allow the CPI Plug to be positioned at the far end of the heat exchanger.

6. Additional PAP installation hardware is suggested as spares.
   a. 1 additional Plug Positioner for each CPI Plug size.
   b. 1 additional Channel Head Pull Rod Assembly (4 ft. or 6 ft.)

7. (2) pair of Vise Grips.

8. 30' tape measure.

## ASSEMBLY OF HYDRAULIC EQUIPMENT

Installation of CPI plugs at the far end of the heat exchanger requires that the Hydraulic Pump be operated to the installation pressure specified for the individual plug size and material, reference Table 1. The pulling pressures will also vary by the hydraulic ram used during installation. Installation pressures are shown in Table 2, Use of the Air Regular Assembly, Part Number REG-TTT, is mandatory.

1. Connect the Air Regulator assembly to the air input connection on the Hydraulic Pump, refer to Figure 3 below.

2. Connect the air supply to the Air Regulator input and set regulator to produce the proper hydraulic pressure by performing the following steps.
   a. Connect hydraulic hose and hydraulic ram only to hydraulic pump output.
   b. Turn the Air Regulator adjustment knob fully counterclockwise.
   c. Depress the Hydraulic Pump pedal while viewing the pressure gauge. While keeping pump pedal depressed, slowly adjust the Air Regulator knob clockwise to activate the pump. Continue operating the pump until the proper hydraulic pressure required for the CPI plug size and material is achieved.
   d. Depress the release end of the Hydraulic Pump pedal to release the built-up pressure. Repressurize the Pump to verify that the proper hydraulic pressure has been set. Adjust Air Regulator as necessary. Release pressure.

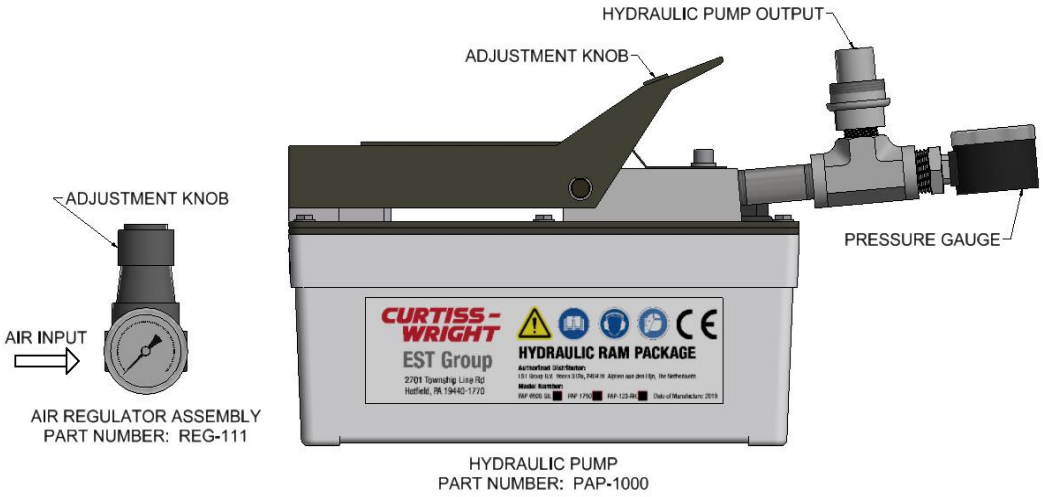



**FIGURE 4: AIR REGULATOR ASSEMBLY & HYDRAULIC PUMP**

## TTT ADAPTER KIT

The TTT Adapter Kit includes a TTT Adapter and a supply of TTT Studs as shown in Figure 4. The TTT (TTT) Adapter has a right-hand male thread on one end and left-hand female thread on the other. The TTT Studs are threaded with both left and right-hand threads. TTT Adapter Kits are plug size specific and are to be used in TTT plugging applications in place of the breakaway supplied with the CPI plugs. The applicable Adapter Kits for given plug sizes are shown in Tables 1 and 2. Adapter Kits should be installed as outlined in the following section.

