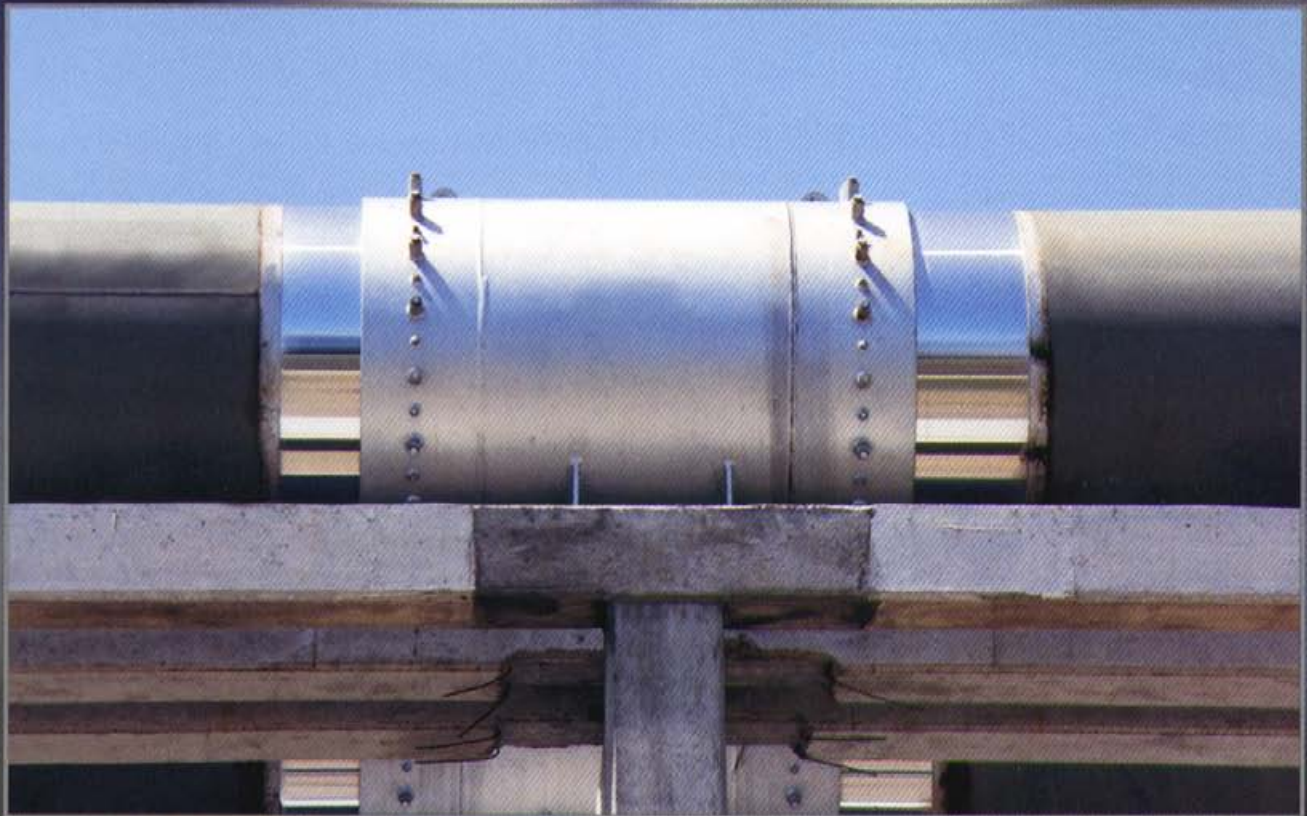


THERMAL PAK TP2 EXPANSION JOINTS

**Standard and Custom Designs for
PACKING INJECTION UNDER FULL LINE PRESSURE**

Field Proven Designs for High Pressure Cogeneration Piping Systems



Bulletin: TP-698



ADVANCED THERMAL SYSTEMS, INC.
"Products and Solutions For Pipe Movement"



ATS THERMAL PAK "TP2" EXPANSION JOINTS

STANDARD AND CUSTOM DESIGNS for use with STEAM, HOT/CHILLED WATER, OIL, GAS and Other Process Fluids

The ATS **Thermal Pak "TP2"** Slip Type Expansion Joint is the **CORRECT** Choice for accommodating the thermal changes that occur in the straight runs of a piping system. The TP2 is constructed of materials that have strength equal to or greater than the pipeline in which it is installed, therefore, there is never a concern that an unscheduled outage will occur due to the expansion joint. If a leak should occur, additional packing can be **SAFELY** added to the expansion joint through the integral packing cylinders while the system is at full operating pressure.

ATS has been the **INDUSTRY INNOVATOR** since the "TP2" was first introduced in 1968. All Technical improvements to packed slip type expansion joints since 1968 have been introduced by ATS.

Here are a few of the ATS Introduced Improvements:

- Self-Lubricated injectable packing to eliminate maintenance associated with periodic lubrication.
- Packing cylinders welded in place in lieu of threaded in place to maximize personnel safety.
- Sliding slips from heavier wall pipe to preclude slip collapse.
- **"Corro-Cote Plus"** - Dual plating system consisting of industrial hard chrome over crack free hard chrome.
- **"HPI"** - An asbestos-free self-lubricating injectable packing for use up to 1000°F. Currently the only injectable packing with a field record of reliability in installations over 600°F.
- Low Friction guide inserts at integral internal and external guide surfaces to protect sliding slip and prevent binding and/or scoring.
- Five Year Leak Free Warranty.
- Packing Cylinders with Integral Safety Valve to allow **SAFE** packing injection to 1000 psig.
- **SAF-T-PACKER** - the only safe and effective way to loosen or remove impacted injectable packing below the packing cylinder's safety valve without blow back.
- Cycle testing to verify slip movement and packing density.

950 PSIG - 760°F

ATS - The Industry Leader

Shown on the right is one of the two 14" Double TP2 Expansion Joints furnished to Minnesota Power and Light Company for use in a steam transmission line in Duluth, MN. These expansion joints were furnished with Schedule 100 Sliding Slips and Type "C" Packing Cylinders and have been in operation since 1987 conveying 950 PSIG - 760°F Steam. This installation is the highest operating pressure application for any packed expansion joint. Also installed were two (2) 8" TP2 Expansion Joints in the condensate return line constructed of all T-304 stainless steel.



THERMAL PAK TYPE "TP2" EXPANSION JOINTS

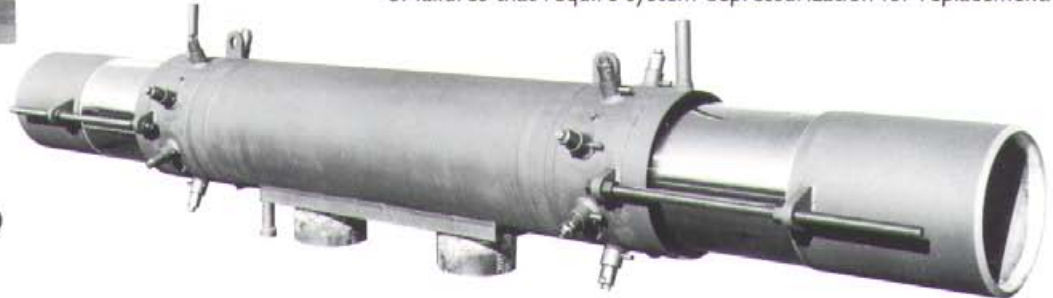


High Pressure... High Temperature... High Performance, plus Safety.

Industry requirements for today's high pressure steam transmission systems accompanied by higher temperatures have dictated a requirement for a more reliable expansion joint that is designed for safe packing injection under full line pressure and not subject to the various types of failures that require system depressurization for replacement.



Type "C" Packing
Cylinder Retainer
with Cap Plug
(For pressure to 1000 PSIG)



Shown above is one of 67 - 18" TP2 Expansion Joints furnished to Northern States Power Company (now known as NRG Energy) in 1984. The units are in a 5-1/2-mile long pipeline located in St. Paul, MN, which supplies steam to a paper mill at 875 PSIG - 800°F. These expansion joints were furnished with 32" Traverse Slips, ATS Type "C" Packing Cylinders (to allow SAFE packing injection), slip adjustment rods (see page 12) and leak detector probes.

The ATSTP2's were supplied to replace externally pressurized bellows expansion joints which were furnished with multi-ply Inconel 600 bellows (some had pure Nickel) that had failed after less than one year in service. The steam line has not had an interruption in service caused by the ATS Expansion Joints since their installation in 1984.

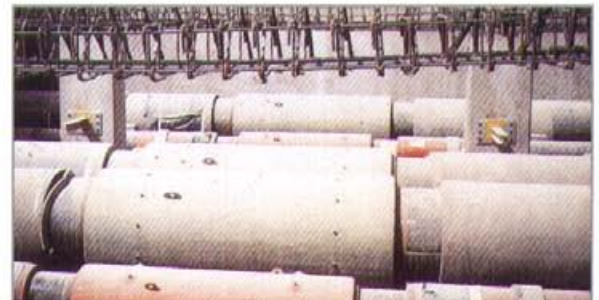
Oil Refining Industry

World's largest expansion joint designed for "Packing Injection under full pressure."

Shown are two of six - 54"-16" x 16" Traverse TP2's furnished to a midwest refinery for flare gas service. Over 33 TP2's, sizes 24" to 54" have been installed at this one refinery since 1976 for flare gas service, a testimony to ATS's quality.



Pictured Below are five of the 587 TP2 Expansion Joints up to 36" diameter installed in the MTHW & CW Piping System at the King Saud University, Riyadh, Saudi Arabia. The TP2's are pre-insulated and encapsulated with 1/4" FRP.



