THROUGH-THE-TUBE PLUGGING TECH TIP

When performing Through-the-tube (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 = 0.15" pin movement (25.4mm or 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 insures 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 20feet (6.1m) for the small ram (PAP-6600) and 40feet (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 Sales for information regarding your specific application.

Table 1 below shows the combined stretch/compression of our 20foot (6.1m) Rod and Tube Extension Assemblies. Note that the stretch/compression will be less for shorter extension assemblies and more for longer extension assemblies.

Table 1. Rod and 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

Happy plugging!

.....Jim Berneski, Engineering Manager

QUESTIONS? Contact EST Customer Service at any of the following locations with questions.
In USA and Canada: tel: 800-355-7044, fax: 215-721-1101, e-mail: info@expansionseal.com
In Europe: tel: +31-172-418841, fax: +31-172-418849; e-mail: info@estgrp.nl
In Asia: tel: +65-6745-8560, fax: +65-6742-8700, e-mail: estasia@singnet.com.sg
On the Internet: www.expansionseal.com

Expansion Seal Technologies is part of the EST Group of companies. **EST Group** provides a complete range of repair products, services and replacement parts covering the life cycle of tubular heat exchangers and condensers; additionally EST provides products and services to facilitate pressure testing pipe, piping systems, pressure vessels and their components. Visit EST Group on the internet at www.estgrp.com.

ES GROUP INC

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06-04600

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info@estgrp.com
www.estgrp.com

September 6, 2006

Boilers & Pressure Vessels Safety Program
Technical Standards & Safety Authority
14th Floor, Centre Tower
3300 Bloor Street West
Toronto, Ontario M8X 2X4
Canada
Attention: Tanya Cooper

Note : CRN revision due to Address change only.

Dear Ms. Cooper,

EST Group Inc., CPI-Perma Pop-A-Plug®: CRN: OA 8874.5 Address Change

We are resubmitting the TSSA Statutory Declaration form (Registration of Fittings) for the purpose of updating our registration.

Our registration is in need of updating to indicate the new address of EST Group Inc. dba Expansion Seal Technologies in Hatfield, Pennsylvania. Expansion Seal Technologies moved to a brand new larger facility in December 2005 to meet the growing needs of our customers. We manufacture the same products, with the same employees, and with the same machinery. We moved from 334 Godshall Drive, Harleysville, PA 19438 USA to 2701 Township Line Road, Hatfield, PA 19440 USA.

The existing CRN: OA 8874.5 was registered by Joe Sharma on September 3, 2004. We are now requesting an official address change of CRN: OA 8874.5.

In support of our request for an official address change, the following documents are attached for your review.

(1) Two updated originally signed and notarized TSSA Statutory Declaration forms (Registration of Fittings)

(2) One copy of the previously issued and stamped Statutory Declaration

(3) One copy of *ISO 9001:2000* for Expansion Seal Technologies for your reference

(4) One copy of *Quality Assurance Manual EST Group, Inc.* for your reference

If you require any additional information, please contact Jim Berneski (215-721-1100)

Yours truly,

James P. Berneski, Jr.
Vice President of Operations
Expansion Seal Technologies

JPB/jgf

Enclosures

® Pop-A-Plug is a registered Trademark of EST Group, Inc.

TECHNICAL STANDARDS & SAFETY AUTHORITY
14th Floor, Centre Tower
3300 Bloor Street West
Toronto, Ontario
Canada M8X 2X4

Show facsimile of manufacturer's logo or trademark, as it will appear on the fitting, in the space below

ES GROUP INC

STATUTORY DECLARATION
Registration of Fittings

I, James P. Berneski, Jr., Vice President of Operations
(Name and Position, e.g. President, Plant Manager, Chief Engineer)

of EST Group, Inc.
(Name of Manufacturer)

Located at 2701 Township Line Rd., Hatfield, PA 19440, USA 215/721-1100 215/721-1101
(Plant Address) *(Telephone No.)* *(Fax No.)*

☐ do solemnly declare that the fittings listed hereunder, which are subject to the ***Technical Standards and Safety Act***, Boilers and Pressure Vessels Regulation, comply with all of the requirements of

(Title of recognized North American Standard)
which specifies the dimensions, materials of construction, pressure/temperature ratings, identification marking the fittings and service;

☑ or are not covered by the provisions of a recognized North American standard and are therefore manufactured to comply with EST proprietary standards as supported by the attached data which identifies the dimensions, material of construction, pressure/temperature ratings and the basis for such ratings, the marking of the fitting for identification and service.

I further declare that the manufacture of these fittings is controlled by a quality system meeting the requirements of ISO 9001 which has been verified by the following authority, TUV America, Inc.

The items covered by this declaration, for which I seek registration, are category A type fittings. In support of this application, the following information and/or test data are attached as follows:
Cover Letter / Request for Address Change for CRN: OA 8874.5, Attachments 1-4
(drawings, calculations, test reports, etc.)

Declared before me at EST Group, Inc. **in the** State **of** PA

the 7th **day of** Sept. **AD 20** 06.

Commissioner for Oaths:

Stacey S. Teramoto
(Printed name)

Stacey S. Teramoto
(Signature)

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
STACEY S. TERAMOTO, Notary Public
Hatfield Twp., Montgomery County
My Commission Expires September 4, 2007

(Signature of Declarer)

Technical Standards and Safety Authority — Boilers and Pressure Vessels Safety Division

FOR OFFICE USE ONLY

To the best of my knowledge and belief, the application meets the requirements of the ***Technical Standards and Safety Act***, Boilers and Pressure Vessels Regulation, and CSA Standard B51 and is accepted for registration in Category A.

CRN: OA 8874.5 Add 2

Registered by: Brian Crow

Dated: 2006-12-14

REGISTERED
C.R.N.: OA 8874.5 Add 2
Signed: Brian Crow
Date: 2006-12-14

NOTE: This registration expires on 2016-12-14

Note: Address change only.

PV 09553 (06/04)

THIS REGISTRATION IS SUBJECT TO AN ACCEPTABLE QUALITY PROGRAM IN FORCE AT THE PLACE OF MANUFACTURE

ZERTIFIKAT • CERTIFICATE • 認証書 • СЕРТИФИКАТ • CERTIFICADO • CERTIFICAT

America

CERTIFICATE

The Certification Body of
TÜV SÜD AMERICA INC.
Management Service Division

hereby certifies that

Expansion Seal Technologies
2701 Township Line Road
Hatfield, PA 19440 USA

has implemented a Quality Management System in accordance with:

ISO 9001:2000

The scope of this Quality Management System includes:

Design and manufacture of pipe and tube pressure testing and plugging equipment.

BOILERS & PRESSURE VESSELS SAFETY DIVISION
REGISTERED
SEE STATUTORY DECLARATION FORM FOR C.R. NUMBER
TSSA

This Certificate is valid until: October 31, 2009

Certificate Registration No: 951 03 1540

Original Issue Date: January 10, 2003
Last Revision Date: December 6, 2006

Gary W. Minks
Director, Certification Body

ACCREDITED

Condenser Plug Selection Criteria[1]

"There are many different types of condenser tube plugs to choose from. In choosing a plug type the following considerations should be kept in mind.

- The plug should be permanent and leak tight for the life of the condenser. At the same time the plug should easily removable for retubing.
- The plug installation process should be controllable and the action of installing the plug should not damage the tube, tubesheet ligaments, tube joints or epoxy coatings applied to the tubesheet and / or tube.
- The plug itself should be constructed of materials that are rated for an infinite life of continuous duty in the condenser environment. The plug materials should resist corrosion and aging effects that might cause leakage.
- The ideal condenser plug should not require periodic re-tightening and inspection to verify that they are leak tight.
- The plug should resist pressure from either direction.

The actual plug cost is not as big a factor especially in situations where previously installed plugs are missing, leaking or have caused collateral damage to the tube and tubesheet. The expense associated with controlling persistent water in-leakage as a result of tube and plug leaks may be many times the cost of even the most expensive plug."

---

1 *Condenser In-Leakage Guideline*, EPRI, Palo Alto, CA: 2000. TR-112819 Page 7-2.

EST Group Incorporated
2701 Township Line Road • Hatfield, PA 19440-1770 USA • 800-355-7044 • 215-721-1100 • Fax: 215-721-1101
E-mail: info@estgrp.com • URL: www.estgrp.com

CPI Pop-A-Plugs® for Process Heat Exchangers

- *CPI Plugs*
- *Perma Plugs™*
- *P2 High Pressure Plugs*
- *Ram Packages*
- *Tube Stabilizers*

TÜV MANAGEMENT SERVICE ISO 9001

The Fast, Safe Way To Seal Leaking Heat Exchangers in Refineries & Chemical Plants

Taper pins can turn into lethal projectiles — and that can pose a real safety hazard for your workers. Now you can eliminate this danger with EST's CPI Pop-A-Plug®. Resistant to thermal cycling and able to provide a seal that's helium-leak tight, EST's CPI Pop-A-Plug installs using controlled force. This protects against damage to tubesheet ligaments and adjacent tubesheet joints, extending the life of your heat exchanger and reducing costs when you need to retube. What's more, the CPI Pop-A-Plug takes only seconds to install. Its broad expansion range fits multiple gages, so you need to keep fewer plugs on hand — reducing inventory and cutting costs. And it's available in carbon steel, stainless steel, and brass.

The CPI Pop-A-Plug is part of a high performance tube plugging system. Tube preparation is the second component. EST removes all tube prep uncertainty by supplying a kit of brushes to cover the CPI Pop-A-Plug's entire expansion range. Other materials are available on a consult factory basis. Ask us about through-the-tube plugging of non-U-tube heat exchangers.

With EST's CPI Pop-A-Plug, you get the following features:

- Fast installation.
- Rated up to 700 psi (48 bar) at 700°F (370°C).
- Safer than taper pins.
- No tube or tubesheet damage.
- Helium leak tight to $1x10^{-10}$ cc/sec.
- Quality Assurance System: Meets requirements of ANSI N45.2, 10CFR50 Appendix B, 10CFR21, and is certified to ISO-9001.
- In stock for immediate delivery.
- Reduced inventory because of high plug expansion range.
- Tube prep brush kit required. Purchased seperately.

ES GROUP INC

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2701 Township Line Road
Hatfield, PA 19440-1770 USA
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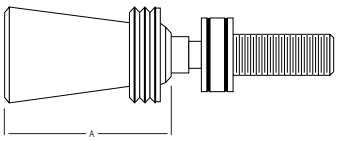
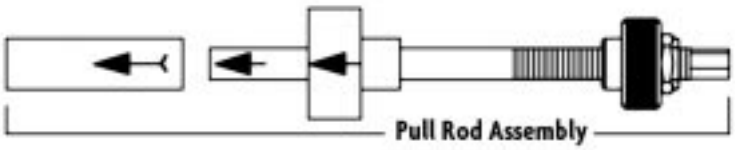
SPECIALISTS IN TUBE TESTING, SLEEVING AND PLUGGING TECHNOLOGY — AN ISO-9001 REGISTERED COMPANY