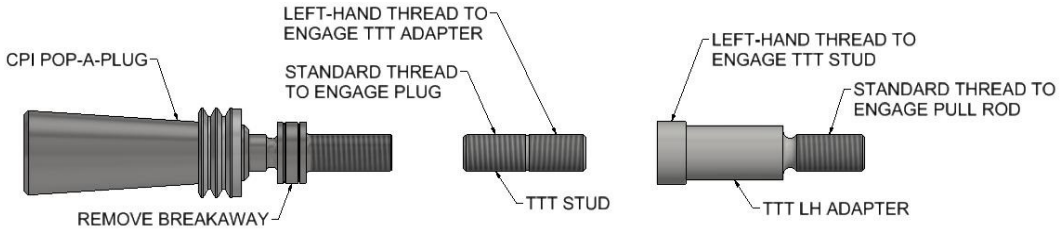



**FIGURE 5: TTT ADAPTER KIT & CPI PLUG**

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**PULL ROD ASSEMBLY FOR THROUGH THE TUBE PLUGGING, SEE FIGURE 5**

The Pull Rod sections need to be assembled to achieve the desired length. The overall suggested length is approximately equal to the heat exchanger tubesheet to tubesheet length plus the length of the channel head (if applicable).

**NOTE:** Pull Rod Extensions are shipped from the factory with the Pull Rods inside the Compression Tube. To speed the assembly process of the Pull Rod Extensions, remove all Pull Rods from the mating Compression Tubes prior to continuing. The Pull Rods should be assembled on the ground to minimize bending. If space is limited, the Pull Rod Extensions can be assembled piece by piece in the heat exchanger tube to be plugged.

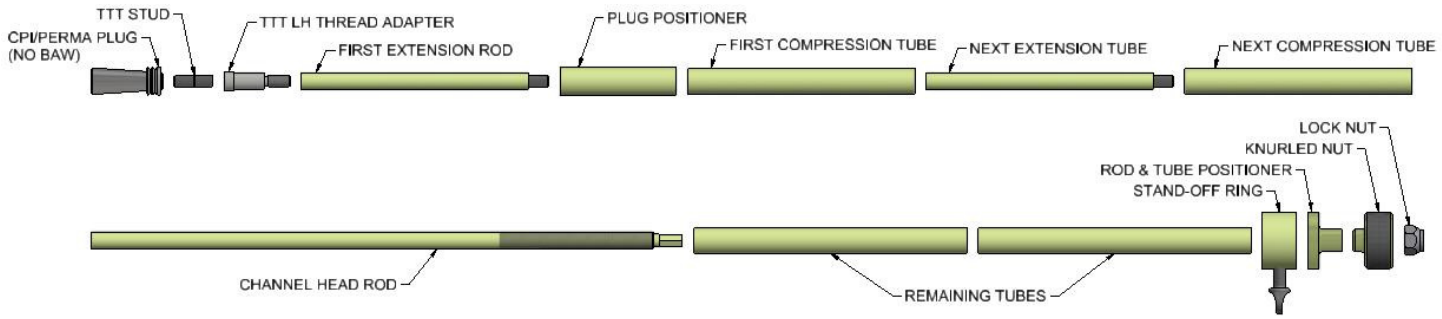


**FIGURE 6: PULL ROD ASSEMBLY SET-UP**

***WARNING! DURING THESE INSTALLATION PROCEDURES CARE MUST BE EXERCISED SO THAT THE EXTENSION RODS DO NOT ROTATE DURING TIGHTENING OR LOOSENING OF OTHER CONNECTIONS. FAILURE TO HEED THIS WARNING MAY RESULT IN THE TTT ADAPTOR PREMATURELY DISENGAGING FROM THE PLUG.***

1. Remove breakaway from the CPI Plug to be installed TTT. Note: Do not grip or in any way mar the surface of the tapered pin when unscrewing the breakaway. Discard the breakaway once removed.

2. Thread the right-hand threaded end of the TTT Stud clockwise into the plug.

3. Holding the plug, thread it into the female left hand thread of the TTT Adapter until fully engaged.

**NOTE: Do not re-tighten after contact or plug / adapter kit assembly may unthread. The pulling stud will remain with the plug after installation. DO NOT USE A THREAD LOCKING AGENT.**

4. Thread a TTT Adapter into the end of the first Extension Rod and tighten by hand.

5. Install the Plug Positioner, with arrow pointing toward plug, onto the first Extension Rod. The Plug Positioner should be installed so it rests against the plug.