Typical Users of Standard and Custom Designs

ENERGY COMPANIES

Trigen Philadelphia Energy Co.
Trigen Boston Energy Co.
Con Edison Company of New York
Indianapolis Power and Light Co.
NRG Energy
Cleveland Energy Co.

INSTITUTIONS

Syracuse University
Cornell University
Indiana University
Pennsylvania State University
University of Minnesota
Univ. of Calif. at San Diego

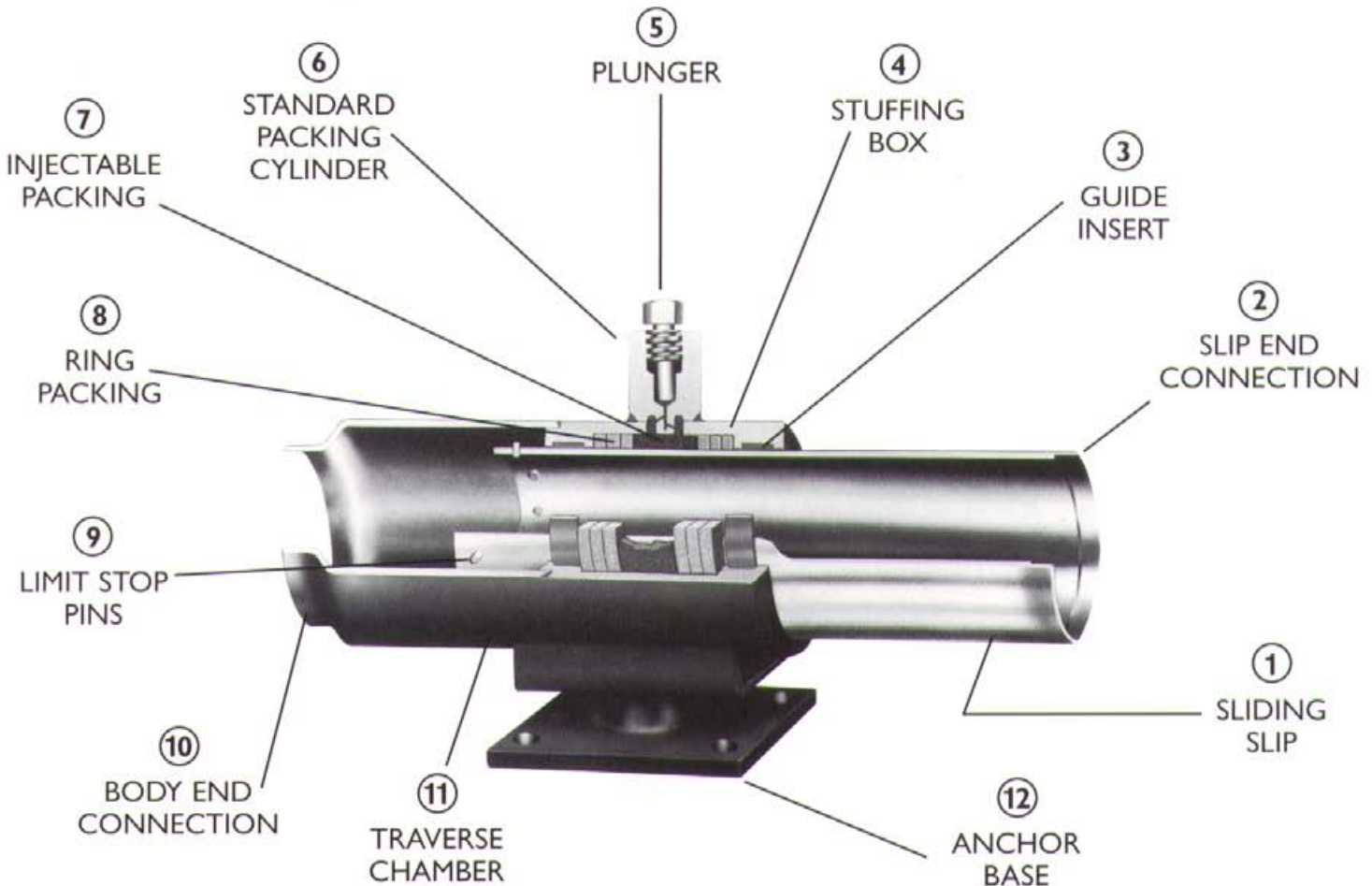
INDUSTRIAL

AK Steel
Koch Refining Co.
General Motors
Newport News Shipbuilding
Boeing Company
Washington National Airport



THE MOST RELIABLE EXPANSION JOINT AVAILABLE

Companies Whose Business is Selling Steam Depend on the TP2 to Keep Their Distribution Systems On Line



5 YEAR WARRANTY and SERVICE GUARANTEE

• WARRANTY TERMS

Advanced Thermal Systems, Inc. Packed Expansion Joints are sold subject to the mutual agreement that they are warranted by ATS to be free from defects in material and workmanship but ATS's liability and the buyer's exclusive remedy shall be limited to repair or replacement without charge, at ATS's factory, of any material defects which become apparent within five years of the date of shipment, and which shall be determined to be defective by ATS upon their return to the factory, freight prepaid, or at ATS's option to a refund of the purchase price, and that ATS shall have no liability for damages of any kind, direct or indirect, arising from an installation and/or use of any material, and by accepting the material the buyer will assume all liability for any damages, direct or consequential, which may result from its use or misuse.

• SERVICE GUARANTEE

In addition ATS guarantees the satisfactory performance of ATS Packed Expansion Joints for a period of five years from date of shipment, provided, only, that the Expansion Joints are installed, operated and serviced in accordance with ATS prescribed standards. ATS will either replace or repair, without charge, FOB ATS factory any Packed Expansion Joint which fails to give five years' service under these prescribed conditions.

5 YEAR LEAK-FREE WARRANTY FOR APPLICATIONS TO 300 PSIG - 800°F

In the event of leakage at the TP2 stuffing box, spare HPI packing plugs will be furnished at no charge for a period of 5 years from the date of shipment when the TP2 is factory packed with HPI injectable packing and equipped with BRONZALON or HC800 low friction guide inserts.

DESIGN AND MATERIAL OF CONSTRUCTION FOR PROVEN RELIABILITY



[] SLIDING SLIP - PART 1:

Machined from heavy wall ASTM A106 Gr B Seamless pipe to prevent slip collapse.

Size	Pipe Schedule
1-1/2" to 16"	Schedule 80
18" to 24"	Schedule 60

Heavier wall furnished for larger sizes and pressures above 600 psig.

The surface of each slip is machined and ground to obtain a 16 RMS finish before plating. ALL SLIPS are plated with "Coro-Cote Plus" a dual plating system consisting of 1 mil of industrial hard chrome over 1 mil of crack free hard chrome.

[] SLIP END CONNECTION - PART 2:

Weld End: Expansion joints can be furnished with ends beveled for welding to any pipe wall thickness. Unless otherwise specified, the standard weld end prep is for welding to Standard Wall Pipe.

Flanged End: A105 Forged Steel Raised Face Slip On Flanges of the specified pressure class.

[] GUIDE INSERTS - PART 3:

All ATS Expansion Joints have integral internal and external guide surfaces. "Bronzalon" a low friction non-metallic insert can be furnished for applications to 500°F. For applications above 500°F, metallic inserts of either Aluminum Bronze or Copper-Nickel can be furnished.

[] STUFFING BOX - PART 4:

Machined from heavy wall seamless mechanical tubing equivalent to ATSM A106 Gr B. Wall thickness of stuffing box is sized to ensure distortion does not occur due to the internal pressure and the hydraulic forces associated with the injectable packing.

[] PACKING CYLINDER & PLUNGER - PARTS 5 & 6:

ATS offers several packing cylinders, refer to Page 8 for a detailed description of the various types offered.

The ATS Type "A" packing cylinder is standard and is machined from 2" Diameter C 1018 carbon steel bar and has internal ACME Threads. The mating plunger, with external ACME Threads is machined from AISI C12L14 bar.

For corrosive and manhole applications, plungers machined from Aluminum Bronze, ATSM B150, are recommended.

[] INJECTABLE PACKING - PART 7:

All ATS Thermal Pak Expansion Joints are furnished with "HPI", an asbestos-free self-lubricating flake graphite injectable packing. The expansion joints are fully packed at the factory and additional packing plugs are provided for future system maintenance.

[] RING PACKING - PART 8:

Various types of ring packing are available for use with different service conditions. All types are asbestos-free. An all Graphite reinforced ring packing is used for Steam Service and all services over 300°F. A Fiberglass/Rubber combination is used for condensate and water service below 300°F.

[] LIMIT STOP PINS - PART 9:

High strength alloy limit stop pins are designed to prevent disengagement of the slip from the stuffing box in the event of an anchor failure. All stop pins are welded in place.

[] BODY END CONNECTION - PART 10:

Weld End: A standard wall concentric reducer meeting ASTM A-234, Gr WPB, or formed from A106 Gr B Standard Wall Pipe is furnished. Heavier wall reducers or eccentric reducers are available on application.

Flanged End: A modified Forged A105 Steel Flange attached to the traverse chamber via a butt weld.

[] TRAVERSE CHAMBER - PART 11:

Standard wall A106 Seamless Pipe used for standard sizes and pressure ratings. Heavier wall pipe used when required by specification or pressure rating.

[] ANCHOR BASE - PART 12:

Fabricated from A36 or equal steel plate with all bolt holes accessible from one side.

Single Slip Expansion Joint: Base is optional. Designed as MAIN ANCHOR BASE when furnished. When expansion joint is furnished with service connection, anchor base is standard.

Double Slip Expansion Joint: Base is standard, and is designed as INTERMEDIATE ANCHOR BASE. When expansion joint is furnished with service connection, anchor base is designed as main anchor.