Part No.	Plug Size/OD	Tube ID Range	Pin Length (A)	Brush Kits (crs/ss)	Brush Kits (brass)	Positioner	Pull Rod Assembly	Channel Head Pull Rod Assembly
V-471-M	0.471 in. (11.96mm)	0.472-0.515 in. (11.99-13.08mm)	1.630 in. (41.40mm)	BSH-471-HT	BSH-471	P-471	PA-471	CPA-471-LL
V-491-M	**0.491 in. (12.47mm)**	**0.492-0.540 in. (12.50-13.72mm)**	**1.670 in. (42.42mm)**	**BSH-491-HT**	**BSH-491**	**P-491**	**PA-491**	**CPA-491-LL**
V-512-M	0.512 in. (13.00mm)	0.513-0.562 in. (13.03-14.27mm)	1.590 in. (40.39mm)	BSH-512-HT	BSH-512	P-512	PA-512	CPA-512-LL
V-524-M	**0.524 in. (13.31mm)**	**0.525-0.585 in. (13.34-14.86mm)**	**1.280 in. (32.51mm)**	**BSH-524-HT**	**BSH-524**	**P-524**	**PA-524**	**CPA-524-LL**
V-555-M	0.555 in. (14.10mm)	0.556-0.616 in. (14.12-15.65mm)	1.400 in. (35.56mm)	BSH-555-HT	BSH-555	P-555	PA-555	CPA-555-LL
V-584-M	**0.584 in. (14.83mm)**	**0.585-0.649 in. (14.86-16.48mm)**	**1.320 in. (33.53mm)**	**BSH-584-HT**	**BSH-584**	**P-584**	**PA-584**	**CPA-584-LL**
V-621-M	0.621 in. (15.77mm)	0.622-0.689 in. (15.80-17.50mm)	1.570 in. (39.88mm)	BSH-621-HT	BSH-621	P-621	PA-621	CPA-621-LL
V-649-M	**0.649 in. (16.48mm)**	**0.650-0.713 in. (16.51-18.11mm)**	**1.320 in. (33.53mm)**	**BSH-649-HT**	**BSH-649**	**P-649**	**PA-649**	**CPA-649-LL**
V-670-M	0.670 in. (17.02mm)	0.671-0.740 in. (17.04-18.80mm)	1.660 in. (42.16mm)	BSH-670-HT	BSH-670	P-670	PA-670	CPA-670-LL
V-712-M	**0.712 in. (18.08mm)**	**0.713-0.777 in. (18.11-19.74mm)**	**1.320 in. (33.53mm)**	**BSH-712-HT**	**BSH-712**	**P-712**	**PA-712**	**CPA-712-LL**
V-735-M	0.735 in. (18.67mm)	0.736-0.810 in. (18.69-20.57mm)	1.680 in. (42.67mm)	BSH-735-HT	BSH-735	P-735	PA-735	CPA-735-LL
V-774-M	**0.774 in. (19.66mm)**	**0.775-0.838 in. (19.69-21.29mm)**	**1.320 in. (33.53mm)**	**BSH-774-HT**	**BSH-774**	**P-774**	**PA-774**	**CPA-774-LL**
V-804-M	0.804 in. (20.42mm)	0.805-0.890 in. (20.45-22.61mm)	1.700 in. (43.18mm)	BSH-804-HT	BSH-804	P-804	PA-804	CPA-804-LL
V-837-M	**0.837 in. (21.26mm)**	**0.838-0.902 in. (21.29-22.91mm)**	**1.320 in. (33.53mm)**	**BSH-837-HT**	**BSH-837**	**P-837**	**PA-837**	**CPA-837-LL**
V-853-M	0.853 in. (21.67mm)	0.854-0.949 in. (21.69-24.10mm)	1.720 in. (43.69mm)	BSH-853-HT	BSH-853	P-853	PA-853	CPA-853-LL
V-899-M	**0.899 in. (22.83mm)**	**0.900-0.963 in. (22.86-24.46mm)**	**1.320 in. (33.53mm)**	**BSH-899-HT**	**BSH-899**	**P-899**	**PA-899**	**CPA-899-LL**
V-919-M	0.919 in. (23.34mm)	0.920-1.019 in. (23.37-25.88mm)	1.760 in. (44.70mm)	BSH-919-HT	BSH-919	P-919	PA-919	CPA-919-LL
V-962-M	**0.962 in. (24.43mm)**	**0.963-1.027 in. (24.46-26.09mm)**	**1.320 in. (33.53mm)**	**BSH-962-HT**	**BSH-962**	**P-962**	**PA-962**	**CPA-962-LL**
V-979-M	0.979 in. (24.87mm)	0.980-1.079 in. (24.89-27.41mm)	1.820 in. (46.23mm)	BSH-979-HT	BSH-979	P-979	PA-979	CPA-979-LL
V-1024-M	**1.024 in. (26.01mm)**	**1.025-1.088 in. (26.04-27.64mm)**	**1.320 in. (33.53mm)**	**BSH-1024-U**	**BSH-1024-U**	**P-1024**	**PA-1024**	**CPA-1024-LL**
V-1054-M	1.054 in. (26.77mm)	1.055-1.154 in. (26.80-29.31mm)	1.900 in. (48.26mm)	BSH-1054-U	BSH-1054-U	P-1054	PA-1054	CPA-1054-LL
V-1087-M	**1.087 in. (27.61mm)**	**1.088-1.152 in. (27.64-29.26mm)**	**1.320 in. (33.53mm)**	**BSH-1087-U**	**BSH-1087-U**	**P-1087**	**PA-1087**	**CPA-1087-LL**
V-1103-M	1.103 in. (28.02mm)	1.104-1.203 in. (28.04-30.56mm)	1.900 in. (48.26mm)	BSH-1103-U	BSH-1103-U	P-1103	PA-1103	CPA-1103-LL
V-1149-M	**1.149 in. (29.18mm)**	**1.150-1.213 in. (29.21-30.81mm)**	**1.320 in. (33.53mm)**	**BSH-1149-U**	**BSH-1149-U**	**P-1149**	**PA-1149**	**CPA-1149-LL**
V-1171-M	1.171 in. (29.74mm)	1.172-1.270 in. (29.77-32.26mm)	2.000 in. (50.80mm)	BSH-1171-U	BSH-1171-U	P-1171	PA-1171	CPA-1171-LL
V-1212-M	**1.212 in. (30.78mm)**	**1.213-1.336 in. (30.81-33.93mm)**	**2.000 in. (50.80mm)**	**BSH-1212-U**	**BSH-1212-U**	**P-1212**	**PA-1212**	**CPA-1212-LL**

Notes:

1. The suffix **M** in the CPI Plug Part Number is a plug material designator. Please replace **M** with one of the following: C for Carbon Steel, S for 316 Stainless Steel, B for Brass.
2. The suffix LL in the Channel Head Pull Rod Assembly Part Number signifies the length, in feet, of the Channel Head Extension. These parts are available in 1, 2, 3, 4, and 6 ft. lengths. Please add -01, -02, etc. for the respective Channel Head Extension length required.

Ordering Information

When ordering please supply the following information:

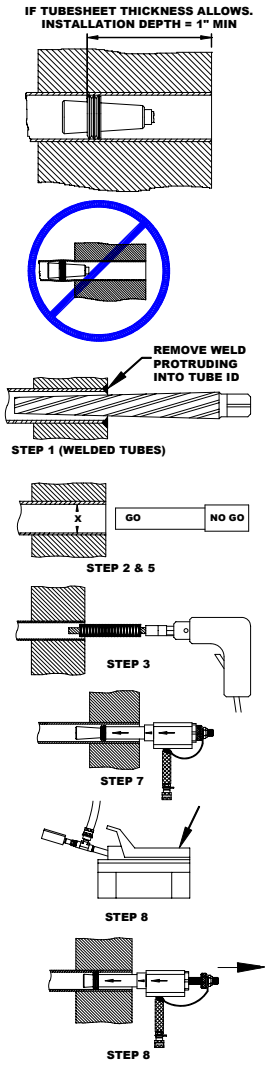
- Tube OD and wall thickness or measured tube ID
- Tube material and/or tubesheet material
- Maximum pressure and temperature
- The type of tube to tubesheet joint (rolled, welded, etc.)

Standard Materials: Brass (B), 316 Stainless Steel (S), Carbon Steel (C)

Maximum Operating Pressure/Temperature: 700 psi (48.0 bar), 700°F (370°C).

Delivery: Substantial quantities of V-524-M to V-1149-M in the three materials listed above are normally in stock for immediate shipment. For details on exact delivery, larger sizes, or alternate materials, contact EST directly.

CPI/PERMA PLUG™ NEAR END INSTALLATION INSTRUCTION



- ***CPI/PERMA PLUGS MUST BE INSTALLED IN THE ROLLED SECTION WITHIN THE TUBESHEET. IF THE TUBE IS NOT EXPANDED INTO THE TUBESHEET, MAXIMUM TUBE ID LIMITS ARE REDUCED BY 0.020"(0.51MM).***
- ***THE INSTALLED PLUG SHOULD NEVER PROJECT BEYOND TUBESHEET FACE UNLESS IT IS ON THE PERIMETER OR IN A THIN TUBESHEET.***
- ***REMOVE TUBE SLEEVES OR SHIELDS PRIOR TO TUBE PREPARATION AND PLUGGING.***
- ***NEVER HIT THE PIN WITH A HAMMER OR HEAVY OBJECT.***

1. If tube is welded to sheet, remove weld droop with a **TAPERED REAMER.** A straight reamer should never be used. Install tapered reamer in a variable speed drill and lightly lubricate. The small end of tapered reamer should fit into tube ID and large end should not. The reamer should be operated in the following manner:
   a. Keep reamer axis parallel to tube axis. See step 1 figure.
   b. Use an on/off method. Lightly squeeze the trigger on the drill to a low rpm and then release.
   c. Use very slight forward pressure. If too much pressure is used the reamer may catch.
   d. Let the reamer do the work. Never force the reamer into the ID.

   Removing weld droop is a fairly quick step and should only take 15 – 30 seconds to remove. Only remove the weld (burr) projecting into the tube ID.

WARNING! FAILURE TO REMOVE WELD DROOP WILL CAUSE GO/NO GO GAGE TO GIVE A FALSE READING. THIS FALSE GO/ NO GO GAGE READING WILL DIRECT USER TO INSTALL AN UNDERSIZED PLUG (SEE REVERSE SIDE FIGURE A) WHICH WILL LEAK EITHER INITIALLY OR LATER.

2. Service permitting, puncture both ends of the tube to be plugged just beyond the tubesheet.

3. Take initial tube ID measurement with Go/No-Go Gage (sold separately). Small end of gage should fit in tube to installation depth & large end should not.

4. Select the smallest of the brushes furnished in the Brush Kit (sold separately) that interferes with the tube ID. Operate the brush with a power drill for at least 30 seconds (5 seconds for Cu/Ni and Brass tubes) back and forth from the tube opening to the installation depth evenly to prevent a tapered condition. If as a result of uneven brushing the tube entrance is smaller, the installed plug may be undersized and leak. Do not use an oversized brush, force the brush into the tube, or bend the stem. These actions will break the stem and cause deep grooves in the tube. Do not reverse drill because bristles will fall out. A Brush lubricant / Spark inhibitor Lube-A-Tube is available from the factory if required. This must be used when brushing stainless steel tubes or brush may wear out quickly. Brush lubricant / Spark inhibitor should be cleaned from tube before plugging.

5. Carefully inspect tube for scale, pitting or other defects. These conditions must be corrected for plug to seal properly. A properly brushed tube should have a shiny metallic finish. Deeply pitted tubes may require the use of larger preparation brushes and plugs.

6. Take a second measurement with Go/No-Go Gage to installation depth. Brushing may remove enough tube material to require the next larger size gage and plug.

7. Thread the plug that matches the correct Go/No-Go Gage onto the appropriate Pull Rod assembly (See stamping on parts or table on reverse side for part numbers). All arrows on Pull Rod Assembly parts should point toward the plug.

8. Remove safety hex nut and knurled nut and insert Pull Rod Assembly into Ram. Thread knurled nut onto pull rod removing all slack in assembly. Secure safety cable on rod and thread safety hex nut onto pull rod. Be sure air and hydraulic hoses are properly connected. Failure to correctly seat and tighten hydraulic fittings will cause ram piston to lock in extended position after activation. Insert plug into prepared tube to recommended installation depth. Never stand directly behind Ram. Guide Ram with hands to avoid cocking plug.

9. Depress pump pedal, Ram will stroke. If plug does not "POP" and psi exceeds 7000 psi on gage, **STOP.** Depress front of hydraulic pump pedal and Ram will retract. If the ring has not contacted the tube ID and plug can be removed from the tube on this first stroke you have an UNDERSIZED PLUG (See reverse side Figure A). Otherwise tighten knurled nut and depress pump pedal. If plug does not "POP", on second stroke an UNDERSIZED PLUG has been installed (See reverse side Figure A), stop and contact EST Customer Service, or your local representative for assistance. Although experience indicates that the breakaway stub will not unthread during normal heat exchanger operating conditions, the best practice is to remove the breakaway stub after plug installation.