6. Install the 6-inch long Tube, supplied as part of the Channel Head Assembly, onto the first Extension Rod so it is against the back of the Plug Positioner.

7. Thread the next Extension Rod onto the previous Extension Rod and firmly hand tighten. Keep both Rods straight to make certain that the joint is not subjected to bending while tightening.

8. Install the next Extension Tube over the Extension Rod.

9. Repeat steps 7 and 8 until the desired Extension length has been achieved. The desired length is approximately equal to the heat exchanger tubesheet to tubesheet length plus the length of the channel head (if applicable).

10. The Channel Head Rod should be threaded onto the Extension Rods and firmly hand tightened. Keep both Rods straight to make certain that the joint is not subjected to bending while tightening. After tightening, verify that the joint cannot be loosened by hand. If it can, retighten. This is the last Rod section.

11. Install the remaining Tubes onto the Rod assembly. Remove slack from the Rod & Tube assembly by holding the last Tube and pulling on the Channel Head Rod.

12. Set the Stand-Off Ring. A Stand-Off Ring is used to set the proper Installation Depth prior to installing the plug. The Stand-Off Ring locks onto an Extension Tube by tightening a thumb screw, refer to Figure 6. Make a measurement from the middle of the ring back along the Extensions for a distance equal to the Installation Depth. Using a file, mark the Extension at that point. The mark is permanent and will allow you to check that the Stand-Off Ring is in the proper position prior to each plug installation. Slide the Stand-Off Ring to the mark and firmly tighten the thumbscrew.

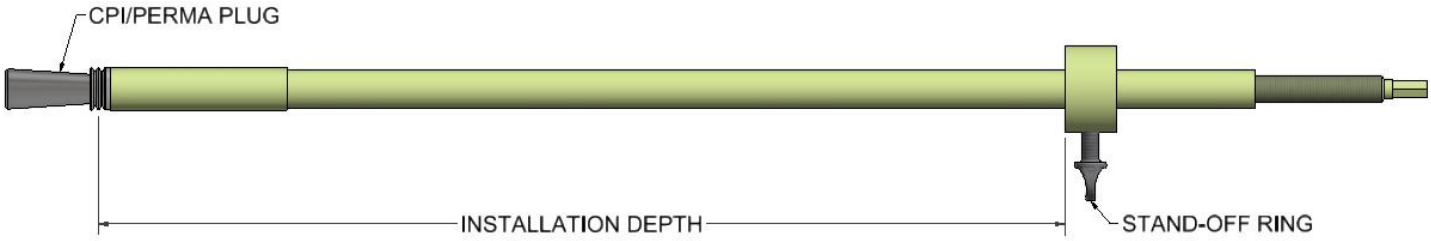


**FIGURE 7: SETTING STAND-OFF RING**

13. Install the Rod & Tube Positioner onto the Rod assembly with arrow pointing toward the plug.

14. Thread the Knurled Nut onto the exposed threads of the Channel Head Rod to hold the assembly together during the next step.

**NOTE: Do not allow the rod to turn while threading on Knurled Nut as it could result in disengaging the TTT Adapter.**

15. Plug should now be positioned for installation. When maneuvering the Pull Rod set-up make certain that it is adequately supported to avoid bending. Slide the set-up, plug end first, into the heat exchanger tube to be plugged until the standoff ring is against the tube end. Remove slack from the Rod & Tube assembly by holding the last Tube and pulling on the Channel Head Rod.

16. Remove the Knurled Nut from the Channel Head Rod without turning rod.

17. Slide the hydraulic Ram onto exposed Channel Head Rod. The Ram should be installed so the Ram piston strokes toward the operator.

18. Thread Knurled Nut onto the Channel Head Rod and firmly tighten against the Ram. Do not allow the rod to turn while threading on Knurled Nut as it could result in disengaging the TTT Adapter.