[] AVAILABLE OPTIONS: See Pages 12 & 13

- Slip Adjustment Rods
- Insulation Blankets
- Service Connections
- Cycle and Force Testing



ATS PRODUCTS DELIVER... ...PERFORMANCE AND RELIABILITY

5-YEAR LEAK-FREE WARRANTY - Through extensive product testing, and a long-term history of successful field operation, the ATS Thermal Pak TP2 Expansion Joint has been demonstrated to be the most reliable expansion joint available. Due to this proven track record, ATS offers a 5-Year Leak-Free Warranty on all TP2 Expansion Joints furnished with **Bronzalon** guide inserts and **HPI** injectable packing (See Page 4 for warranty details).

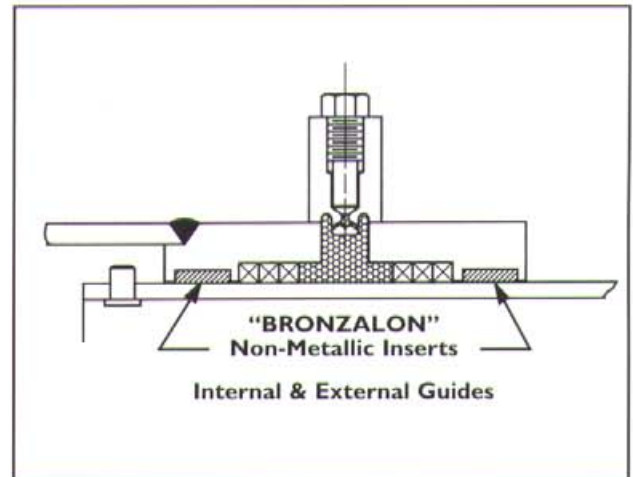
CERTIFIED LEAK FREE FOR 25,000 CYCLES: - The ATS Thermal Pak expansion joint has been certified by an independent testing laboratory to be steam leak-free for 25,000 cycles while pressurized at 400 psig saturated steam. Certifications of test results furnished on specification or request.

ATS TP2 THERMAL PAK Expansion Joints Include These ATS Innovated Features

Performance:

[] **BRONZALON-Guide Inserts:**

The most significant development in providing expansion joint reliability has been the introduction, by ATS, of **Bronzalon** as a low friction guide insert. Bronzalon is a Bronze Filled Teflon - **NON-METALLIC** - material that is inserted into both the internal and external integral guide surfaces. This material provides two prime functions; 1) It provides a low friction - non-scoring guide surface for the slip, which eliminates all metal to metal contact, and 2) It provides the expansion joint with the ability to resist binding due to small amounts of misalignment since the material will deform slightly under high loads and relieve a binding condition. These two functions **CANNOT** be accomplished by the use of a metal insert such as Brass or Bronze. **This is one of the most distinguishing features of the ATS Thermal Pak Expansion Joint.** Use of Bronzalon is limited to applications of 500°F maximum.



[] **HPI - High Performance Injectable:**

All ATS expansion joints are furnished with "HPI" Injectable Packing. **HPI is a non-asbestos - self-lubricating - semi-plastic - Flake Graphite** packing material that provides superior sealing for all types of service up to 1000°F. This packing was pioneered by ATS and is the only non-asbestos packing that has a long-term history of successful operation.

[] **CORRO-COTE PLUS - Duplex Chrome:**

Corro-Cote Plus is a duplex chrome plating system that consists of 1 mil minimum of Industrial Hard Chrome over 1 mil minimum of Crack Free Hard Chrome. **This system offers the best plating combination for achieving both a hard scratch resistant and corrosion resistant surface for the sliding portion of the slip.**

[] **PACKING SAFETY - Packing Cylinders with Integral Shut-Off Valve:**

The ATSTypes "B" and "C" Packing Cylinders offer complete operator safety during the packing operation due to the integral stainless steel shut-off valve. During packing or clean out, the operator can easily close the valve to isolate the pressurized portion of the stuffing box from the packing cylinder chamber. With this accomplished, the plunger can be removed to allow either packing to be added, or the use of the ATS SAF-T-PACKER (See Page 8 and 9).

"BRONZALON", "HPI", "CORRO-COTE PLUS", and "SAF-T-PACKER" are registered Trademarks of ATS.

Reliability:

[] Never an Unscheduled Shutdown:

The TP2 Thermal Pak Expansion Joint has two distinct advantages over other types of axial expansion devices. 1) It is constructed from materials as strong or stronger than the pipeline, so there is never the chance of a catastrophic type failure that would force an unscheduled outage or jeopardize the safety of personnel in the area, and 2) In the unlikely event that a leak should occur, additional packing can be added to the expansion joint to stop the leak while the system is at full operating pressure. These features make the TP2 the first choice of companies whose business is selling thermal energy.

[] Proven Field Record of Reliability:

ATS Products have the most extensive history of reliable service of any expansion joint. Utility and Industrial users, whose business depends on keeping their system on line, depend on ATS for both reliable products and service.

Those responsible for the selection of mechanical pipe expansion devices should insist on the manufacturer's record of installations and not rely on claims based on short-term in house testing. ATS will gladly provide a User List on request, which includes contact names and telephone numbers of responsible persons to contact. **ATS strongly encourages potential users to verify their selection with current users before purchasing expansion joints.**

Service:

[] Customer Service:

The ATS commitment is to provide engineered products and support service to their customers. It is the goal of ATS to ensure that its products are the highest quality possible, and that they are the proper product for the application. Whenever possible, ATS will review each application to ensure the installation is correct. ATS Engineers have extensive experience with piping systems and the application of expansion devices. When required, detailed computer assisted analysis is performed to determine and verify compliance of the design with the applicable code. This service is generally performed at no cost.

[] Delivery:

All facets of the manufacturing process are performed in the ATS Facility (except Chrome Plating) by ATS employees, thereby assuring complete control over the delivery and the quality of all ATS Products. ATS maintains an extensive inventory of completed components, which can be assembled into finished expansion joints with a short manufacturing cycle. Shipment of standard expansion joints up to 24" diameter can be made in 1 - 2 days on an emergency basis when required.

QUALITY CONTROL

ATS maintains a modern manufacturing facility in Lancaster, NY. All facets of the manufacturing process, including all machining, welding, and assembly, are performed in the ATS Shop, thereby assuring the highest possible quality. Some of the modern "state-of-the-art" equipment at ATS includes: three (3) CNC turning centers, a CNC Vertical Turning Lathe which can accommodate parts up to 59" in diameter, (shown right) and a cylindrical OD grinder for grinding slips up to 42" in diameter.



Expansion Joint and Thermal Pak Flexible Ball Joints are designed to meet the requirements of the ASME Boiler and Pressure Vessel Code and ANSI B31.1 and B31.3. ATS products are registered in Canada (CRN), as well as the Flexible Ball Joints being listed by UL. Complete Quality Assurance Procedures and Documentation are in place, and on specification ATS can perform nondestructive testing - 100% Radiograph of butt welds and magnetic particle inspection of fillet welds.

Modern welding equipment allows for welding by SMAW (stick), GMAW (mig), SAW (submerged arc), plus a burning table with optical tracer. All ATS weld procedures and welders have been certified to ASME Section IX. Pressure containing components for both the TP2

ATS maintains an ongoing testing program to ensure its products are the highest possible quality. Force and cycle testing of both the TP2 Expansion Joints and Flexible Ball Joints are performed at random on production units to verify packing density, friction/flex torque values, and free movement.



ATS ENGINEERED PACKING CYLINDERS -

Solution to Safe and Effective Packing Injection

ATS offers three (3) packing cylinder designs for use with the TP2 Thermal Pak Expansion Joint. Carbon Steel is the standard material of construction for both the packing cylinder and plunger for applications up to 800°F. For corrosive applications, i.e., salt water and manholes, other materials such as stainless steel packing cylinders and aluminum bronze plungers are available.

Key Safety Features of all ATS Packing Cylinders:

- Welded directly to Stuffing Box
- 2" Diameter to prevent splitting due to hydraulic pressure of packing operation.
- Heavy Duty 1" - 5 Acme Threads.
- Discharge tip incorporates "Check Valve Effect" design.

TYPE	MAXIMUM PRESSURE	APPLICABLE EJ SIZE
"A"	300 psig	1 1/2" & larger
"B"	850 psig	1 1/2" & larger
"C"	1000 psig	6" & larger

[] TYPE "A" PACKING CYLINDER:



The ATS Type "A" Packing Cylinder has for many years provided economic and safe provisions for packing injection under full line pressure. Unless otherwise specified all ATS Thermal Pak Expansion Joints for service up to 300 psig will be furnished with the ATS Type "A" Packing Cylinder. The design of the discharge tip of the Type "A", and all other Types, is such that a "check valve effect" is created to resist blow back of the packing during the injection process. All ATS Packing Cylinders are machined from C1018 carbon steel and have heavy duty internal Acme Threads. The mating plunger has matching Acme Threads, and is machined from C12L14, a slightly softer material that prevents damage to the internal threads of the packing cylinder.

[] TYPE "B" PACKING CYLINDER:



The ATS Type "B" Packing Cylinder has an integral Stainless Steel Safety Valve which provides for positive shut off during the packing injection process. It also contains the same discharge tip design, internal Acme Threads, and is machined from the same materials as the Type "A" Packing Cylinder. The Type "B" Packing Cylinder is provided on all TP2 Thermal Pak Expansion Joints designed for service over 300 psig. When using the Type "B" Packing Cylinder, the valve is rotated to the closed position, as indicated by the indicator pin, which then provides a positive shut off from the flowing media. The packing plunger can then be removed to allow a packing plug to be inserted into the packing cylinder without operator concern over possible blow back. **While this type packing cylinder is required for operating pressures over 300 psig, it will provide the maintenance personnel with a feeling of safety at all service conditions.**

[] TYPE "C" PACKING CYLINDER:



The ATS Type "C" Packing Cylinder is a heavy duty packing cylinder, designed for use in high pressure/temperature applications which require maximum reliability. This design is furnished for all applications over 850 psig, and for other applications on specification. The Type "C" Packing Cylinder consists of a **retainer** welded to the expansion joint which contains the integral **stainless steel safety valve**. During normal operation, a **cap plug** is threaded into the retainer. When packing is to be injected, the cap plug is removed and a **packing injector** is threaded into the retainer. Packing is accomplished using the same procedure outlined above. Upon completion of the packing operation, the packing injector should be removed and the cap plug installed.