10. **Note:** Weeping during hydro test indicates small surface imperfections in the tube that are difficult to see. A large leak indicates surface imperfection in the tube such as scarring from a drill used to remove a sleeve or tapered pin, that should have been seen in step 4. In either case, remove plug using EST removal tool and repeat procedure using next larger brush and plug size.

QUESTIONS? Contact EST Customer Service at any of the following locations with questions.
In USA and Canada: tel: 800-355-7044, fax: 215-721-1101, e-mail: info@expansionseal.com
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Expansion Seal Technologies is part of the EST Group of companies. **EST Group** provides a complete range of repair products, services and replacement parts covering the life cycle of tubular heat exchangers and condensers; additionally EST provides products and services to facilitate pressure testing pipe, piping systems, pressure vessels and their components. Visit EST Group on the internet at www.estgrp.com.

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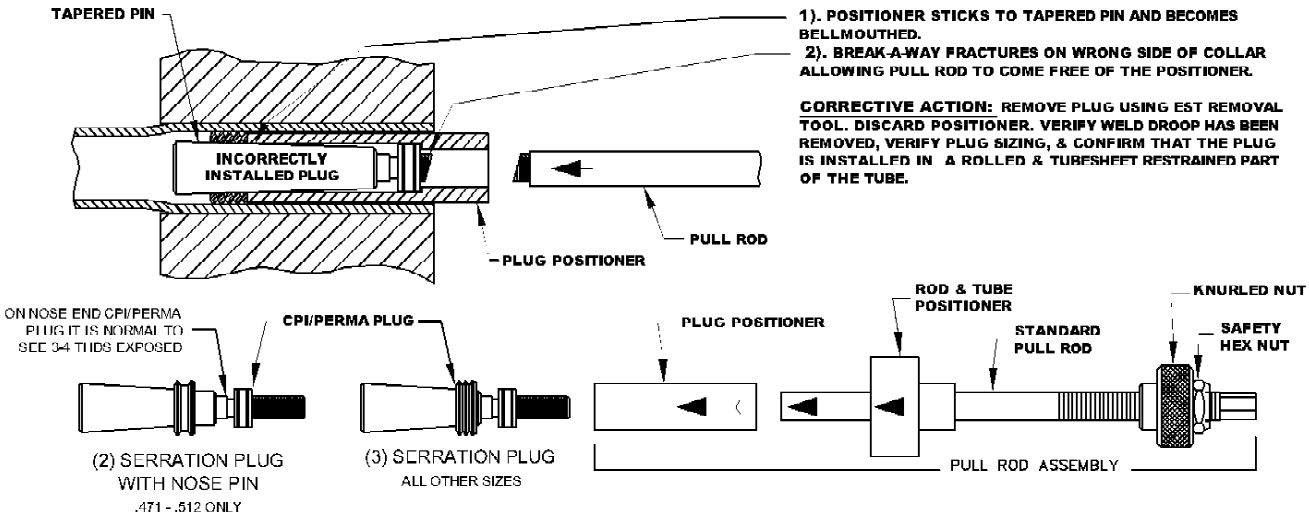
FIGURE A: SIGNS OF UNDERSIZED PLUG, A PLUG INSTALLED BEYOND THE TUBESHEET, OR A PLUG INSTALLED IN UNROLLED TUBE INSIDE TUBESHEET



PLUG SIZE	TUBE I.D. RANGE (INCHES) (SEE NOTE 5)	TUBE I.D. RANGE (mm) (SEE NOTE 5)	CPI/PERMA PLUG KIT (SEE NOTE 1)	PLUG POSITIONER	PULL ROD ASSEMBLY	CHANNEL HEAD PULL ROD ASSEMBLY (SEE NOTE 2)	TUBE PREPARATION BRUSH KIT (SEE NOTE 3&4)
.471	.472 TO .515	11.99 TO 13.08	V-471-M	P-471	PA-471	CPA-471-YY	BSH-471-HT
.491	.492 TO .540	12.50 TO 13.72	V-491-M	P-491	PA-491	CPA-491-YY	BSH-491-HT
.512	.513 TO .562	13.03 TO 14.27	V-512-M	P-512	PA-512	CPA-512-YY	BSH-512-HT
.524	.525 TO .585	13.34 TO 14.86	V-524-M	P-524	PA-524	CPA-524-YY	BSH-524-HT
.555	.556 TO .616	14.12 TO 15.65	V-555-M	P-555	PA-555	CPA-555-YY	BSH-555-HT
.584	.585 TO .649	14.86 TO 16.48	V-584-M	P-584	PA-584	CPA-584-YY	BSH-584-HT
.621	.622 TO .689	15.80 TO 17.50	V-621-M	P-621	PA-621	CPA-621-YY	BSH-621-HT
.649	.650 TO .713	16.51 TO 18.11	V-649-M	P-649	PA-649	CPA-649-YY	BSH-649-HT
.670	.671 TO .740	17.04 TO 18.80	V-670-M	P-670	PA-670	CPA-670-YY	BSH-670-HT
.712	.713 TO .777	18.11 TO 19.74	V-712-M	P-712	PA-712	CPA-712-YY	BSH-712-HT
.735	.736 TO .810	18.69 TO 20.57	V-735-M	P-735	PA-735	CPA-735-YY	BSH-735-HT
.774	.775 TO .838	19.69 TO 21.29	V-774-M	P-774	PA-774	CPA-774-YY	BSH-774-HT
.804	.805 TO .890	20.45 TO 22.61	V-804-M	P-804	PA-804	CPA-804-YY	BSH-804-HT
.837	.838 TO .902	21.29 TO 22.91	V-837-M	P-837	PA-837	CPA-837-YY	BSH-837-HT
.853	.854 TO .949	21.69 TO 24.10	V-853-M	P-853	PA-853	CPA-853-YY	BSH-853-HT
.899	.900 TO .963	22.86 TO 24.46	V-899-M	P-899	PA-899	CPA-899-YY	BSH-899-HT
.919	.920 TO 1.019	23.37 TO 25.88	V-919-M	P-919	PA-919	CPA-919-YY	BSH-919-HT
.962	.963 TO 1.027	24.46 TO 26.09	V-962-M	P-962	PA-962	CPA-962-YY	BSH-962-HT
.979	.980 TO 1.079	24.89 TO 27.41	V-979-M	P-979	PA-979	CPA-979-YY	BSH-979-HT
1.024	1.025 TO 1.088	26.04 TO 27.64	V-1024-M	P-1024	PA-1024	CPA-1024-YY	BSH-1024-NY
1.054	1.055 TO 1.154	26.80 TO 29.31	V-1054-M	P-1054	PA-1054	CPA-1054-YY	BSH-1054-NY
1.087	1.088 TO 1.152	27.64 TO 29.26	V-1087-M	P-1087	PA-1087	CPA-1087-YY	BSH-1087-NY
1.103	1.104 TO 1.203	28.04 TO 30.56	V-1103-M	P-1103	PA-1103	CPA-1103-YY	BSH-1103-NY
1.149	1.150 TO 1.213	29.21 TO 30.81	V-1149-M	P-1149	PA-1149	CPA-1149-YY	BSH-1149-NY
1.171	1.172 TO 1.270	29.77 TO 32.26	V-1171-M	P-1171	PA-1171	CPA-1171-YY	BSH-1171-NY
1.212	1.213 TO 1.336	30.81 TO 33.93	V-1212-M	P-1212	PA-1212	CPA-1212-YY	BSH-1212-NY
*1.334	1.335 TO 1.458	33.91 TO 37.03	V-1334-M	P-1334	PA-1334-L	CPA-1334-L-YY	BSH-1334-NY
*1.456	1.457 TO 1.579	37.01 TO 40.11	V-1456-M	P-1456	PA-1456-L	CPA-1456-L-YY	BSH-1456-NY
*1.578	1.579 TO 1.701	40.01 TO 43.21	V-1578-M	P-1578	PA-1578-L	CPA-1578-L-YY	BSH-1578-NY
*1.700	1.701 TO 1.823	43.21 TO 46.30	V-1700-M	P-1700	PA-1700-L	CPA-1700-L-YY	BSHV-1700-NY
*1.822	1.823 TO 1.945	46.30 TO 49.40	V-1822-M	P-1822	PA-1822-L	CPA-1822-L-YY	BSH-1822-NY
*1.944	1.945 TO 2.067	49.40 TO 52.50	V-1944-M	P-1944	PA-1944-L	CPA-1944-L-YY	BSH-1944-NY

*Must use Large Hydraulic Ram, P/N: PAP-1750, to install these plugs

NOTES:

1. CPI/PERMA Plug kits contain 10 plugs. The suffix “M” in the CPI/PERMA kit part number is the plug material designator. Please replace M with one of the following: B for Brass, C for Carbon Steel, S for 316 Stainless Steel. Plug material must match tube material. Inventory of 0.471 to 1.212 in the three standard materials is normally maintained.
2. The extended length of the Channel Head Assembly allows the installer to properly position the plug without having to reach or lean into heat exchangers with channel barrels or divider plates. The suffix YY signifies the length, in feet, of the Channel Head Extension. These parts are available in 1, 2, 3, 4 and 6 foot lengths. Replace YY with 01, 02, etc. for respective Channel Head Extension size required.
3. Brushes are required for tube preparation with all CPI/PERMA Plugs. The part number suffix "HT" is used to denote the most aggressive brushes for carbon steel and stainless steel applications; no suffix is used for brass. The part number suffix "NY" is used to denote the nylon coated brushes for all materials. For Utility applications, (1) brush kit per order plus (1) additional brush kit per each (5) plug kits ordered is recommended. For Petro/Chem applications, (2) brush kits per order plus (2) additional brush kits per each (5) plug kits ordered are recommended.
4. EST can provide a brush lubricant / spark inhibitor, which will reduce the potential of sparking during all brushing and reaming, P/N: BSH-LUBE.
5. If tube is not expanded into the tubesheet the maximum tube ID limit is reduced by 0.020”(0.51mm). See DC1222 for tube ID ranges of Titanium plugs. Tube ID ranges differ from standard materials listed in note 1.

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CPI/PERMA PLUG™ ROLLED TUBE SIZING CHART

(FOR NEAR END APPLICATIONS ONLY)

ALL TUBE INNER DIAMETERS LISTED BELOW ARE BASED UPON A 10% WALL REDUCTION AS A RESULT ROLLER EXPANDING OR EQUIVALENT EXPANDING METHOD. IF TUBE IS NOT ROLLED OR EXPANDED INTO THE TUBESHEET CALL EST CUSTOMER SERVICE FOR RECOMMENDATIONS.