19. Install the Ram Safety Cable then the locknut onto the Pull Rod and hand tighten. Verify that the Stand-Off Ring is against the tube end.

20. While viewing the pressure gauge, slowly press the Pump pedal to pressurize the Ram. The Air Regulator, previously adjusted, will allow only the set pressure to build. If it appears that the proper installation pressure is going to be exceeded, STOP and readjust the Regulator as specified above. Continue to operate the Pump until the Ram bottoms out or the previously set installation pressure is reached.

**NOTE: When the Ram piston bottoms out, the hydraulic pressure will reach the set pressure only because the piston is at the end of its travel. At this point it is still necessary to continue to step 19.**

21. Release hydraulic pressure and allow the Ram to fully retract. Hold Ram handle while pulling on the Knurled Nut to remove any slack from the set-up. Thread Knurled Nut so it is firmly tightened against the Ram.

**Note: Do not allow the rod to turn when tightening the Knurled Nut.**

22. While viewing the pressure gauge, slowly press the Pump pedal to pressurize the Ram. Continue to operate the Pump until the Ram bottoms out or the proper installation pressure is reached. If the Ram bottoms out, repeat step 19. If the proper installation pressure has been reached and the Knurled Nut cannot be hand tightened by more than 1/4 of a turn after the hydraulic pressure is released, the plug has been properly installed. If the proper installation pressure has been reached and the Knurled Nut can be hand tightened more than 1/4 of a turn after the hydraulic pressure is released, repeat steps 19 and 20 until the Knurled Nut cannot be hand tightened by more than 1/4 of a turn after the hydraulic pressure is released.

**NOTE: Additional Adjustment of the Regulator may be necessary during this step.**

**NOTE: Having to repeat steps 19 & 20, 4 to 5 times is not uncommon.**

23. Released hydraulic pressure to allow the Ram to fully retract.

24. Remove the Knurled Nut and hydraulic Ram from the Rod. Do not allow the rod to turn while threading off the Knurled Nut.

25. Reinstall the Knurled Nut to ensure that no parts slip off of the Rod. Apply a light pulling force while turning the Rod clockwise to unthread the Pull Rod set-up from the installed plug. The Dual Thread Pulling Stud will remain with the installed plug. When disengaged, withdraw the Pull Rod set-up from the tube. When maneuvering the Pull Rod set-up, make certain that it is adequately supported to avoid bending.

## TABLE 1: ADAPTER KIT AND BAW IDENTIFICATION

| TYPICAL CPI/PERMA PLUG (V-XXX-M) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **CPI/PERMA PLUG SIZE** | **PIN THREAD** | **THROUGH-THE-TUBE ADAPTER KIT** | **CPI/PERMA PLUG SIZE** | **PIN THREAD** | **THROUGH-THE-TUBE ADAPTER KIT** | **CPI/PERMA PLUG SIZE** | **PIN THREAD** | **THROUGH-THE-TUBE ADAPTER KIT** |
| .471 | 10-32 | TTT-1032 | .735 | 1/4-28 | TTT-1428 | 1.087 | 5/16-24 | TTT-51624 |
| .471 | 12-28 | TTT-1228 | .774 | 5/16-24 | TTT-51624 | 1.103 | 5/16-24 | TTT-51624 |
| .491 | 12-28 | TTT-1228 | .804 | 5/16-24 | TTT-51624 | 1.149 | 5/16-24 | TTT-51624 |
| .512 | 12-28 | TTT-1228 | .837 | 5/16-24 | TTT-51624 | 1.171 | 5/16-24 | TTT-51624 |
| .524 | 12-28 | TTT-1228 | .853 | 5/16-24 | TTT-51624 | 1.212 | 5/16-24 | TTT-51624 |
| .555 | 12-28 | TTT-1228 | .899 | 5/16-24 | TTT-51624 | 1.334 | 1/2-20 | TTT-1220 |
| .584 | 1/4-28 | TTT-1428 | .919 | 5/16-24 | TTT-51624 | 1.456 | 1/2-20 | TTT-1220 |
| .621 | 1/4-28 | TTT-1428 | .962 | 5/16-24 | TTT-51624 | 1.578 | 1/2-20 | TTT-1220 |
| .649 | 1/4-28 | TTT-1428 | .979 | 5/16-24 | TTT-51624 | 1.700 | 1/2-20 | TTT-1220 |
| .670 | 1/4-28 | TTT-1428 | 1.024 | 5/16-24 | TTT-51624 | 1.822 | 1/2-20 | TTT-1220 |
| .712 | 1/4-28 | TTT-1428 | 1.054 | 5/16-24 | TTT-51624 | 1.944 | 1/2-20 | TTT-1220 |