HIGH PRESSURE + HIGH TEMPERATURE + TP2 + SAF-T-PACKER = *Safe and Effective Packing*



TYPE "GB" SAF-T-PACKER

Patent Number:
4,711,013



TYPE "GC" SAF-T-PACKER

SAF-T-PACKERS are shown fully engaged with the Type "B" and Type "C" Packing Cylinders

The Only Safe and Effective Method - to clean out the packing cylinder:

Due to the integral safety valve of the ATS Types "B" and "C" Packing Cylinders, a long column of impacted packing remains in the packing cylinder above the discharge tip. This column of packing adds to the effectiveness of the discharge tip, however, it also increases the amount of torque required to inject packing, especially the first plug.

To reduce the effort required to inject packing, this column of packing should be loosened and cleaned out. The only **safe and effective** method to accomplish this is with the use of an **ATS SAF-T-PACKER**. Use of the **SAF-T-PACKER** greatly reduces the time and effort required to inject packing into the ATS Types "B" and "C" Packing Cylinders, while providing complete operator safety.

Use of the SAF-T-PACKER - both Safe and Simple

The SAF-T-PACKER is normally used when injecting the first plug of packing into either a Type "B" or Type "C" Packing Cylinder. With the safety valve on the packing cylinder in the closed position, the packing plunger is disengaged from the packing cylinder. The SAF-T-PACKER is then threaded into the packing cylinder. Note: The drill bit on the SAF-T-PACKER must be fully retracted into the housing. The safety valve on the packing cylinder is then opened, and the handle on the SAF-T-PACKER rotated clockwise until the bit is fully engaged. The handle is then rotated counterclockwise to completely disengage the bit. Before the SAF-T-PACKER is removed from the packing cylinder, the safety valve must be closed. Complete instructions for use of all styles of ATS SAF-T-PACKER's are furnished with each SAF-T-PACKER shipped.

The ATS Type "A" Packing Cylinders do not have the integral safety valve and ATS therefore does not recommend the use of a SAF-T-PACKER with a Type "A" Packing Cylinder when the system is pressurized.

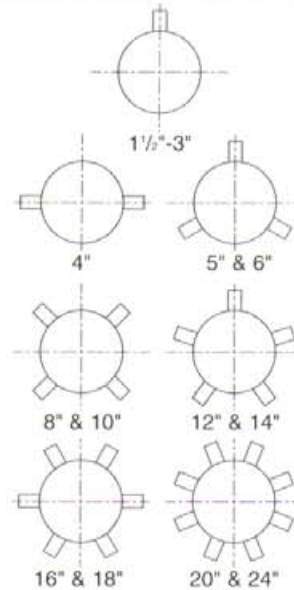
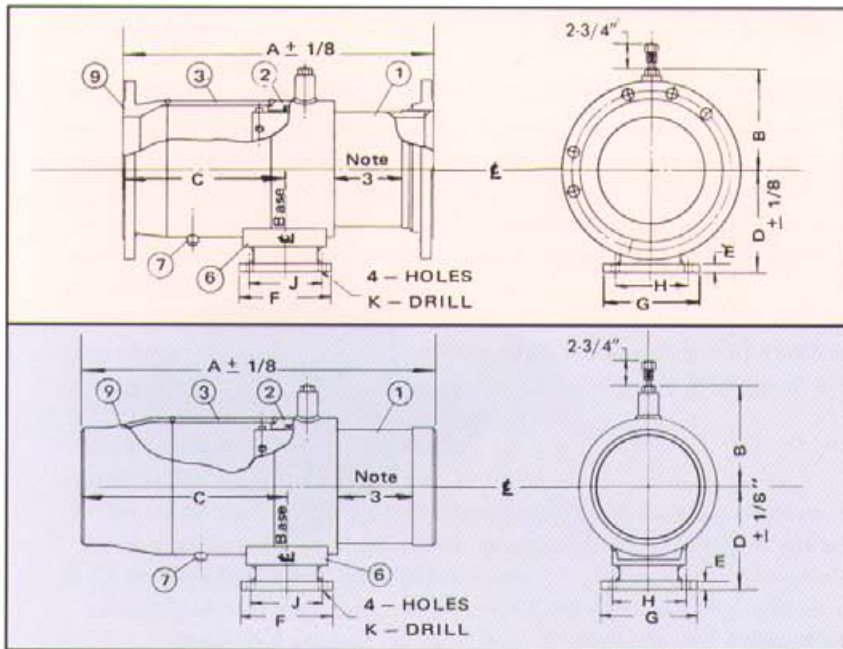
SAFETY PRECAUTION: The injection of packing into a fully pressurized expansion joint is a safe operation when it is accomplished using the procedures and instructions furnished with the expansion joint. Personnel doing the packing injection should read and understand the instructions before starting packing injection. ATS offers training seminars for maintenance personnel when requested.



THERMAL PAK TYPE "TP2" SINGLE EXPANSION JOINTS

MEETS ASTM F1007

Packing Cylinder Orientation



DIMENSIONS - INCHES

EXP. JOINT SIZE	A (NOTE 3) NOMINAL TRAVERSE										C						EXP. JOINT SIZE			
	150 LB. FLG.			300 LB. FLG.			150 & 300 LB. WELD			B	150 LB. FLANGED			300 LB. FLANGED				150 & 300 LB. WELD		
	4"	8"	12"	4"	8"	12"	4"	8"	12"		4"	8"	12"	4"	8"	12"		4"	8"	12"
1 1/2	23 1/4	31 1/4	39 1/4	23 3/8	31 3/8	39 3/8	22 3/8	30 3/8	38 3/8	5 1/4	12 1/4	16 1/4	20 1/4	12 3/8	16 3/8	20 3/8	12 3/8	16 3/8	20 3/8	1 1/2
2	23 3/4	31 3/4	39 3/4	23 7/8	31 7/8	39 7/8	22 7/8	30 7/8	38 7/8	5 3/8	12 3/4	16 3/4	20 3/4	12 7/8	16 7/8	20 7/8	12 7/8	16 7/8	20 7/8	2
2 1/2	20 3/8	28 3/8	36 3/8	21 1/8	29 1/8	37 1/8	23 1/8	31 1/8	39 1/8	5 5/8	10 3/8	14 3/8	18 3/8	10 7/8	14 7/8	18 7/8	13 1/8	17 1/8	21 1/8	2 1/2
3	21 1/4	29 1/4	37 1/4	22	30	38	23 3/4	31 3/4	39 3/4	6 1/8	10 1/4	14 1/4	18 1/4	11	15	19	13 3/4	17 3/4	21 3/4	3
4	21 1/2	29 1/2	37 1/2	22 1/2	30 1/2	38 1/2	25	33	41	6 3/8	10 1/2	14 1/2	18 1/2	11 1/8	15 1/8	19 1/8	14 1/2	18 1/2	22 1/2	4
5	22 1/4	30 1/4	38 1/4	23 1/4	31 1/4	39 1/4	26	34	42	7 1/8	11 1/8	15 1/8	19 1/8	12	16	20	15 1/2	19 1/2	23 1/2	5
6	27 1/2	35 1/2	43 1/2	22 3/4	30 3/4	38 3/4	26 1/2	34 1/2	42 1/2	8 1/8	16 1/8	20 1/8	24 1/8	11 1/4	15 1/4	19 1/4	16	20	24	6
8	28 3/4	36 3/4	44 3/4	23	31	39	27 1/2	35 1/2	43 1/2	9 1/8	16 3/4	20 3/4	24 3/4	11	15	19	16 1/4	20 1/4	24 1/4	8
10	31 3/8	39 3/8	47 3/8	25 1/4	33 1/4	41 1/4	30 3/8	38 3/8	46 3/8	10 1/8	18 3/8	22 3/8	26 3/8	12 1/4	16 1/4	20 1/4	18 3/8	22 3/8	26 3/8	10
12	25 1/2	33 1/2	41 1/2	26 1/4	34 1/4	42 1/4	30 3/8	38 3/8	46 3/8	11	11 1/4	15 1/4	19 1/4	12 3/4	16 3/4	20 3/4	17 3/8	21 3/8	25 3/8	12
14	25 3/8	33 3/8	41 3/8	27 1/8	35 1/8	43 1/8	31 3/8	39 3/8	47 3/8	11 1/4	12 3/8	16 3/8	20 3/8	13 3/8	17 3/8	21 3/8	18 3/8	22 3/8	26 3/8	14
16	26 1/4	34 1/4	42 1/4	27 1/4	35 1/4	43 1/4	31 3/8	39 3/8	47 3/8	12 1/4	12 3/4	16 3/4	20 3/4	13 3/4	17 3/4	21 3/4	18 3/4	22 3/4	26 3/4	16
18	28 1/2	36 1/2	44 1/2	29 1/4	37 1/4	45 1/4	33 3/8	41 3/8	49 3/8	13 1/4	13 3/8	17 3/8	21 3/8	14 3/8	18 3/8	22 3/8	19 3/8	23 3/8	27 3/8	18
20	30 3/8	36 3/8	44 3/8	31	37 1/4	45 1/4	34 3/8	40 3/8	48 3/8	14 1/4	15	17 1/4	21 1/4	15 3/8	18 3/8	22 3/8	20 3/8	22 3/8	26 3/8	20
24	32	37 1/2	45 1/2	33	38 3/4	46 1/2	35 3/4	41 3/4	49 3/4	16 1/4	15 1/2	16 1/2	20 1/2	16 3/4	17 3/4	21 3/4	20	21 1/2	25 1/2	24