WALL THICKNESS			TUBE O.D.						
BWG	DECIMAL		5/8 (15.88 mm)	3/4" (19.05 mm)	7/8" (22.23 mm)	1" (25.40 mm)	1-1/4" (31.75 mm)	1-1/2" (38.10 mm)	1-3/4" (44.45 mm)
8	.165 (4.19 mm)	I.D. PLUG			.578 (14.68 mm) V-555	.703 (17.86 mm) V-670	.953 (24.21 mm) V-919	1.203 (30.56 mm) V-1171	1.453 (36.91 mm) V-1334
9	.148 (3.76 mm)	I.D. PLUG		.484 (12.29 mm) V-471	.609 (15.47 mm) V-584	.734 (18.64 mm) V-712	.984 (24.99 mm) V-979	1.234 (31.34 mm) V-1212	1.484 (37.69 mm) V-1456
10	.134 (3.40 mm)	I.D. PLUG		.509 (12.93 mm) V-491	.634 (16.10 mm) V-621	.759 (19.28 mm) V-735	1.009 (25.63 mm) V-979	1.259 (31.98 mm) V-1212	1.509 (38.33 mm) V-1456
11	.120 (3.05 mm)	I.D. PLUG		.534 (13.56 mm) V-524	.659 (16.74 mm) V-649	.784 (19.91 mm) V-774	1.034 (26.26 mm) V-1024	1.284 (32.61 mm) V-1212	1.534 (38.96 mm) V-1456
12	.109 (2.77 mm)	I.D. PLUG		.554 (14.07 mm) V-524	.679 (17.25 mm) V-670	.804 (20.42 mm) V-774	1.054 (26.77 mm) V-1024	1.304 (33.12 mm) V-1212	1.554 (39.47 mm) V-1456
13	.095 (2.41 mm)	I.D. PLUG		.579 (14.71 mm) V-555	.704 (17.88 mm) V-670	.829 (21.06 mm) V-804	1.079 (27.41 mm) V-1054	1.329 (33.76 mm) V-1212	1.579 (40.11 mm) V-1456
14	.083 (2.11 mm)	I.D. PLUG	.476 (12.09 mm) V-471	.601 (15.27 mm) V-584	.726 (18.44 mm) V-712	.851 (21.62 mm) V-837	1.101 (27.97 mm) V-1087	1.351 (34.32 mm) V-1334	1.601 (40.67 mm) V-1578
15	.072 (1.83 mm)	I.D. PLUG	.495 (12.57 mm) V-491	.620 (15.75 mm) V-584	.745 (18.92 mm) V-735	.870 (22.10 mm) V-853	1.120 (28.45 mm) V-1103	1.370 (34.80 mm) V-1334	1.620 (41.15 mm) V-1578
16	.065 (1.65 mm)	I.D. PLUG	.508 (12.90 mm) V-491	.633 (16.08 mm) V-621	.758 (19.25 mm) V-735	.883 (22.43 mm) V-853	1.133 (28.78 mm) V-1103	1.383 (35.13 mm) V-1334	1.633 (41.48 mm) V-1578
17	.058 (1.47 mm)	I.D. PLUG	.521 (13.23 mm) V-512	.646 (16.41 mm) V-621	.771 (19.58 mm) V-735	.896 (22.76 mm) V-853	1.146 (29.11 mm) V-1103	1.396 (35.46 mm) V-1334	1.646 (41.81 mm) V-1578
18	.049 (1.24 mm)	I.D. PLUG	.537 (13.64 mm) V-524	.662 (16.81 mm) V-649	.787 (19.99 mm) V-774	.912 (23.16 mm) V-899	1.162 (29.51 mm) V-1149	1.412 (35.86 mm) V-1334	1.662 (42.21 mm) V-1578
19	.042 (1.07 mm)	I.D. PLUG	.549 (13.94 mm) V-524	.674 (17.12 mm) V-649	.799 (20.29 mm) V-774	.924 (23.47 mm) V-899	1.174 (29.82 mm) V-1149	1.424 (36.17 mm) V-1334	1.674 (42.52 mm) V-1578
20	.035 (0.89 mm)	I.D. PLUG	.562 (14.27 mm) V-524	.687 (17.45 mm) V-649	.812 (20.62 mm) V-774	.937 (23.80 mm) V-899	1.187 (30.15 mm) V-1149	1.437 (36.50 mm) V-1334	1.687 (42.85 mm) V-1578
21	.032 (0.81 mm)	I.D. PLUG	.567 (14.40 mm) V-555	.692 (17.58 mm) V-670	.817 (20.75 mm) V-804	.942 (23.93 mm) V-919	1.192 (30.28 mm) V-1171	1.442 (36.63 mm) V-1334	1.692 (42.98 mm) V-1578
22	.028 (0.71 mm)	I.D. PLUG	.575 (14.61 mm) V-555	.700 (17.78 mm) V-670	.825 (20.96 mm) V-804	.950 (24.13 mm) V-919	1.200 (30.48 mm) V-1171	1.450 (36.83 mm) V-1334	1.700 (43.18 mm) V-1700
23	.025 (0.64 mm)	I.D. PLUG	.580 (14.73 mm) V-555	.705 (17.91 mm) V-670	.830 (21.08 mm) V-804	.955 (24.26 mm) V-919	1.205 (30.61 mm) V-1171	1.455 (36.96 mm) V-1334	1.705 (43.31 mm) V-1700
24	.022 (0.56 mm)	I.D. PLUG	.585 (14. 86 mm) V-555	.710 (18.03 mm) V-670	.835 (21.21 mm) V-804	.960 (24.38 mm) V-919	1.210 (30.73 mm) V-1171	1.460 (37.08 mm) V-1456	1.710 (43.43 mm) V-1700

NOTES:

1. Heat exchanger tube ID's often vary between inlet & outlet. More than one plug size may be required. For recommended plug sizes in Through-The-Tube applications refer to Through-the-Tube Plugging Procedures, DC4015.
2. Plug Materials: designate plug material by adding a suffix (B for Brass; S for Stainless Steel 316; C for carbon steel) to the plug numbers listed above. Example: A 5/8" x 20 BWG brass tube would require V-524-B plugs.
3. Tube Preparation Brushes. Brushes are required for tube preparation with all CPI / Perma Plugs. For utility applications, one (1) brush kit per order, plus one (1) brush kit per 50 plugs is required. For petro/chem applications, two (2) brush kits per 50 plugs is required.

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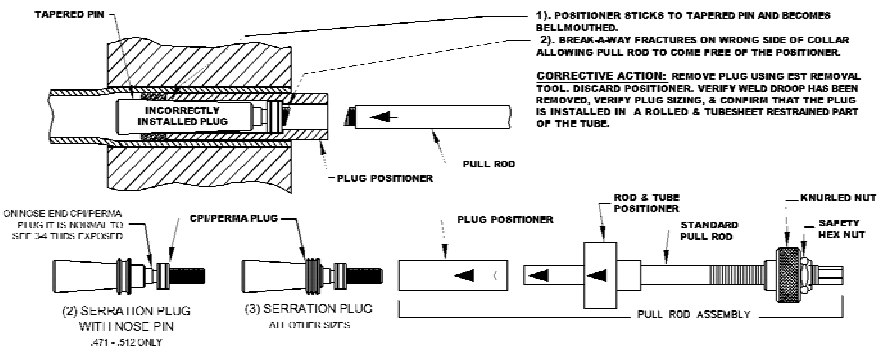
TITANIUM CPI / PERMA PLUGS NEAR END INSTALLATION INSTRUCTIONS (SUPPLEMENTS DC1220)

Tube ID's applicable to Titanium CPI / Perma plugs may differ from plugs manufactured in other materials. See chart below for Titanium plugs ranges only. For ID ranges for all other plug materials, see DC1220 Page 2.

FIGURE A: SIGNS OF UNDERSIZED PLUG, A PLUG INSTALLED BEYOND THE TUBESHEET, OR A PLUG INSTALLED IN UNROLLED TUBE INSIDE TUBESHEET



PLUG SIZE	TUBE I.D. RANGE (INCHES) (SEE NOTE 5)	TUBE I.D. RANGE (mm) (SEE NOTE 5)	CPI/PERMA PLUG KIT (SEE NOTE 1)	PLUG POSITIONER	PULL ROD ASSEMBLY	CHANNEL HEAD PULL ROD ASSEMBLY (SEE NOTE 2)	TUBE PREPARATION BRUSH KIT (SEE NOTE 3&4)
.471	.472 TO .507	11.99 TO 12.88	V-471-T	P-471	PA-471	CPA-471-YY	BSH-471-HT
.491	.492 TO .530	12.50 TO 13.46	V-491-T	P-491	PA-491	CPA-491-YY	BSH-491-HT
.512	.513 TO .552	13.03 TO 14.02	V-512-T	P-512	PA-512	CPA-512-YY	BSH-512-HT
.524	.525 TO .563	13.34 TO 14.30	V-524-T	P-524	PA-524	CPA-524-YY	BSH-524-HT
.555	.556 TO .600	14.12 TO 15.24	V-555-T	P-555	PA-555	CPA-555-YY	BSH-555-HT
.584	.585 TO .632	14.86 TO 16.05	V-584-T	P-584	PA-584	CPA-584-YY	BSH-584-HT
.621	.622 TO .672	15.80 TO 17.07	V-621-T	P-621	PA-621	CPA-621-YY	BSH-621-HT
.649	.650 TO .704	16.51 TO 17.88	V-649-T	P-649	PA-649	CPA-649-YY	BSH-649-HT
.670	.671 TO .727	17.04 TO 18.47	V-670-T	P-670	PA-670	CPA-670-YY	BSH-670-HT
.712	.713 TO .775	18.11 TO 19.69	V-712-T	P-712	PA-712	CPA-712-YY	BSH-712-HT
.735	.736 TO .800	18.69 TO 20.32	V-735-T	P-735	PA-735	CPA-735-YY	BSH-735-HT
.774	.775 TO .838	19.69 TO 21.29	V-774-T	P-774	PA-774	CPA-774-YY	BSH-774-HT
.804	.805 TO .879	20.45 TO 22.33	V-804-T	P-804	PA-804	CPA-804-YY	BSH-804-HT
.837	.838 TO .902	21.29 TO 22.91	V-837-T	P-837	PA-837	CPA-837-YY	BSH-837-HT
.853	.854 TO .933	21.69 TO 23.70	V-853-T	P-853	PA-853	CPA-853-YY	BSH-853-HT
.899	.900 TO .963	22.86 TO 24.46	V-899-T	P-899	PA-899	CPA-899-YY	BSH-899-HT
.919	.920 TO 1.011	23.37 TO 25.68	V-919-T	P-919	PA-919	CPA-919-YY	BSH-919-HT
.962	.963 TO 1.027	24.46 TO 26.09	V-962-T	P-962	PA-962	CPA-962-YY	BSH-962-HT
.979	.980 TO 1.079	24.89 TO 27.41	V-979-T	P-979	PA-979	CPA-979-YY	BSH-979-HT
1.024	1.025 TO 1.088	26.04 TO 27.64	V-1024-T	P-1024	PA-1024	CPA-1024-YY	BSH-1024-NY
1.054	1.055 TO 1.154	26.80 TO 29.31	V-1054-T	P-1054	PA-1054	CPA-1054-YY	BSH-1054-NY
1.087	1.088 TO 1.152	27.64 TO 29.26	V-1087-T	P-1087	PA-1087	CPA-1087-YY	BSH-1087-NY
1.103	1.104 TO 1.203	28.04 TO 30.56	V-1103-T	P-1103	PA-1103	CPA-1103-YY	BSH-1103-NY
1.149	1.150 TO 1.213	29.21 TO 30.81	V-1149-T	P-1149	PA-1149	CPA-1149-YY	BSH-1149-NY
1.171	1.172 TO 1.270	29.77 TO 32.26	V-1171-T	P-1171	PA-1171	CPA-1171-YY	BSH-1171-NY
1.212	1.213 TO 1.336	30.81 TO 33.93	V-1212-T	P-1212	PA-1212	CPA-1212-YY	BSH-1212-NY
1.334	*1.335 TO 1.458	33.91 TO 37.03	V-1334-T	P-1334	PA-1334-L	CPA-1334-L-YY	BSH-1334-NY
1.456	*1.457 TO 1.579	37.01 TO 40.11	V-1456-T	P-1456	PA-1456-L	CPA-1456-L-YY	BSH-1456-NY
1.578	*1.579 TO 1.701	40.01 TO 43.21	V-1578-T	P-1578	PA-1578-L	CPA-1578-L-YY	BSH-1578-NY
1.700	*1.701 TO 1.823	43.21 TO 46.30	V-1700-T	P-1700	PA-1700-L	CPA-1700-L-YY	BSHV-1700-NY
1.822	*1.823 TO 1.945	46.30 TO 49.40	V-1822-T	P-1822	PA-1822-L	CPA-1822-L-YY	BSH-1822-NY
1.944	*1.945 TO 2.067	49.40 TO 52.50	V-1944-T	P-1944	PA-1944-L	CPA-1944-L-YY	BSH-1944-NY

*Must use Large Hydraulic Ram, P/N: PAP-1750, to install these plugs

NOTES:
1. CPI/PERMA Plug kits contain 10 plugs. The suffix "T" in the CPI/PERMA PLUG kit part designates Titanium. Plug material must match tube material.
2. The extended length of the Channel Head Assembly allows the installer to properly position the plug without having to reach or lean into heat exchangers with channel barrels or divider plates. The suffix YY signifies the length, in feet, of the Channel Head Extension. These parts are available in 1, 2, 3, 4 and 6 foot lengths. Replace YY with 01, 02, etc. for respective Channel Head Extension size required.
3. Brushes are required for tube preparation with all CPI/PERMA Plugs. The part number suffix "HT" is used to denote the most aggressive brushes for Titanium applications. The part number suffix "NY" is used to denote the nylon coated brushes for all materials. For Utility applications, (1) brush kit per order plus (1) additional brush kit per each (5) plug kits ordered is recommended. For Petro/Chem applications, (2) brush kits per order plus (2) additional brush kits per each (5) plug kits ordered are recommended.
4. EST can provide a brush lubricant / spark inhibitor, which will reduce the potential of sparking during all brushing and reaming, P/N: BSH-LUBE.
5. If tube is not expanded into the tubesheet the maximum tube ID limit is reduced by 0.020"(0.51mm). Titanium Plug tube ID ranges differ from plugs manufactured from other materials. See DC1220 installation instructions for all other material plugs.