***NOTE: BAW Identification are TYPICAL, always verify actual BAW on plug prior to setting installation pressure**

## TABLE 2: HYDRAULIC INSTALLATION PRESSURES FOR SMALL, MEDIUM, & LARGE RAM PACKAGES

| THROUGH-THE-TUBE (TTT) ADAPTER KIT STOCK CODE | PIN THREAD SIZE | PULL ROD THREAD SIZE | BAW IDENTIFICATION (# OF GROOVES) | INSTALLATION PRESSURES | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | FORCE | SMALL RAM (PAP-6600) (AREA OF RAM 1.326 IN²) | | MEDIUM RAM (PAP-123) (AREA OF RAM 2.76 IN²) | | LARGE RAM (PAP-1750) (AREA OF RAM 3.53 IN²) | |
| | | | | | PSIG | BARG | PSIG | BARG | PSIG | BARG |
| TTT-1032 | 10-32 | 12-28 | 1 | 2122 | 1600 | 110 | 769 | 53 | 601 | 41 |
| | | | 2 | 2519 | 1900 | 131 | 913 | 63 | 714 | 49 |
| | | | 4 | 3023 | 2280 | 157 | 1095 | 76 | 856 | 59 |
| TTT-1228 | 12-28 | 12-28 | 1 | 2785 | 2100 | 145 | 1009 | 70 | 789 | 54 |
| | | | 2 | 3580 | 2700 | 186 | 1297 | 89 | 1014 | 70 |
| | | | 0 | 3978 | 3000 | 207 | 1441 | 99 | 1127 | 78 |
| | | | 4 | 4774 | 3600 | 248 | 1730 | 119 | 1352 | 93 |
| TTT-1428 | 1/4-28 | 1/4-28 | 0 | 2100 | 1584 | 109 | 761 | 52 | 595 | 41 |
| | | | 1 | 4111 | 3100 | 214 | 1489 | 103 | 1165 | 80 |
| | | | 2 | 5304 | 4000 | 276 | 1922 | 133 | 1503 | 104 |
| | | | 4 | 6365 | 4800 | 331 | 2306 | 159 | 1803 | 124 |
| TTT-51624 | 5/16-24 | 5/16-24 | 3 | 4111 | 3100 | 214 | 1489 | 103 | 1165 | 80 |
| | | | 0 | 5304 | 4000 | 276 | 1922 | 133 | 1503 | 104 |
| | | | 1 | 7028 | 5300 | 366 | 2546 | 176 | 1991 | 137 |
| | | | 2 | 8752 | 6600 | 455 | 3171 | 219 | 2479 | 171 |
| | | | 4 | 9680 | 7300 | 503 | 3507 | 242 | 2742 | 189 |
| TTT-1220 | 1/2-20 | 1/2-20 | 1 | 7060 | N/A | | 2558 | 176 | 2000 | 138 |
| | | | 2 | 11296 | N/A | | 4093 | 282 | 3200 | 221 |
| | | | 0 | 15179 | N/A | | 5500 | 379 | 4300 | 297 |
| | | | 3 | 18709 | N/A | | 6779 | 467 | 5300 | 366 |
| | | | 4 | 22451 | N/A | | 8134 | 561 | 6360 | 439 |

***NOTE 1: BAW Identification Grooves are TYPICAL, always verify actual BAW on plug prior to setting installation pressure**
***NOTE 2: BAW's with 0-3 Identification Grooves are made from Carbon Steel**
***NOTE 3: BAW's with 4 Identification Grooves are made from Stainless Steel**