EXP. JOINT SIZE	ANCHOR BASE DIMENSIONS (*):												EXP. JOINT SIZE	
	FLANGED AND WELD ENDS													
	150 LB. MWP						300 LB. MWP							
D	E	F	G	H	J	K	E	F	G	H	J	K		
1 1/2	4	1/2	5 1/2	5 1/2	4	4	3/8	1/2	5 1/2	5 1/2	4	4	3/8	1 1/2
2	4 1/4	1/2	5 1/2	5 1/2	4	4	3/8	1/2	5 1/2	5 1/2	4	4	3/8	2
2 1/2	4 3/8	1/2	5 1/2	5 1/2	4	4	3/8	1/2	5 1/2	5 1/2	4	4	3/8	2 1/2
3	5	1/2	6	6	4 1/2	4 1/2	3/8	1/2	6	6	4 1/2	4 1/2	3/8	3
4	5 1/4	1/2	7	7	4 3/4	4 3/4	3/4	1/2	7	7	4 3/4	4 3/4	3/4	4
5	6 1/2	3/8	8	8	5 1/4	5 1/4	1/2	3/8	8	8	5 1/4	5 1/4	1/2	5
6	7 1/4	3/8	8	8	5 1/4	5 1/4	1/2	3/8	8	8	5 1/4	5 1/4	1/2	6
8	8 3/4	3/4	10	10	7 1/2	7 1/2	1	3/4	10	10	7 1/2	7 1/2	1	8
10	10 1/2	1	10 1/2	12	9 1/2	8	1 1/8	1	10 1/2	12	9 1/2	8	1 1/8	10
12	11 1/4	1	12	14 1/2	11 1/2	8 1/2	1 1/8	1	12	14 1/2	11 1/2	8 1/2	1 1/8	12
14	12 1/4	1/8	12	15	12	9	1 1/4	1	14	16	12	10 1/2	1 1/8	14
16	13 1/2	1/8	12 1/2	15 1/2	12 1/2	9	1 1/4	1 1/4	14	16	12 1/2	10 1/2	1 1/4	16
18	15	1	14	16	12 1/2	10 1/2	1 1/2	1 1/4	15	17	13	11	1 1/4	18
20	16 1/4	1	15	17	13	10 1/2	1 1/2	1 1/4	18	18	13 1/2	13 1/2	1 1/8	20
24	18 1/4	1 1/4	18 1/2	18 1/2	14	14	1 1/8	1 1/2	19	19	14	14	2 1/8	24

MODEL NUMBERS			
PRESSURE	ENDS	BASE	MODEL NUMBER
150 LB.	FLG'D	NO	TP2F-121
		YES	TP2F-122
300 LB.	FLG'D	NO	TP2F-131
		YES	TP2F-132
150 LB.	WELD	NO	TP2W-121
		YES	TP2W-122
300 LB.	WELD	NO	TP2W-131
		YES	TP2W-132

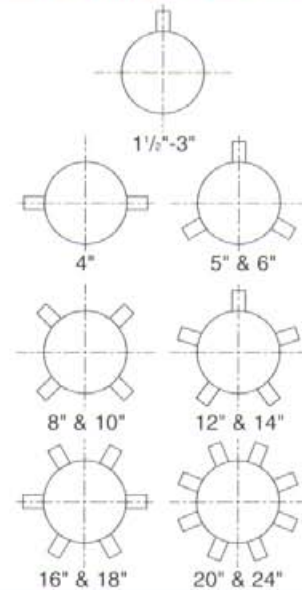
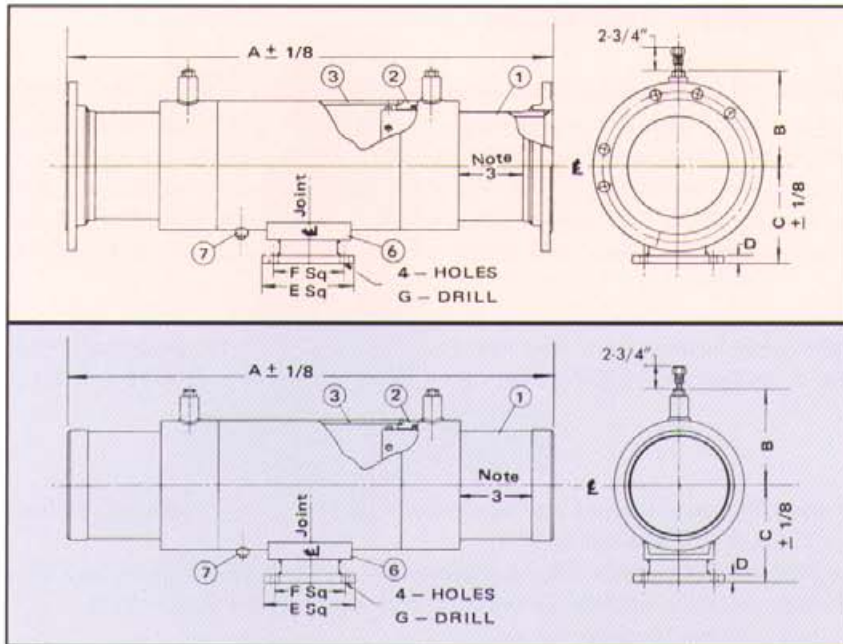
(*): Single Slip Expansion Joints furnished with anchor base only if specified.

THERMAL PAK TYPE "TP2" DOUBLE EXPANSION JOINTS



MEETS ASTM F1007

Packing Cylinder Orientation



EXP. JOINT SIZE	DIMENSIONS - INCHES												EXP. JOINT SIZE						
	A (NOTE 3)																		
	NOMINAL TRAVERSE EACH SLIP																		
	150 LB. FLG.			300 LB. FLG.			150 LB. WELD			300 LB. WELD				B	BASE DIMENSIONS ALL PRESSURES				
4"	8"	12"	4"	8"	12"	4"	8"	12"	4"	8"	12"	C	D		E	F	G		
1 1/2	38 3/4	54 3/4	70 3/4	38 3/4	54 3/4	70 3/4	37 3/4	53 3/4	69 3/4	37 3/4	53 3/4	69 3/4	5 1/4	4	1/2	5 1/2	4	3/8	1 1/2
2	38 3/4	54 3/4	70 3/4	38 3/4	54 3/4	70 3/4	37 3/4	53 3/4	69 3/4	37 3/4	53 3/4	69 3/4	5 3/8	4 1/4	1/2	5 1/2	4	3/8	2
2 1/2	39 1/4	55 1/4	71 1/4	39 1/4	55 1/4	71 1/4	38 1/4	54 1/4	70 1/4	38 1/4	54 1/4	70 1/4	5 7/8	4 3/8	1/2	5 1/2	4	3/8	2 1/2
3	40 1/2	56 1/2	72 1/2	40 1/2	56 1/2	72 1/2	39 1/2	55 1/2	71 1/2	39 1/2	55 1/2	71 1/2	6 1/8	5	1/2	6	4 1/2	3/8	3
4	41	57	73	41	57	73	40	56	72	40	56	72	6 3/8	5 1/4	1/2	7	4 3/4	3/4	4
5	46 1/4	58 1/4	74 1/4	46 1/4	58 1/4	74 1/4	45	57	73	45	57	73	7 1/4	6 1/2	3/8	8	5 3/4	7/8	5
6	46 1/4	58 1/4	74 1/4	46 1/4	58 1/4	74 1/4	45	57	73	45	57	73	8 1/8	7 1/4	3/8	8	5 3/4	7/8	6
8	46 1/2	58 1/2	74 1/2	46 1/2	58 1/2	74 1/2	45	57	73	45	57	73	9 1/8	8 3/4	3/4	10	7 1/2	1	8
10	49 3/4	61 3/4	77 3/4	49 3/4	61 3/4	77 3/4	48 1/4	60 1/4	76 1/4	48 1/4	60 1/4	76 1/4	10 1/8	10 1/2	3/4	10	7 1/2	1 1/8	10
12	50 3/4	62 3/4	78 3/4	50 3/4	62 3/4	78 3/4	49 1/4	61 1/4	77 1/4	49 1/4	61 1/4	77 1/4	11	11 1/4	7/8	12	9	1 1/4	12
14	52 1/4	64 1/4	80 1/4	52 1/4	64 1/4	80 1/4	50 3/4	62 3/4	78 3/4	50 3/4	62 3/4	78 3/4	11 3/4	12 1/4	7/8	12	9	1 1/4	14
16	52 3/4	64 3/4	80 3/4	52 3/4	64 3/4	80 3/4	51 1/4	63 1/4	79 1/4	51 1/4	63 1/4	79 1/4	12 3/4	13 1/2	7/8	14	10 1/2	1 3/8	16
18	54 1/2	66 1/2	82 1/2	54 1/2	66 1/2	82 1/2	52 3/4	64 3/4	80 3/4	52 3/4	64 3/4	80 3/4	13 3/4	15	7/8	14	10 1/2	1 3/8	18
20	60 1/2	68 1/2	84 1/2	60 1/2	68 1/2	84 1/2	58 3/4	66 3/4	82 3/4	58 3/4	66 3/4	82 3/4	14 3/4	16 1/4	1	16	12 1/2	1 1/2	20
24	61 3/4	69 3/4	85 3/4	61 3/4	69 3/4	85 3/4	59 1/2	67 1/2	83 1/2	59 1/2	67 1/2	83 1/2	16 3/4	18 3/4	1	18	13 1/2	1 7/8	24

GENERAL NOTES:

1. **Protection:** One shop coat of Red Oxide Primer paint is applied to all unfinished exterior surfaces.
2. **Sliding surface of Slip** is a "Dual" Hard Chrome plate - minimum 2 mil thick.
3. The overall dimension "A" is the shipped length of the Expansion Joint for hot service which includes a 1" factory precompression of the slip. Allowable movement of each slip is 1" in extension and compression equal to the nominal traverse. Exposed chrome length is equal to the nominal traverse. For cold service additional precompression is required.
4. **Weld Ends machined and beveled to match Std. wall pipe unless otherwise specified.**
5. Drain connection (3000# THD'D. Cplg.) furnished only if specified.