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CPI / PERMA PLUG APPLICATION DATA

This document lists specifications of the standard CPI / Perma Plug heat exchanger tube plugs and technical information concerning their field application. CPI / Perma Plugs are part of the Pop-A-Plug® Tube Plugging System.

Plug Sizes 0.471" through 1.944" (11.96 through 49.38mm).

Plug Materials Carbon Steel, Stainless Steel, Brass, and Titanium. (Other alloys materials available by request)
Carbon Steel to be alloy 1018 and/or alloy 1045 as required by design
Stainless Steel to be alloy 316.
Brass to be alloy 360 and/or alloy 464 as required by design
Titanium to be grade 1/2 ring and grade 23 (6AL4V ELI) pin
Copper Nickel to be 70/30.

Pressure Rating CPI Plugs: 700 psig (48 Bar) Perma Plugs 300 psig (21 Bar)

Temperature Rating 700°F (371C) maximum for Carbon Steel. 900°F (482C) maximum for 316 Stainless Steel and Titanium.
400°F (204C) maximum for Brass. 500°F (260C) maximum for Copper Nickel.

Operating Ranges (Ranges apply to all materials except where noted for Titanium)

CPI/perma Plug Size	Material	Tube ID Range (in)	Tube ID Range (mm)
V-471	All	.472 - .515	11.99 - 13.08
V-471-T	Titanium only	.472 - .507	11.99 - 12.88
V-491	All	.492 - .540	12.50 - 13.72
V-491-T	Titanium only	.492 - .530	12.50 - 13.46
V-512	All	.513 - .562	13.03 - 14.27
V-512-T	Titanium only	.513 - .552	13.03 - 14.02
V-524	All	.525 - .585	13.34 - 14.86
V-524-T	Titanium only	.525 - .563	13.34 - 14.30
V-555	All	.556 - .616	14.12 - 15.65
V-555-T	Titanium only	.556 - .600	14.12 - 15.24
V-584	All	.585 - .649	14.86 - 16.48
V-584-T	Titanium only	.585 - .632	14.86 - 16.05
V-621	All	.622 - .689	15.80 - 17.50
V-621-T	Titanium only	.622 - .672	15.80 - 17.07
V-649	All	.650 - .713	16.51 - 18.11
V-649-T	Titanium only	.650 - .704	16.51 - 17.88
V-670	All	.671 - .740	17.04 - 18.80
V-670-T	Titanium only	.671 - .727	17.04 - 18.47
V-712	All	.713 - .777	18.11 - 19.74
V-712-T	Titanium only	.713 - .775	18.11 - 19.69
V-735	All	.736 - .810	18.69 - 20.57
V-735-T	Titanium only	.736 - .800	18.69 - 20.32
V-774	All	.775 - .838	19.69 - 21.29

CPI/perma Plug Size	Material	Tube ID Range (in)	Tube ID Range (mm)
V-804	All	.805 - .890	20.45 - 22.61
V-804-T	Titanium only	.805 - .879	20.45 - 22.33
V-837	All	.838 - .902	21.29 - 22.91
V-853	All	.854 - .949	21.69 - 24.10
V-853-T	Titanium only	.854 - .933	21.69 - 23.70
V-899	All	.900 - .963	22.86 - 24.46
V-919	All	.920 - 1.019	23.37 - 25.88
V-919-T	Titanium only	.920 - 1.011	23.37 - 25.68
V-962	All	.963 - 1.027	24.46 - 26.09
V-979	All	.980 - 1.079	24.89 - 27.41
V-1024	All	1.025 - 1.088	26.04 - 27.64
V-1054	All	1.055 - 1.154	26.80 - 29.31
V-1087	All	1.088 - 1.152	27.64 - 29.26
V-1103	All	1.104 - 1.203	28.04 - 30.56
V-1149	All	1.150 - 1.213	29.21 - 30.81
V-1171	All	1.172 - 1.270	29.77 - 32.26
V-1212	All	1.213 - 1.336	30.81 - 33.93
V-1334	All	1.335 - 1.458	33.91 - 37.03
V-1456	All	1.457 - 1.579	37.01 - 40.11
V-1578	All	1.579 - 1.701	40.11 - 43.21
V-1700	All	1.701 - 1.823	43.21 - 46.30
V-1822	All	1.823 - 1.945	46.30 - 49.40
V-1944	All	1.945 - 2.067	49.40 - 52.50

Application Information

The CPI/Perma Plug is designed to be installed in the near end of heat exchangers, which meet the above operating conditions. The material of the plug must be matched to the material into which it is being installed to minimize the effects of corrosion and thermal expansion. Cases where the plug material will differ from the surrounding material may require further evaluation in the form of calculations or tests.

CPI/Perma Plugs must be installed in the tube end within the region of the tube sheet. Ideally the plug installation depth should be selected so that the pin is slightly recessed within the tube sheet after installation. When plugging tube ends where the tubes are not fully expanded into the tube sheet, select the CPI/Perma Plug size so that the tube ID is at the lower end of the working range of the plug being installed.

For the best plug performance, the tube ID or tubesheet hole ID should be free from pits, scars and other leak causing surface defects. Tube / tube hole preparation should be accomplished using a tube preparation brush. Brushing removes these defects, reduces tube ovality and effectively roughens the tube surface allowing the installed plug to withstand the highest differential pressure.

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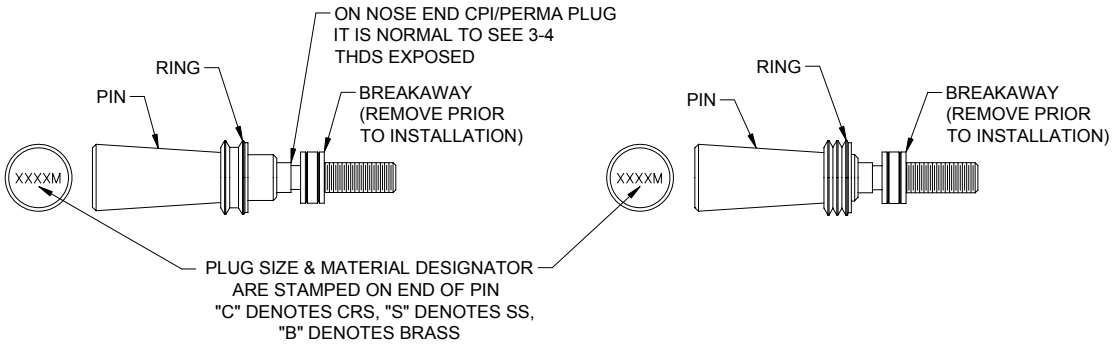
THROUGH-THE-TUBE PLUGGING WITH CPI / PERMA PLUGS

CPI / Perma Plugs are part of the Pop-A-Plug® Tube Plugging System. Unlike other tube plug designs, and under the proper conditions, CPI / Perma 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 the Through-the-Tube plugging procedure, the limitations of the technique, and the installation process.



(2) SERRATION PLUG
WITH NOSE PIN
.471 - .512 ONLY

(3) SERRATION PLUG
ALL OTHER SIZES

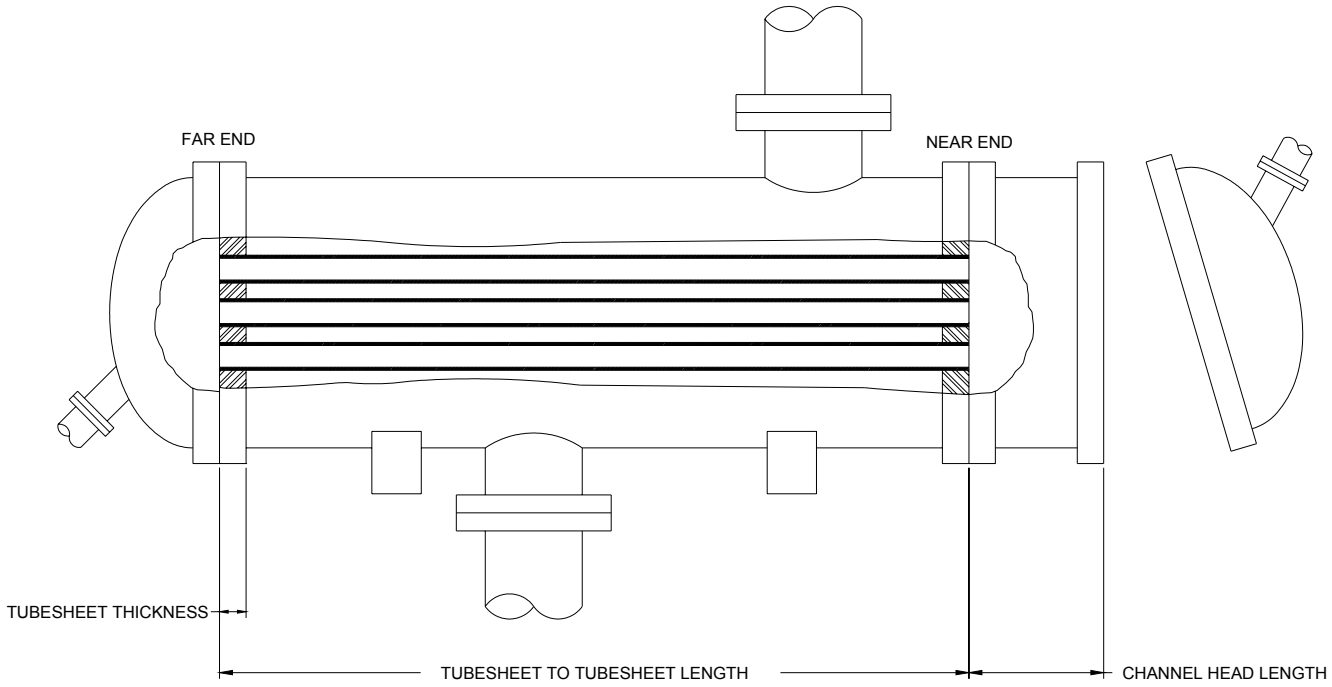
WARNING! SUCCESSFULLY INSTALLING CPI / PERMA PLUGS BY PASSING THEM THROUGH-THE-TUBE REQUIRES THAT THE OPERATOR CAREFULLY FOLLOW THIS PROCEDURE. THE OPERATOR SHOULD BECOME FAMILIAR WITH THIS PLUGGING PROCEDURE AND POSSESS A CLEAR UNDERSTANDING OF HOW TO INSTALL CPI / PERMA PLUGS AT THE NEAR END BEFORE ATTEMPTING THROUGH-THE-TUBE 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. ***CPI / PERMA PLUGS MUST NEVER BE INSTALLED IN THE TRANSITION ZONE BETWEEN EXPANDED AND UNEXPANDED AREA OF 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.

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. **Heat Exchanger Channel.**
   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 Pop-A-Plug System equipment? Do any of the obstructions require that the Pull Rod and Tube sections be a specific length?

LIMITATIONS OF THIS TECHNIQUE

While the Through-the-Tube 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 / PERMA PLUG SIZE

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

1. A sufficient supply of CPI / Perma Plugs in the proper size and plug material.

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

3. A Pop-A-Plug System Ram Package. Based on the plug size and material select either the Small Ram, Part Number PAP-6600, or Large Ram Package, Part Number PAP-1750. ***Note: V-1334 plug sizes and larger must be installed using the Large Ram.***

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

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

6. Additional Pop-A-Plug installation hardware is suggested as spares.

   6.1. 1 additional Plug Positioner for each CPI / Perma Plug size.
   6.2. 1 additional Channel Head Pull Rod Assembly (4 ft. or 6 ft.)