**Questions?** Contact EST Group Customer Service at any of the following locations.

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## TABLE 3: RECOMMENDED CPI PLUG SIZES FOR USE IN TTT PLUGGING APPLICATIONS ONLY

| WALL THICKNESS | | | TUBE OD | | | | |
|---|---|---|---|---|---|---|---|
| **BWG** | **DECIMAL** | | **5/8"** | **3/4"** | **7/8'** | **1"** | **1-1/4"** |
| 10 | 0.134 | UNROLLED ID | | 0.482 | 0.607 | 0.732 | 0.982 |
| | | ROLLED ID | | 0.509 | 0.634 | 0.759 | 1.009 |
| | | PLUG PART # | N/A | V-471 | V-584 | V-712 | V-962 |
| 11 | 0.12 | UNROLLED ID | | 0.510 | 0.635 | 0.760 | 1.010 |
| | | ROLLED ID | | 0.534 | 0.659 | 0.784 | 1.034 |
| | | PLUG PART # | N/A | V-491 | V-621 | V-735 | V-979 |
| 12 | 0.109 | UNROLLED ID | | 0.532 | 0.657 | 0.782 | 1.032 |
| | | ROLLED ID | | 0.554 | 0.679 | 0.804 | 1.054 |
| | | PLUG PART # | N/A | V-512 | V-621 | V-735 | V-979 |
| 13 | 0.095 | UNROLLED ID | | 0.560 | 0.685 | 0.810 | 1.060 |
| | | ROLLED ID | | 0.579 | 0.704 | 0.829 | 1.079 |
| | | PLUG PART # | N/A | V-524 | V-649 | V-774 | V-1024 |
| 14 | 0.083 | UNROLLED ID | | 0.584 | 0.709 | 0.834 | 1.084 |
| | | ROLLED ID | | 0.601 | 0.726 | 0.851 | 1.101 |
| | | PLUG PART # | N/A | V-555 | V-670 | V-804 | V-1054 |
| 15 | 0.072 | UNROLLED ID | 0.481 | 0.606 | 0.731 | 0.856 | 1.106 |
| | | ROLLED ID | 0.495 | 0.620 | 0.745 | 0.870 | 1.120 |
| | | PLUG PART # | V-471 | V-584 | V-712 | V-837 | V-1054 |
| 16 | 0.065 | UNROLLED ID | 0.495 | 0.620 | 0.745 | 0.870 | 1.120 |
| | | ROLLED ID | 0.508 | 0.633 | 0.758 | 0.883 | 1.133 |
| | | PLUG PART # | V-471 | V-584 | V-712 | V-837 | V-1054 |
| 17 | 0.058 | UNROLLED ID | 0.509 | 0.634 | 0.759 | 0.884 | 1.134 |
| | | ROLLED ID | 0.521 | 0.646 | 0.771 | 0.896 | 1.146 |
| | | PLUG PART # | V-491 | V-621 | V-735 | V-853 | V-1103 |
| 18 | 0.049 | UNROLLED ID | 0.527 | 0.652 | 0.777 | 0.902 | 1.152 |
| | | ROLLED ID | 0.537 | 0.662 | 0.787 | 0.912 | 1.162 |
| | | PLUG PART # | V-512 | V-621 | V-735 | V-853 | V-1103 |
| 19 | 0.042 | UNROLLED ID | 0.541 | 0.666 | 0.791 | 0.916 | 1.166 |
| | | ROLLED ID | 0.549 | 0.674 | 0.799 | 0.924 | 1.174 |
| | | PLUG PART # | V-524 | V-649 | V-774 | V-853 | V-1149 |
| 20 | 0.035 | UNROLLED ID | 0.555 | 0.680 | 0.805 | 0.930 | 1.180 |
| | | ROLLED ID | 0.562 | 0.687 | 0.812 | 0.937 | 1.187 |
| | | PLUG PART # | V-524 | V-649 | V-774 | V-853 | V-1149 |
| 21 | 0.032 | UNROLLED ID | 0.561 | 0.686 | 0.811 | 0.936 | 1.186 |
| | | ROLLED ID | 0.567 | 0.692 | 0.817 | 0.942 | 1.192 |
| | | PLUG PART # | V-524 | V-670 | V-774 | V-919 | V-1149 |
| 22 | 0.028 | UNROLLED ID | 0.569 | 0.694 | 0.819 | 0.944 | 1.194 |
| | | ROLLED ID | 0.575 | 0.700 | 0.825 | 0.950 | 1.200 |
| | | PLUG PART # | V-524 | V-670 | V-774 | V-919 | V-1171 |
| 23 | 0.025 | UNROLLED ID | 0.575 | 0.700 | 0.825 | 0.950 | 1.200 |
| | | ROLLED ID | 0.580 | 0.705 | 0.830 | 0.955 | 1.205 |
| | | PLUG PART # | V-555 | V-670 | V-804 | V-919 | V-1171 |
| 24 | 0.022 | UNROLLED ID | 0.581 | 0.706 | 0.831 | 0.956 | 1.206 |
| | | ROLLED ID | 0.585 | 0.710 | 0.835 | 0.960 | 1.210 |
| | | PLUG PART # | V-555 | V-670 | V-804 | V-919 | V-1171 |