MODEL NUMBERS		
PRESSURE	ENDS	MODEL NUMBER
150 LB.	FLG'D	TP2F-222
300 LB.	FLG'D	TP2F-232
150 LB.	WELD	TP2W-222
300 LB.	WELD	TP2W-232

SERVICE CONNECTION:

Single and Double Expansion Joints with Anchor base are available with a service (branch) connection. Where a service connection is required, the last digit of the Model No. becomes a 4.

Dimension "A" of the Single and Double expansion joints is increased to allow full flow area at service connection when slip is in fully closed position.

CONSULT FACTORY FOR DIMENSIONAL DATA.



[] Slip Adjustment Rods: Used in Replacement Applications

When installing an expansion joint in a line that will not be at ambient temperature during the installation, it may be necessary to pre-compress the slip an additional amount over the standard factory pre-compression to ensure there is sufficient slip extension when the pipeline is allowed to reach ambient conditions at some later date. During the installation process, the slip may have to be moved in the field to accommodate the opening in the pipeline. Due to the large force required to move the slip, it is often difficult to field improvise a method to efficiently move the slip. ATS can provide the expansion joint with lugs welded to both the expansion joint body and slip (refer to photo on Page 3). Use of the lugs in conjunction with the threaded rods provided will allow the slip to be conveniently moved in the field.

This option is normally only provided for expansion joints furnished with ends beveled for welding. When the expansion joint is furnished with flanged ends, the slip can be moved in the field by use of threaded rods and nuts placed through the bolt holes in the flanges on both ends of the expansion joint.

CAUTION:

1. The use of two adjustment rods located 180° apart is always required, and adjustment must be made simultaneously to both rods to prevent the slip from becoming cocked in the stuffing box and binding.
2. Once the installation of the expansion joint has been completed, **the rods must be removed.** If insulation blankets have been provided, or field insulation is to be applied, the lugs should be carefully burned off at both the body and slip locations.

[] Insulation Blankets: Cost-Effective Energy Savings

ATS Removable - Reusable Insulation Blankets provide a cost-effective method for insulating the expansion joint. Designs are available for various service conditions:

LT450 SS	450°F, for non-corrosive environment, suitable for outdoor use.
MT550 NN	550°F, best for damp installations with salt exposure, i.e., manholes, not suitable for exposure to UV Rays.
MT800 SGM	800°F, for non-corrosive environment, suitable for outdoor use.



ATS supplied insulation blankets can be furnished in various configurations dependent upon the users requirements. Typical configurations include:

- Two Piece: One piece covers the body and a separate blanket(s) is furnished for the slip(s).
- Slip Only: Body covered with same insulation as mating pipeline, blanket(s) furnished for slip(s) only.

All blankets are weather resistant and have a protective cloth cover on both the inner and outer surface. In addition, the inner surface has an Inconel wire mesh screen to further protect the blanket surface. All blankets are custom made to fit the ATS Expansion Joint and have access to the packing cylinders to allow packing injection to be accomplished without requiring the body blanket to be removed. Having the insulation blanket furnished by the expansion joint manufacturer ensures a proper fit.

[] Service Connections:

ATS expansion joints can be supplied with service connections up to the full line size. Whenever a service connection is provided, the expansion joint will always be supplied with an anchor base designed as a main anchor to take the loads and moments associated with the service connection. The service connection is incorporated onto the body by use of a Forged Steel Weld-O-Let. The service connection can be furnished with ends machined and beveled to any Pipe Schedule, or with a Forged Steel Flange. Note: The overall length of expansion joints furnished with service connections will be greater than that listed as Dimension "A" on Pages 10 and 11.

Performance of the ATS Thermal Pak TP2 Expansion Joint

[] Aluminum Bronze Plungers:

In applications where the expansion joints will be in a wet, damp, or corrosive environment, consideration should be given to the use of Aluminum Bronze Plungers in lieu of the standard carbon steel plungers.

[] Cycle and Force Test:

The cycle and force test is a quality enhancement test that can be performed to verify both the free movement of the slip and the force required to move the slip. **When proper techniques are employed for factory injection of the packing, the force required to move the slip of a packed slip joint can be used to correlate the density of the packing.** Through experience and testing, ATS has been able to establish the minimum packing density required to seal expansion joints at various service conditions.

The cycle and force test performed by ATS requires that the slip be cycled through its full rated traverse three (3) times, and that the force required to move the slip be measured and recorded. This test virtually eliminates leakage of the expansion joint at startup.

[] Dirt Leg:

ATS can supply TP2 Expansion Joints with dirt legs in sizes up to full line size. A standard dirt leg consists of a heavy wall pipe section, heavy wall end cap, two (2) side mounted and one (1) bottom mounted threaded connections. The dirt leg is attached to the expansion joint body using a Forged Steel Weld-O-Let. When dirt legs are required in the system, it is normally cost-effective to have ATS include a dirt leg on the expansion joint body.

[] NPT Threaded Ends:

ATS can supply the TP2 Expansion Joint with NPT Threaded Ends in Sizes 1 1/2" to 3". When threaded ends are specified, the overall length of the expansion joint will be longer than the dimensions shown for a weld end expansion joint.

[] Drain Connections:

ATS does not furnish drain connections as standard with the TP2 Expansion Joint. Drains will be furnished when specified. There is no additional charge for furnishing a drain connection.





SPECIFICATION FOR HIGH PERFORMANCE EXPANSION JOINTS

The following specification should be used as a model to ensure an expansion joint that will provide years of reliable service is specified. The user should verify the proven performance, quality and reliability of their selection, as well as the service provided by the manufacturer, prior to making a selection. ATS maintains a current users list, and encourages potential users of the TP2 to contact the individuals on the list.

NOTE: Optional requirements are shown in red. Items which appear in *highlighted italics* are to be included as appropriate for the intended service. This specification should be used for expansion joints rated at 300 psig - 500°F or below. Consult ATS when writing a specification for higher pressure/temperature applications. Contact ATS to obtain a copy of this specification on computer disk.

1. GENERAL:

The expansion joint shall be the packed slip tube type which allows for additional packing to be injected while the expansion joint is under full line pressure. The design is based on the ADVANCED THERMAL SYSTEMS, INC. "TP2 THERMAL PAK EXPANSION JOINT."

2. DESIGN:

- 2.1 The expansion joint shall be designed for *(150/300)* psig - 500°F *(steam/condensate/other)* service.
- 2.2 Expansion joint shall be *(single/double)* slip design, and furnished *(with/without)* an anchor base. The ends of the slip and body shall be *(machined for welding to {standard wall/extra heavy wall} pipe/furnished with {150 lb./300 lb.} raised face forged steel flanges).*
- 2.3 The stuffing box shall have integral internal and external guide surfaces. **The guide surfaces shall have low friction, non-metallic inserts.**
- 2.4 The expansion joint shall have 2" minimum diameter packing cylinders welded in place to allow packing to be injected under full line pressure. The packing cylinder tip shall incorporate a "check valve effect" tip design to prevent the blow back of packing while adding packing to the expansion joint at full line pressure. **The packing cylinders shall be furnished with an integral stainless steel shut-off valve. A tool designed to allow safe removal of the impacted packing shall be furnished whenever packing cylinders with integral shut-off valves are furnished.**
- 2.5 The packing friction force of the expansion joint shall not exceed 1,000 lbs. per inch of expansion joint nominal diameter (i.e., 6,000 lbs. for a 6" size). **The packing friction force is to be verified by performing a cycle test consisting of moving the slip through its full rated traverse three (3) times. The force shall be measured and recorded.**
- 2.6 All circumferential body welds shall be of the butt weld type.

3. MATERIALS:

- 3.1 The stuffing box and body shall be machined from A106 or equivalent heavy wall mechanical tubing, or seamless pipe.
- 3.2 The slip shall be machined from A106 seamless pipe, Schedule 80 for sizes 1 1/2" to 16", Schedule 60 for sizes 18" to 24". All slips are to be machined and ground to achieve a 16 RMS finish before plating. Plating shall consist of 1 mil minimum of industrial hard chrome over 1 mil minimum of crack free hard chrome.
- 3.3 Expansion joint shall be factory packed for the intended service with Flake Graphite Injectable Packing. The stuffing box packing area in contact with the slip shall be at least 15 times the nominal diameter of the expansion joint. Spare packing plugs are to be furnished with each expansion joint order.

4. GUIDING:

- 4.1 Factory produced primary and intermediate guides shall be the *(split housing spider/low friction graphite)* type.
- 4.2 Primary and intermediate guide spacing shall be in accordance with the expansion joint manufacturer's recommendations.

5. INSULATION BLANKETS:

- 5.1 A two (2) piece removable reusable insulation blanket is to be provided with the expansion joint to cover the expansion joint body and slip, and is to incorporate access to the packing cylinders without removal of the body portion of the blanket.
- 5.2 The insulation blanket is to be *(xx)* inches thick, and designed to mate with *(xx)* inches thick insulation on the adjacent pipe.
- 5.3 The inner and outer covers are to be made from Silicone Impregnated Nomex Cloth. An Inconel wire mesh liner is to be attached to the inner cover.