7. (2) small pipe wrenches (6" or smaller) or (2) pair of Vise Grips.

8. 30' tape measure.

ASSEMBLY OF HYDRAULIC EQUIPMENT:

Installation of CPI / Perma 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. The pulling pressures will also vary by the hydraulic ram used during installation. Installation pressures are shown in either Table 1, for installations with the Small Ram, and Table 2, for installations with the Large Ram. 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. Disconnect any items connected to the 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 / Perma plug size and material is achieved. Refer to Table 1 for plug installations using the Small Ram, or Table 2 for installations using the Large Ram.

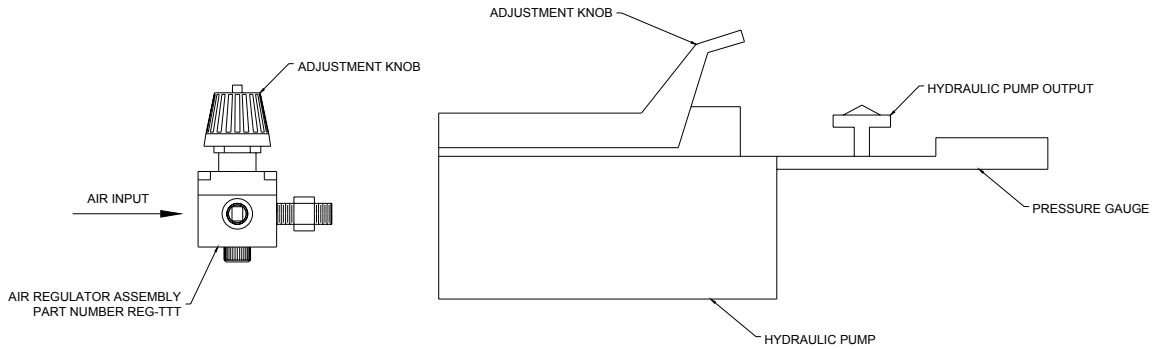


FIGURE 3. Air Regulator Assembly And Hydraulic Pump

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.

e. Connect one end of the hydraulic hose to the Pump output. The other end of the hose is to be connected to the Hydraulic Ram. Verify that all quick connects are fully tightened. The ram is now ready for use.

THROUGH-THE-TUBE ADAPTER KIT

The Through-The-Tube Adapter Kit includes a Through-The-Tube Adapter and a supply of Through-The-Tube Studs as shown in Figure 4. The Through-The-Tube (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 through-the-tube plugging applications in place of the breakaway supplied with the CPI / Perma 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.

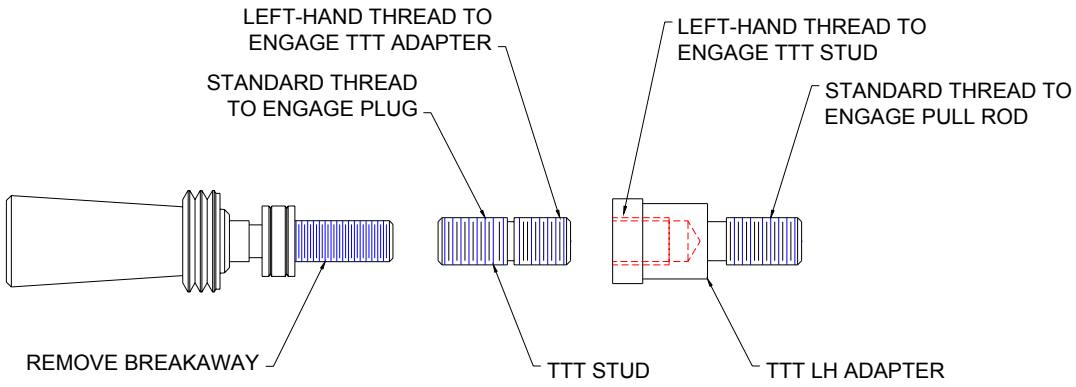


FIGURE 4. Through-The-Tube Adapter Kit and CPI / Perma Plug

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.

1. Remove breakaway from the CPI/Perma Plug to be installed through the tube. 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.

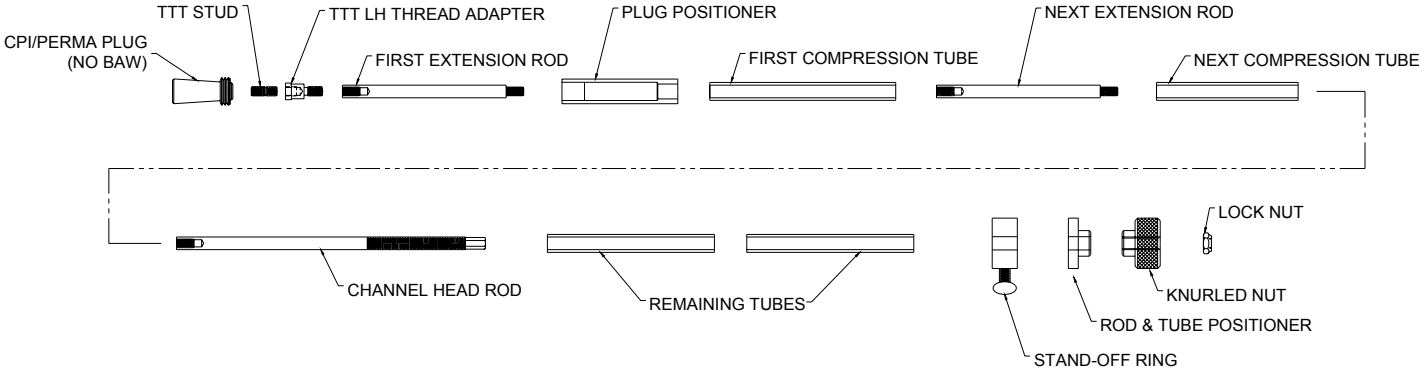


FIGURE 5. Pull Rod Assembly Set-up

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 THRU-THE-TUBE ADAPTOR PREMATURELY DISENGAGING FROM THE PLUG.

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 Rods.

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 (if applicable).

10. The Channel Head Rod should be threaded onto the Extension Rods and firmly hand tighten. 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 and 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.

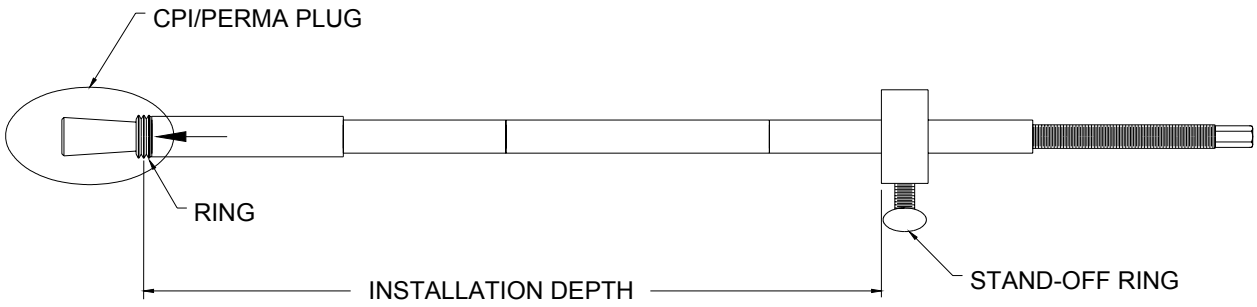


FIGURE 6. Setting Stand-Off Ring

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 and 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, press the Pump pedal to slowly 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 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 to 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 against the Ram and firmly tighten. Do not allow rod to turn when tightening the Knurled Nut.

22. While viewing the pressure gauge, press the Pump pedal to slowly 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 and 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.

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TABLE 1. Hydraulic Installation Pressures For Use With Small Ram Package (PAP-6600) Only. (See Table 2 for Large Ram)

CPI / PERMA PLUG SIZE	THROUGH-THE-TUBE ADAPTER KIT		SMALL RAM INSTALLATION PRESSURE (PSI)	
	BRASS PLUGS	STAINLESS STEEL & CARBON STEEL PLUGS	BRASS PLUGS	STAINLESS STEEL & CARBON STEEL PLUGS
.471	TTT-1032	TTT-1228	1900	2100
.491	TTT-1228		2100	2100
.512	TTT-1228		2100	2100
.524	TTT-1228		2100	3000
.555	TTT-1228		2100	3000
.584	TTT-1428		2100	3100
.621	TTT-1428		2100	3100
.649	TTT-1428		2100	4000
.670	TTT-1428		2100	4000
.712	TTT-1428		3100	4000
.735	TTT-1428		3100	4000
.774	TTT-51624		3100	5300
.804	TTT-51624		3100	5300
.837	TTT-51624		3100	5300
.853	TTT-51624		3100	5300
.899	TTT-51624		3100	5300
.919	TTT-51624		4000	5300
.962	TTT-51624		4000	5300
.979	TTT-51624		4000	5300
1.024	TTT-51624		4000	6600
1.054	TTT-51624		4000	6600
1.087	TTT-51624		4000	6600
1.103	TTT-51624		4000	6600
1.149	TTT-51624		4000	6600
1.171	TTT-51624		4000	6600
1.212	TTT-51624		5300	6600

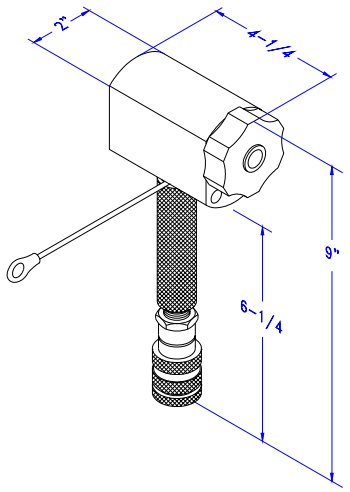

FIGURE 7. Small (White) Ram, Model PAP-6600

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TABLE 2. Hydraulic Installation Pressures For Use With Large Ram Package (PAP-1750) Only. (See Table 1 for Small Ram)

CPI / PERMA PLUG SIZE	THROUGH-THE-TUBE ADAPTER KIT		LARGE RAM INSTALLATION PRESSURE (PSI)	
	BRASS PLUGS	STAINLESS STEEL & CARBON STEEL PLUGS	BRASS PLUGS	STAINLESS STEEL & CARBON STEEL PLUGS
.471	TTT-1032	TTT-1228	714	789
.491	TTT-1228		789	789
.512	TTT-1228		789	789
.524	TTT-1228		789	1127
.555	TTT-1228		789	1127
.584	TTT-1428		789	1165
.621	TTT-1428		789	1165
.649	TTT-1428		789	1503
.670	TTT-1428		789	1503
.712	TTT-1428		1165	1503
.735	TTT-1428		1165	1503
.774	TTT-51624		1165	1991
.804	TTT-51624		1165	1991
.837	TTT-51624		1165	1991
.853	TTT-51624		1165	1991
.899	TTT-51624		1165	1991
.919	TTT-51624		1503	1991
.962	TTT-51624		1503	1991
.979	TTT-51624		1503	1991
1.024	TTT-51624		1503	2479
1.054	TTT-51624		1503	2479
1.087	TTT-51624		1503	2479
1.103	TTT-51624		1503	2479
1.149	TTT-51624		1503	2479
1.171	TTT-51624		1503	2479
1.212	TTT-51624		1991	2479
1.334	TTT-1220		2000	3200
1.456	TTT-1220		N/A	4300
1.578	TTT-1220		N/A	4300
1.700	TTT-1220		N/A	4300
1.822	TTT-1220		N/A	4300
1.944	TTT-1220		N/A	4300

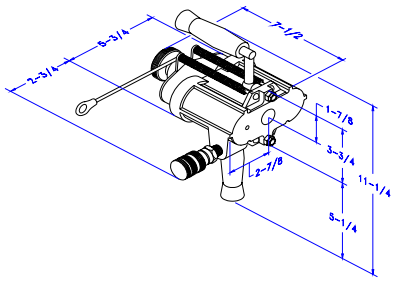

FIGURE 8. Large (Orange) Ram, Model PAP-1750

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APPENDIX 1. Recommended CPI / Perma Plug Sizes For Use In Through-The-Tube Plugging Applications Only