***NOTE: Plug Part Numbers above do not include material designation. For recommended sizes in near end applications refer to CPI Plug rolled tube sizing chart shown in (DC1221).**

**Questions?** Contact EST Group Customer Service at any of the following locations.

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## TTT PLUGGING TECH TIP

When performing TTT Plugging, the installation load from the hydraulic ram causes the pull rod to stretch and the compression tube to compress. The combined stretch and compression of the extensions takes away from effective travel of the pin relative to the ring. To explain differently, the small ram (PAP-6600) has a total stroke of 1" (25.4mm). If using the PAP-0200 as indicated below, the combined stretch and compression of a 20-foot (6.1m) extension assembly will be approximately 0.85" (21.6mm), refer to Table 1. This translates to approximately 0.15" (3.8mm) of pin travel relative to the ring (1" of ram stroke minus 0.85" of stretch/compression equals 0.15" pin movement (25.4mm of ram stroke minus 21.6mm of stretch/compression equals 3.8mm of pin travel relative to the ring)). So, when a full stroke of the ram is seen during installation the plug at the far end of the exchanger has only stroked by approximately 0.15" (3.8mm). This is why the TTT Plugging instructions indicate that the ram must be repeatedly stroked to the installation pressure and when released, the knurled nut cannot be tightened by more than ¼ of a turn. This repeated stroking ensures that the plug will be properly installed.

**Question:** What is the longest length of TTT extension we can use?

**Answer:** The rule of thumb is roughly 20 feet (6.1m) for the small ram (PAP-6600) and 40-feet (12.2m) for the large ram (PAP-1750). Tubes longer than 40-feet (12.2m) can be plugged using the TTT technique provided a hydraulic ram with enough stroke to overcome the stretch/compression is utilized. Please contact **EST Group** for information regarding your specific application.

Table 4 below shows the combined stretch/compression of our 20-foot (6.1m) Rod & Tube Extension Assemblies.

**Table 4: Rod & Tube Extension Assembly Stretch / Compression During TTT Plugging**

| Part Number | Stretch/Compression of 20ft. Assembly (in) | Breakaway Pressure (psi) | Pull Rod OD (in) | Compression Tube OD (in) | Breakaway Thread |
|---|---|---|---|---|---|
| PAP-0200 | 0.85 | 2700 | 5/16 | 7/16 | 12-28 |
| PAP-0201 | 0.71 | 3000 | 5/16 | 1/2 | 12-28 |
| PAP-0202 | 0.72 | 4000 | 3/8 | 9/16 | 1/4-28 |
| PAP-0213 | 0.80 | 6600 | 1/2 | 11/16 | 5/16-24 |
| PAP-0203 | 0.68 | 6600 | 1/2 | 3/4 | 5/16-24 |
| PAP-0204 | 0.40 | 3200 (Lg. Ram) | 3/4 | 1 1/8 | 1/2-20 |
| PAP-0205 | 0.32 | 3200 (Lg. Ram) | 7/8 | 1 1/4 | 1/2-20 |

***Note: The stretch/compression will be less for shorter extension assemblies and more for longer extension assemblies.**

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