The bitterness of poor quality lingers long after the sweetness of a cheap price is forgotten.

HOW TO ORDER THERMAL PAK "TP2" EXPANSION JOINTS



To insure correct and efficient production of Expansion Joint Orders, use full catalog number designation as described in example below



FIELD No.

1. Pipe size.
2. Expansion Joint Design:
TP2 = Thermal Pak.
3. W= Weld Ends.
F = Flanged Ends.
S = Screwed Ends (3" maximum size).
Single Joints only
F x W = Flange at body end, weld at slip end.
W x F = Weld at body end, flange at slip end.
4. 1 = Single slip Expansion Joint.
2 = Double slip Expansion Joint.
5. 2 = 150 lb. pressure class. 6 = 600 lb. pressure class.
3 = 300 lb. pressure class. 8 = 800 lb. pressure class.
4 = 400 lb. pressure class. 9 = 900 lb. pressure class.
6. 1 = Without anchor base.
2 = With anchor base (double joints are furnished with an intermediate anchor base).
4 = With service connection. Size and type (weld, flanged, threaded) of service connection and its location must be specified. If service connection is at side of Single Expansion Joint, specify which side when facing the slip. Anchor base required for all Expansion Joints with service connections.
5 = With Drip/Dirt leg. Specify size and max. length.
6 = With service connection and Drip/Dirt leg.

7. Nominal traverse per slip. Traverse furnished in 4" increments, i.e., 4", 8", 12", 16". Consult Factory where traverse exceeds 16".

8. Packing Designation:

- *200H
 - *300H
 - *350H
 - 400H
- *Std. unless specified otherwise
- Refer to Table 1

TABLE I
PACKING CODE - Field 8

PACKING CODE (Field 8)	BRAIDED RING PACKING	INJECTABLE PACKING	SERVICE	MAX. TEMP. °F	ASBESTOS FREE
200H	Fiberglass/Rubber/Graphite	"HPI" Flake GRAPHITE	Cond.	300	YES
300H	Fiberglass/Rubber		CW/Air	300	
350H	Reinforced Graphite		Steam	600	
400H	Reinforced Graphite		Steam	800	

HPI® is a registered trademark of Advanced Thermal Systems

9. Optional low friction inserts for internal and external guides. Specify **Bronzal** for temperature to 500°F or **HC800** for higher temperatures to 800°F. Omit if not required.
10. Type of Packing Cylinder as shown below:

TYPES OF PACKING CYLINDERS

TYPE	MAXIMUM PRESSURE	AVAILABLE FOR E.J. SIZES
A	300 PSIG	1 1/2" & larger
B	850 PSIG	1 1/2" & larger
C	1000 PSIG	6" & larger

OTHER DATA

1. If ends are to be beveled for welding to other than standard wall pipe, specify wall thickness or pipe schedule of weld ends.
2. Always advise design service conditions, i.e., fluid, pressure and temperature, for nameplate data.
3. If other than standard 1" factory slip pre-compression is required, specify requirements.
4. All Expansion Joints are normally furnished without a drain connection unless otherwise specified. Specify DRAIN if required.
5. Bases for single joints are designed as an axial load main anchor base unless otherwise specified and are drilled accordingly. If

base is to be used as a sliding support base, so state so base plate will not be drilled to avoid field error of anchoring the base.

6. Specify any unusual conditions or length requirements to fit existing conditions, etc.
7. Aluminum Bronze Plungers (ASTM B150), where required, must be specified separately.
8. Slip adjustment rods, where required, must be specified separately. Recommended for weld end joints only.
9. Insulation blankets, where required, must be specified separately. Specify thickness of insulation on mating pipe and maximum operating temperature.



ENGINEERING INFORMATION

ATS Engineers are available to help provide a solution to your piping problem. Mail or FAX your piping configuration for a computer generated flexibility analysis, recommendations and a proposal.

[] THERMALLY INDUCED CHANGES OF PIPELINES:

Pipelines will always change in length as the temperature of the pipeline changes. This change must be accommodated by some method, either by natural flexibility of the pipeline or by use of an expansion device. The TP2 Expansion Joint is the ideal selection when long straight runs of pipe are involved.

Table 2 is used to determine the total change in length of the pipe run based upon the maximum and minimum temperatures of the system. The net change in length of the pipe run per 100 ft. of piping is the algebraic difference between the expansion constant at the highest temperature and the expansion constant at the lowest temperature. This difference is then multiplied by the total length of the pipe run divided by 100. NOTE: the minimum temperature may not be the installation temperature.

EXAMPLE: Determine the total change in length of a 250-ft. long pipe run that is designed for 250 psig saturated steam (406°F) and is being installed outside where the ambient temperature may reach -20°F.

$$3.29 - (-0.15) \times \frac{250}{100} = 8.6 \text{ in}$$

[] TRAVERSE SELECTION AND PRE-COMPRESSION:

Traverse is normally supplied in 4" increments, with 4", 8" and 12" nominal traverse considered standard. Once the total growth of the pipe run is determined, a safety factor of 10% should be added (See Table 2 footnotes), and a standard expansion joint traverse larger than the total growth should be selected. Assuming a single slip expansion joint is to be used for the example above, a 12" traverse expansion joint should be selected.

All ATS expansion joints for hot service are shipped with the slips pre-compressed 1", and are capable of moving the nominal traverse in compression and 1" in extension. For cold service, the slips are pre-compressed the nominal traverse, and are capable of moving the nominal traverse in extension and 1" in compression. Consult the factory whenever the installation temperature of the expansion joint is going to be abnormal, i.e., installing the expansion joint in a hot line, or installing the expansion joint on an exceptionally hot day in a normally cold location.

[] EXPANSION JOINT PACKING FRICTION FORCE:

The packing friction force of a slip type expansion joint is the force required to move the slip due to the injectable packing acting on the slip inside the stuffing box. ATS has determined from testing that for expansion joints properly packed for service up to 300 psig, this force is equal to approximately 1,000 lbs. per inch of expansion joint nominal diameter, i.e., a 6" expansion joint will require 6,000 lbs. of force to move the slip. Packing friction forces are tabulated in Table 3.

NOTE: When an expansion joint is to be packed for service above 300 psig, consult the factory for the appropriate packing friction force.

[] PRESSURE THRUST:

The pressure thrust associated with a packed slip type expansion joint can be calculated by multiplying the design pressure of the system by the thrust area of the expansion joint. The thrust areas for the ATS expansion joints are listed in Table 3. The pressure thrust is a very important component in the calculation of anchor loading and must be properly calculated and accounted for.

TABLE 2
THERMAL EXPANSION OF STEEL PIPE
—INCHES PER 100FT.

Saturated Steam Vacuum in HG below 212°F., Pressure psig above 212°F.	Temperature Degrees Fahrenheit	Carbon & Carbon Molybdenum Steel
	-40	-0.29
	-20	-0.15
	0	0
	20	0.15
	32	0.23
	40	0.30
	60	0.45
29.39	80	0.58
28.89	100	0.75
27.99	120	0.91
26.48	140	1.06
24.04	160	1.20
20.27	180	1.36
14.63	200	1.52
6.45	212	1.61
0	220	1.68
2.5	227	1.74
5.0	240	1.84
10.3	260	2.02
20.7	267	2.08
25.0	280	2.18
34.5	298	2.33
50.0	300	2.35
52.3	320	2.53
74.9	340	2.70
103.3	353	2.82
125.0	360	2.88
138.3	366	2.93
150.0	380	3.06
180.9	388	3.13
200.0	400	3.23
232.4	406	3.29
250.0	420	3.42
293.7	422	3.44
300.0	440	3.60
366.1	448	3.67
400.0	460	3.78
451.3	470	3.87
500.0	480	3.96
550.3	489	4.04
600.0	500	4.15
664.3	520	4.34
795.3	540	4.53
945.3	560	4.73
1115	580	4.93
1308	600	5.13
1525	620	5.33
1768	640	5.53
2041	660	5.75
2346	680	5.95
2705	700	6.16
3080	720	6.36
	740	6.57
	760	6.79
	780	7.00
	800	7.23
	820	7.45
	840	7.66
	860	7.97
	880	8.10
	900	8.34

Add a minimum of 10% to calculated expansion for selection of the expansion joint nominal traverse for (1) discrepancies in minimum or installation temperatures, (2) jobsite necessity to relocate anchor points, and (3) temperature surges.



[] ANCHORS:

All piping systems must be divided into individual expanding segments by means of anchors which are attached to the piping and in turn to a support structure. Machinery and equipment, such as turbines and pumps are also considered anchors, since their bases are fixed and resist all forces and moments imposed upon them.

The installation of slip type expansion joints, like any other axial motion type expansion joint, introduces forces which must be resisted by the anchors. Anchors can be categorized as either main or intermediate type, depending upon the forces they must withstand.

The **main anchors** must resist forces which involve the internal pressure of the system as well as the frictional forces associated with the pipe supports and expansion joint packing friction. **Intermediate anchors** usually involve only the frictional forces of the system.