WALL THICKNESS			TUBE OD				
BWG	**DECIMAL**		**5/8"**	**3/4"**	**7/8'**	**1"**	**1-1/4"**
10	.134	UNROLLED ID		.482	.607	.732	.982
		ROLLED ID		.509	.634	.759	1.009
		PLUG PART #	N/A	V-471	V-584	V-712	V-962
11	.120	UNROLLED ID		.510	.635	.760	1.010
		ROLLED ID		.534	.659	.784	1.034
		PLUG PART #	N/A	V-491	V-621	V-735	V-979
12	.109	UNROLLED ID		.532	.657	.782	1.032
		ROLLED ID		.554	.679	.804	1.054
		PLUG PART #	N/A	V-512	V-621	V-735	V-979
13	.095	UNROLLED ID		.560	.685	.810	1.060
		ROLLED ID		.579	.704	.829	1.079
		PLUG PART #	N/A	V-524	V-649	V-774	V-1024
14	.083	UNROLLED ID		.584	.709	.834	1.084
		ROLLED ID		.601	.726	.851	1.101
		PLUG PART #	N/A	V-555	V-670	V-804	V-1054
15	.072	UNROLLED ID	.481	.606	.731	.856	1.106
		ROLLED ID	.495	.620	.745	.870	1.120
		PLUG PART #	V-471	V-584	V-712	V-837	V-1054
16	.065	UNROLLED ID	.495	.620	.745	.870	1.120
		ROLLED ID	.508	.633	.758	.883	1.133
		PLUG PART #	V-471	V-584	V-712	V-837	V-1054
17	.058	UNROLLED ID	.509	.634	.759	.884	1.134
		ROLLED ID	.521	.646	.771	.896	1.146
		PLUG PART #	V-491	V-621	V-735	V-853	V-1103
18	.049	UNROLLED ID	.527	.652	.777	.902	1.152
		ROLLED ID	.537	.662	.787	.912	1.162
		PLUG PART #	V-512	V-621	V-735	V-853	V-1103
19	.042	UNROLLED ID	.541	.666	.791	.916	1.166
		ROLLED ID	.549	.674	.799	.924	1.174
		PLUG PART #	V-524	V-649	V-774	V-853	V-1149
20	.035	UNROLLED ID	.555	.680	.805	.930	1.180
		ROLLED ID	.562	.687	.812	.937	1.187
		PLUG PART #	V-524	V-649	V-774	V-853	V-1149
21	.032	UNROLLED ID	.561	.686	.811	.936	1.186
		ROLLED ID	.567	.692	.817	.942	1.192
		PLUG PART #	V-524	V-670	V-774	V-919	V-1149
22	.028	UNROLLED ID	.569	.694	.819	.944	1.194
		ROLLED ID	.575	.700	.825	.950	1.200
		PLUG PART #	V-524	V-670	V-774	V-919	V-1171
23	.025	UNROLLED ID	.575	.700	.825	.950	1.200
		ROLLED ID	.580	.705	.830	.955	1.205
		PLUG PART #	V-555	V-670	V-804	V-919	V-1171
24	.022	UNROLLED ID	.581	.706	.831	.956	1.206
		ROLLED ID	.585	.710	.835	.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 / Perma Plug rolled tube sizing chart shown in (DC1221).

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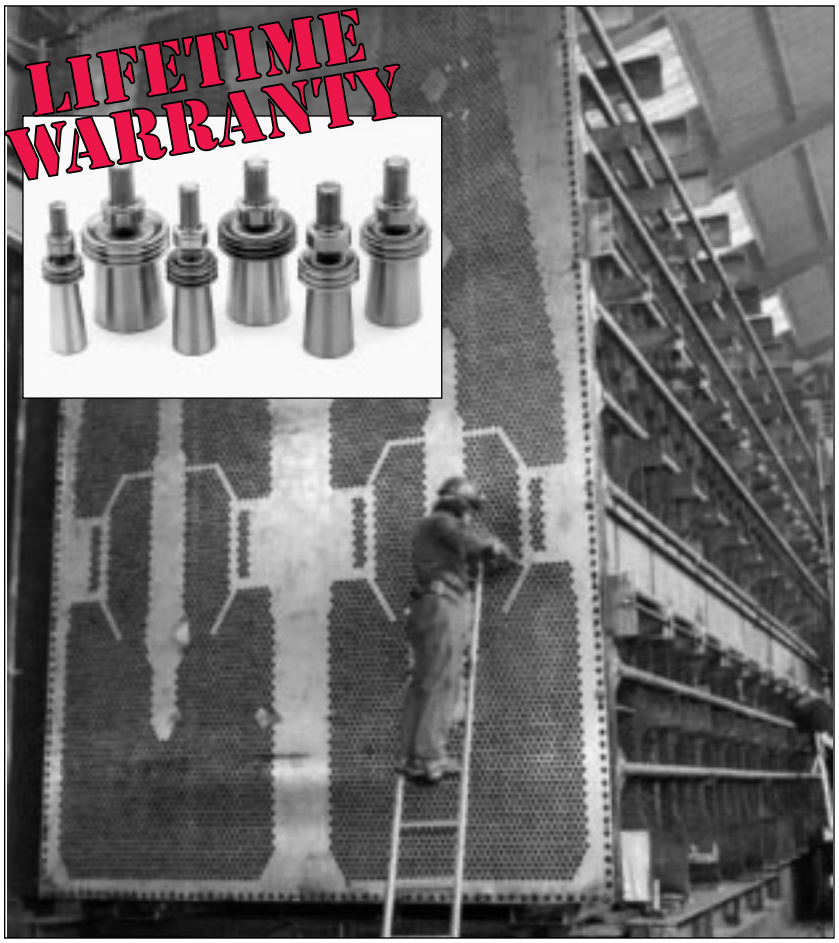
Perma Plug® Condenser Plugs



- Perma Plugs
- CPI Plugs
- P2 High Pressure Plugs
- Ram Packages
- Tube Stabilizers
- Manual Installation Tools
- Plug Removal Tools

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Seal Leaking Tubes Permanently In Seconds, For Less.

Just set 'em and forget 'em.

That's because no other condenser plug gives you the same trouble-free performance as EST's Perma Plug® Condenser Plug. With no elastomers to wear out, you never have to worry about leaking or lost seals. And since they install in seconds using proven Pop-A-Plug technology, downtime is kept to a minimum. In fact, our condenser plugs carry a lifetime warranty. So you know they're built to last.

- Installs in seconds for reduced downtime.
- Eliminates tube and tubesheet damage.
- Easy to install and remove for retubing.
- Compact design won't interfere with in-service tests.
- Lowest final installed cost. No replacing lost or leaking plugs every few years.
- Condenser specific design, for normal 18-24 BWG tubes.

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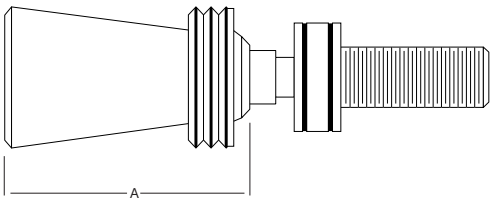

Nominal Tube OD	Plug OD	Tube ID Size Range	Perma Plug Part Number[1]	Pin Length A	Brush Kit Part Number	Pull Rod Assembly	Channel Head Pull Rod Assembly[2]
	.460 in. (11.69 mm)	.461 - .490 in. (11.71 - 12.45 mm)	V-460-M	.95 in. (24.1 mm)	BSH-460	PA-460	CHA-460-LL
	.490 in. (12.45 mm)	.491 - .526 in. (12.47 - 13.36 mm)	V-490-M	1.02 in. (25.9 mm)	BSH-490	PA-490	CHA-490-LL
5/8 in. (15.88 mm)	.524 in. (13.31 mm)	.525 - .585 in. (13.34 - 14.86 mm)	V-524-M	1.28 in. (32.5 mm)	BSH-524	PA-524	CPA-524-LL
	.584 in. (14.83 mm)	.585 - .649 in. (14.86 - 16.48 mm)	V-584-M	1.32 in. (32.5 mm)	BSH-584	PA-584	CPA-584-LL
3/4 in. (19.05 mm)	.649 in. (16.48 mm)	.650 - .713 in. (16.51 - 18.11 mm)	V-649-M	1.32 in. (33.5 mm)	BSH-649	PA-649	CPA-649-LL
	.712 in. (18.08 mm)	.713 - .777 in. (18.11 - 19.74 mm)	V-712-M	1.32 in. (33.5 mm)	BSH-712	PA-712	CPA-712-LL
7/8 in. (22.23 mm)	.774 in. (19.66 mm)	.775 - .838 in. (19.69 - 21.29 mm)	V-774-M	1.32 in. (33.5 mm)	BSH-774	PA-774	CPA-774-LL
	.837 in. (21.26 mm)	.838 - .902 in. (21.29 - 22.91 mm)	V-837-M	1.32 in. (33.5 mm)	BSH-837	PA-837	CPA-837-LL
1 in. (25.40 mm)	.899 in. (22.83 mm)	.900 - .963 in. (22.86 - 24.46 mm)	V-899-M	1.32 in. (33.5 mm)	BSH-899	PA-899	CPA-899-LL
	.962 in. (24.43 mm)	.963 - 1.027 in. (24.46 - 26.09 mm)	V-962-M	1.32 in. (33.5 mm)	BSH-962	PA-962	CPA-962-LL
1-1/8 in. (28.58 mm)	1.024 in. (26.01 mm)	1.025 - 1.088 in. (26.04 - 27.64 mm)	V-1024-M	1.32 in. (33.5 mm)	BSH-1024	PA-1024	CPA-1024-LL
	1.087 in. (27.61 mm)	1.088 - 1.152 in. (27.64 - 29.26 mm)	V-1087-M	1.32 in. (33.5 mm)	BSH-1087	PA-1087	CPA-1087-LL
1-1/4 in. (31.75 mm)	1.149 in. (29.18 mm)	1.150 - 1.213 in. (29.21 - 30.81 mm)	V-1149-M	1.32 in. (33.5 mm)	BSH-1149	PA-1149	CPA-1149-LL
	1.212 in. (30.78 mm)	1.213 - 1.336 in. (30.81 - 33.93 mm)	V-1212-M	2.00 in. (50.8 mm)	BSH-1212	PA-1212	CPA-1212-LL
	1.334 in. (33.88 mm)	1.335 - 1.458 in. (33.91 - 37.04 mm)	V-1334-M	2.00 in. (50.8 mm)	BSH-1334	PA-1334	CPA-1334-LL
	1.456 in. (36.98 mm)	1.457 - 1.579 in. (37.01 - 40.11 mm)	V-1456-M	2.00 in. (50.8 mm)	BSH-1456	PA-1456	CPA-1456-LL

Specifications subject to change without notice.

Notes:

1. The suffix M in the Perma Plug Part Number is a plug material designator. Please replace M with one of the following: B for brass, S for 316 stainless steel.
2. The suffix LL in the Channel Head Pull Road Assembly Part Number signifies the length, in feet, of the Channel Head Extension. These parts are available in 1, 2, 3, 4, and 6-ft. lengths. Please add -01, -02, etc. for the respective Channel Head Extension size required.

Ordering Information

When ordering please supply the following information:

- Tube OD and wall thickness or measured tube ID.
- Tube material.
- Tubesheet material is required if plug will be installed directly into tubesheet.
- Maximum pressure and temperature.
- The type of tube to tubesheet joint (rolled, welded, etc.).

Standard Materials: Brass (B), 316 Stainless Steel (S)
Maximum Operating Pressure/Temperature: 300 psi (20.59 bar), 300°F (149°C).
Delivery Substantial quantities of V-524-M to V-1149-M in the two materials listed above are normally in stock for immediate shipment. For details on exact delivery, larger sizes, or alternate materials, contact EST directly.

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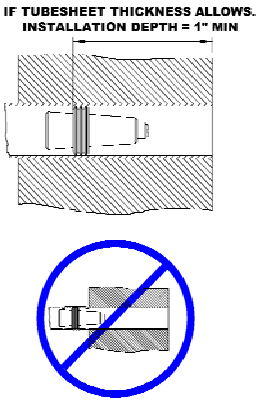
CPI/PERMA PLUG™ CLOSE QUARTER RAM INSTALLATION INSTRUCTIONS



- ***CPI/PERMA PLUGS MUST BE INSTALLED IN THE ROLLED SECTION WITHIN THE TUBESHEET. IF THE TUBE IS NOT EXPANDED INTO THE TUBESHEET, MAXIMUM TUBE ID LIMITS ARE REDUCED BY 0.020"(0.51MM).***
- ***THE INSTALLED PLUG SHOULD NEVER PROJECT BEYOND TUBESHEET FACE UNLESS IT IS ON THE PERIMETER OR IN A THIN TUBESHEET.***
- ***REMOVE TUBE SLEEVES OR SHIELDS PRIOR TO TUBE PREPARATION AND PLUGGING.***
- ***NEVER HIT THE PIN WITH A HAMMER OR HEAVY OBJECT***

INSTALLATION INSTRUCTIONS

1. Follow the first five steps of CPI/Perma Plug instructions DC1220 for proper methods of tube preparation and plug sizing.
2. Remove any tapered plugs that will prohibit the ram from installing the plug to the desired depth within the tube sheet.
3. Slide the pull rod through the pivot. See Figure A.

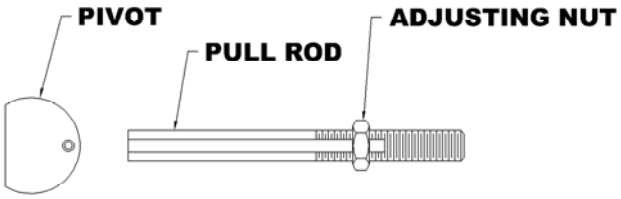


Figure A.

4. Place the positioner over the pull rod (arrow on the plug positioner points to the plug). Thread the plug into the pull rod. Hand-tighten the adjusting nut against the pivot. See Figure B. **Lubricate rounded surface of pivot and mating surface of ram with antiseize prior to operation**.

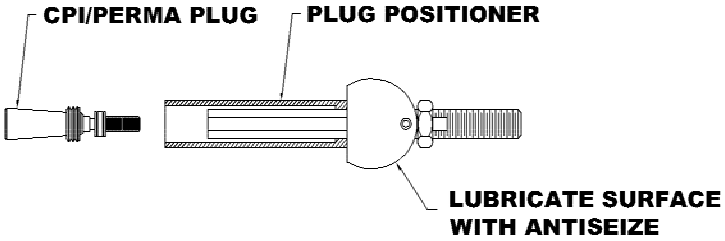


Figure B.

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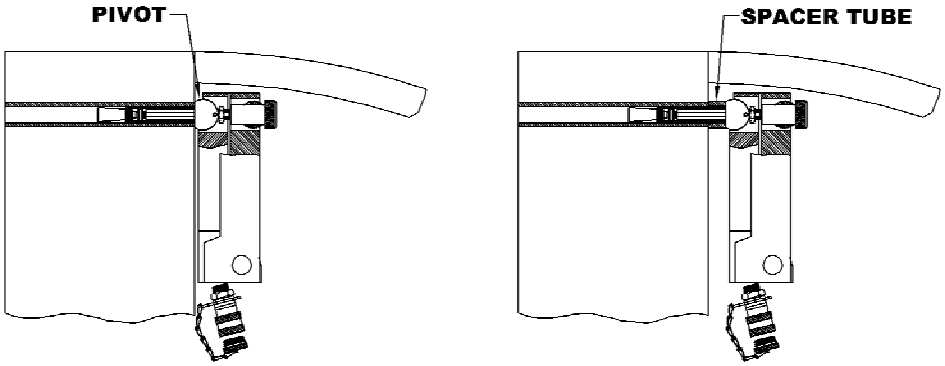


Figure C.

5. If clearance within the heat exchanger allows, mate the pull rod with ram by inserting the pull rod into the ram and hand tightening the knurled nut. Insert plug into the tube to desired depth. See Figure C.

WARNING!
THE CQ RAM MUST REST AGAINST THE TUBESHEET FACE OR THE USE OF A SPACER (NOT SUPPLIED) THAT WILL ELIMINATE ALL SPACE BETWEEN THE CQ RAM AND THE TUBESHEET FACE, DURING PLUG INSTALLATION, WILL BE REQUIRED. SEE FIGURE C. THE SPACER IS REQUIRED SO THAT DURING INSTALLATION, ANY RECOIL OF THE RAM WILL BE TRANSMITTED TO THE TUBESHEET RATHER THAN TO THE INSTALLED PLUG. PLEASE OBSERVE AND FOLLOW THE SUGGESTED INSTALLATION DEPTH GUIDELINES AND MAKE ANY SPACER WITH THE REQUIRED CPI/PERMA PLUG INSTALLATION DEPTH IN MIND. CONTACT EST SHOULD YOU HAVE ANY QUESTIONS.

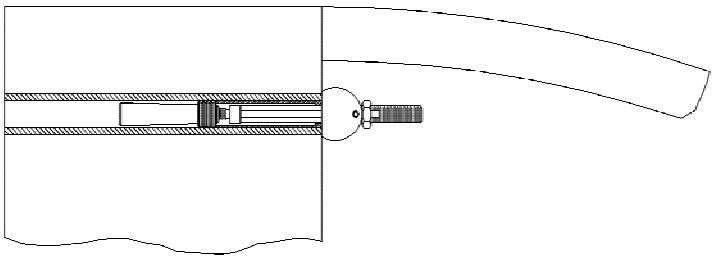


Figure D.

6. Restricted access applications: Insert the plug end of the assembly into the prepared tube, resting the flat side against the tube sheet face. See figure D. Couple the ram to the pull rod assembly, seating the pivot into the ram. Thread the knurled nut onto the pull rod removing all slack from the assembly. See Figure C.

7. Be sure air and hydraulic hoses are properly connected. Failure to correctly seal and tighten the hydraulic fittings will cause the ram to lock in open position after activation.

8. Never stand directly behind the ram. Guide ram with hands to avoid cocking the plug. Ram should be gripped at the hydraulic connection.

9. Hold the ram so the flat face of the pivot or the spacer tube (if required) rests flat against the tube sheet face. Do not cock the ram. Insure there is intimate contact between the tube sheet face and the pivot or spacer tube.

10. Depress pump pedal, and the ram will stroke. See Figure E. As ram strokes, allow the ram to pivot away from the tube sheet. If the ram is rigidly held and not allowed to pivot, the Breakaway, pull rod, or ram may malfunction resulting in an improper plug installation. When plug “pops” immediately stop hydraulic pump. If the plug does not “pop” and the ram is fully opened, the plug is not properly installed. Stop and call E.S.T or your local representative for assistance. Close Quarters Ram will recoil when plug “pops”. The recoil, in some cases, may cause the breakaway to fracture where it threads into the pull rod.

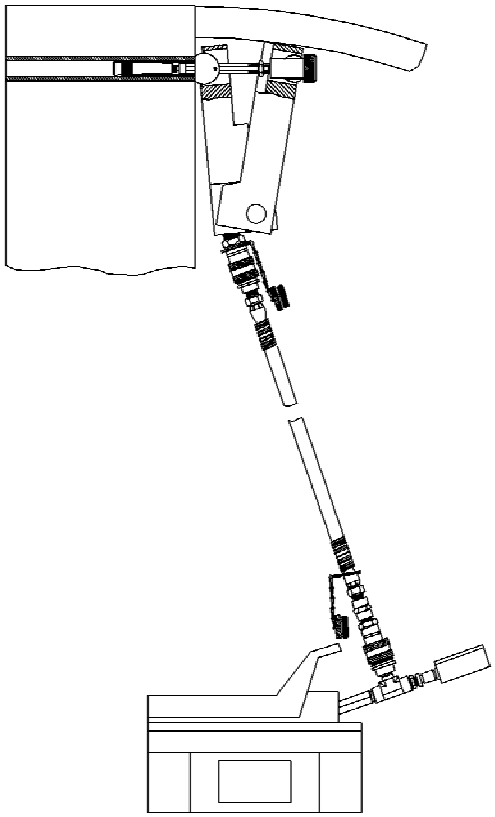
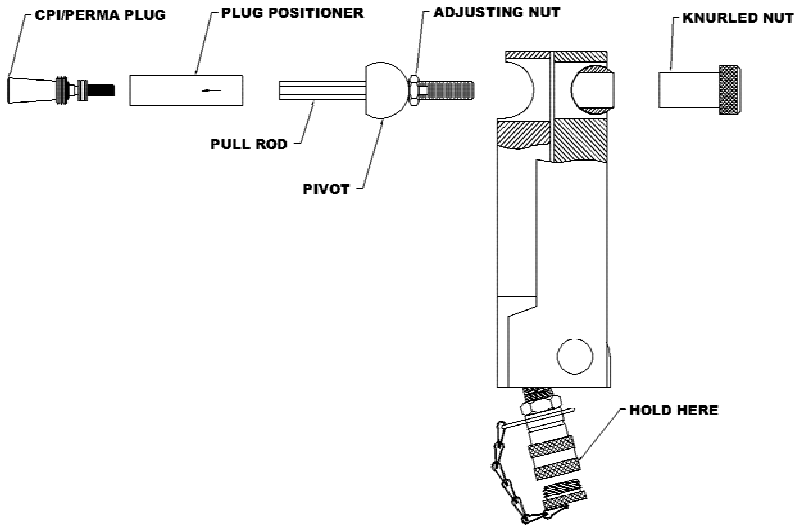


Figure E.

11. Depress front of hydraulic pump pedal, ram will retract

12. Remove knurled nut from pull rod assembly. Remove ram, remove pull rod assembly, and loosen adjusting nut. Although experience indicates that the breakaway stub will not unthread during normal heat exchanger operating conditions, the best practice is to remove the breakaway stub after plug installation. Thread next plug into pull rod assembly.



THE CLOSE QUARTERS RAM PULL ROD ASSEMBLY IS COMPRISED OF A POSITIONER, PULL ROD, PIVOT, ADJUSTING NUT, AND A KNURLED NUT.

CPI PLUGS COVERED BY PULL ROD ASSEMBLY	CLOSE QUARTER PULL ROD ASSEMBLY (1) (CQP)	CLOSE QUARTER CPI PLUG POSITIONER
V-471 (ALL MATERIALS)	*CQP-471*	*CPP-471*
V-491 (ALL MATERIALS)	*CQP-491*	*CPP-491*
V-512 (ALL MATERIALS)	*CQP-512*	*CPP-512*
V-524 (ALL MATERIALS)	*CQP-524*	*CPP-524*
V-555 (ALL MATERIALS)	*CQP-555*	*CPP-555*
V-584 (ALL MATERIALS)	*CQP-584*	*CPP-584*
V-621 (ALL MATERIALS)	*CQP-621*	*CPP-621*
V-649 (ALL MATERIALS)	*CQP-649*	*CPP-649*
V-670 (ALL MATERIALS)	*CQP-670*	*CPP-670*
V-712 (ALL MATERIALS)	*CQP-712*	*CPP-712*
V-735 (ALL MATERIALS)	*CQP-735*	*CPP-735*
V-774 (BRASS ONLY)	*CQP-774*	*P-774*
V-837 (BRASS ONLY)	*CQP-837*	*P-837*
V-899 (BRASS ONLY)	*CQP-899*	*P-899*
V-962 (BRASS ONLY)	*CQP-962*	*P-962*
V-1024 (BRASS ONLY)	*CQP-1024*	*P-1024*
V-1087 (BRASS ONLY)	*CQP-1087*	*P-1087*
V-1149 (BRASS ONLY)	*CQP-1149*	*P-1149*

NOTE: FOR 774 AND LARGER CPI / PERMA PLUG SIZES, ONLY BRASS PLUGS CAN BE INSTALLED AS THE INSTALLATION LOAD IS BEYOND THE CQ RAM'S CAPABILITIES.

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Expansion Seal Technologies is part of the EST Group of companies. **EST Group** provides a complete range of repair products, services and replacement parts covering the life cycle of tubular heat exchangers and condensers; additionally EST provides products and services to facilitate pressure testing pipe, piping systems, pressure vessels and their components. Visit EST Group on the internet at www.estgrp.com.

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