[] ANCHOR FORCES:

Anchor forces are calculated by adding the three components listed below, refer to Table 3:

- Pressure Thrust (Fp): (ATS Primer on Pressure Thrust furnished upon request).
 $F_p = p \times a$
- Expansion Joint Packing Friction (Fc):
 $F_c = K \times D$
- Pipe Support Friction (Fs):
 Total Pipe Support Friction = $F_s \times (L / 100)$

In addition to the static forces listed above, there are also dynamic forces that sometimes need to be considered. For steam service the dynamic forces are quite low and can be accounted for by adding a 5% minimum load factor to the total calculated force. For high density fluids, the dynamic forces can be quite significant due to the effect of the moving fluid impinging upon an elbow and can result in a substantial force on the elbow anchor. The magnitude of this force can be calculated by using the following formula: (See sample anchor load calculations on back cover flap).

$$F_p = \frac{2A \rho V^2}{g} \times \frac{\sin \theta}{2}$$

[] ANCHOR MOMENTS:

In addition to the moments imposed upon anchors from the normal axial forces described above, consideration must also be given to additional moments due to branch connections, anchors located some distance from a change in direction, i.e., a 90° elbow, or other external forces. **Anchor design calculations must include all forces and moments.**

Table 3 - Anchor Calculation Values

Nominal Pipe Size	Thrust Area a - in ²	Packing Friction Force Fc - lbs.	Pressure Thrust Fp - lbs.		Pipe Support Friction Fs - lbs./100 ft.	
			150 psi	300 psi	Water	Steam
1 1/2"	2.8	1,500	420	840	215	185
2"	4.4	2,000	660	1,320	270	220
2 1/2"	6.5	2,500	975	1,950	390	320
3"	9.6	3,000	1,440	2,880	485	370
4"	15.9	4,000	2,385	4,770	735	545
5"	24.3	5,000	3,645	7,290	1,005	700
6"	34.5	6,000	5,175	10,350	1,315	880
8"	58.4	8,000	8,760	17,520	2,030	1,275
10"	90.8	10,000	13,620	27,240	3,000	1,805
12"	127.7	12,000	19,155	38,310	3,900	2,180
14"	153.9	14,000	23,085	46,170	4,500	2,385
16"	201.0	16,000	30,150	60,300	5,500	2,720
18"	254.5	18,000	38,175	76,350	6,710	3,160
20"	314.0	20,000	47,100	94,200	7,920	3,505
24"	452.0	24,000	67,000	135,600	10,770	4,330

Notes:

1. The packing friction forces shown, Fc, are applicable for an operating pressure up to 300 psig. Consult factory for values at pressures greater than 300 psig.
2. Tabulated values of Fs are based upon the following:
 - (a) Carbon steel standard wall pipe.
 - (b) Insulation material thickness to 500°F (Calcium Silicate).
 - (c) Mean Static Coefficient of friction of 0.35.
3. For piping systems utilizing graphite on graphite guides and supports, multiply the tabulated Fs values by 0.45.



General Guidelines for Guiding when using ATS Thermal Pak TP2 Expansion Joints:

1. Table 4 shows the recommended location for the primary guide, and the recommended spacing for the intermediate guides and supports. The Primary guide spacings shown are for use with standard wall pipe and are satisfactory for above ground and tunnel installations. They are applicable to the following:

- a. Single Expansion Joints with integral anchor base or Single Expansion Joints installed immediately adjacent to an anchor.
- b. Double Expansion Joints.

2. When a Single Expansion Joint without base is installed in the center, or approximate center, of a pipe run, the primary guide spacing must be modified as follows:

- a. Sizes 1 1/2" to 4" inclusive: Primary guides should be located six (6) pipe diameters from each end of the expansion joint.
- b. Sizes 5" to 24" inclusive: Primary guides should be located three (3) pipe diameters from each end of the expansion joint.

c. To preclude the possibility of cocking the slip on heavier expansion joints, 6" and larger, a sliding support under the expansion joint is recommended.

3. Whenever possible, valves or other heavy accessories should not be installed in the pipe run between the slip and the first guide. **Where this is not possible, the valve or accessory must be supported on a sliding support.**

4. Installations using a buried conduit system with expansion joints installed in manholes or vaults, require guiding at the manhole wall. Properly sized and installed gland and link seals are considered adequate guiding. In addition, consideration should be given to installation of a "moment" guide within 10 ft. of the manhole wall. Moment guides should not be attached to the manhole wall. "BRONZALON" low friction guide inserts should be used with all expansion joints used in buried conduit systems.

5. PIPE GUIDE/SUPPORT SELECTION: See ATS Bulletin PG594 for detailed information concerning guides and supports.
Primary Guide: The preferred design for primary guides are those that guide the pipe to allow only axial movement, such as the ATS "GA" Radial Pipe Guide, or the ATS Fig 101 and Fig 100 Low Friction Pipe Guide.
Intermediate Guides: The ATS Fig 101 and Fig 100 Low Friction Pipe Guide are recommended for intermediate guides.
Supports: The ATS Fig 201 and Fig 200 Low Friction Pipe Supports are recommended for all pipe support locations.

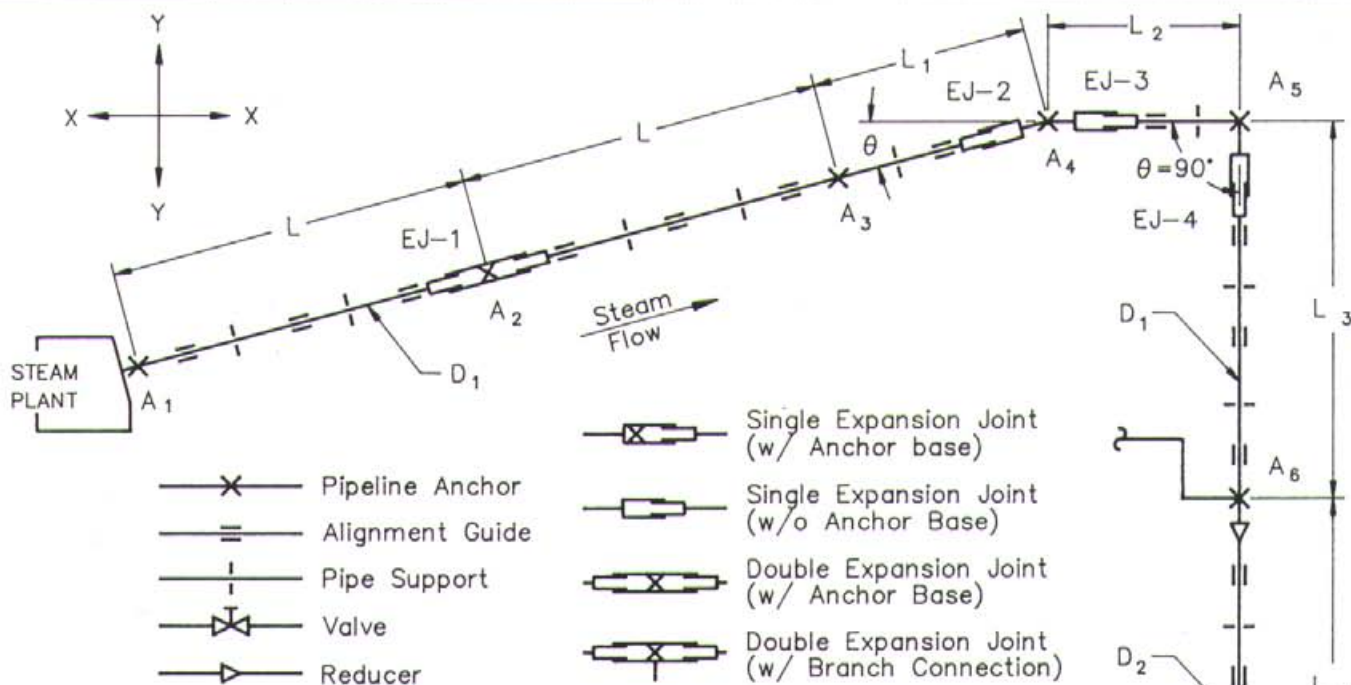
Note: Roller supports should not be considered low friction supports. While rollers almost always roll when first installed, normally after a period of time the rolling mechanism will corrode, greatly increasing the friction force transmitted back to the pipe anchor.

6. The pipe support spacing shown in Table 4 is the maximum span as specified by the ASME/ANSI Power Piping Code B31.1, and is applicable for horizontal straight runs of pipe, without concentrated loads such as valves or heavy fittings between supports. The span distance applies to standard weight or heavier pipe operating at a maximum temperature of 750°F (400°C).

7. Lateral Forces on Guides: Pipe alignment guides and their support structures may be subjected to lateral forces in addition to the frictional forces along the longitudinal axis of the pipe. It is recommended that both the pipe guide and support structure be designed to resist a lateral load force equal to 250 lb./inch of nominal pipe diameter.

TABLE 4 PIPE ALIGNMENT GUIDE AND SUPPORT SPACING								
Nominal Pipe Size	Primary (1st) Guide from End(s) of Slip (Feet)	Intermediate Guide Spacing (Feet)				Pipe Support Spacing (Note 5)		
		Pressure (PSIG)				Water	Steam	
		100	150	300	400			
1 1/2	1 1/2	8	8	7	7	8	10	
2	2	9	9	8	8	10	13	
2 1/2	2	12	12	11	11	11	14	
3	3	15	15	12	12	12	15	
4	4	20	20	18	16	14	17	
5	6	28	27	25	22	16	18	
6	6	35	33	30	27	17	21	
8	8	48	45	40	35	19	24	
10	8	65	60	55	50	22	27	
12	12	75	70	60	55	23	30	
14	12	80	75	65	60	25	32	
16	16	90	85	75	70	27	35	
18	20	100	95	85	80	28	37	
20	20	110	105	95	90	30	39	
24	25	130	125	110	100	32	42	

ATS THERMAL PAK "TP2" EXPANSION JOINTS



- Pipeline Anchor
- Alignment Guide
- Pipe Support
- Valve
- Reducer

- Single Expansion Joint (w/ Anchor base)
- Single Expansion Joint (w/o Anchor Base)
- Double Expansion Joint (w/ Anchor Base)
- Double Expansion Joint (w/ Branch Connection)

Main Anchors	
$FA_1 = F_p + F_c + F_s \frac{L}{100}$	FA_1
$FA_4 = (F_1 + F_2) \sin \frac{\theta}{2}$ $F_1 = F_2 = F_p + F_c$ $FA_4 = 2(F_p + F_c) \sin \frac{\theta}{2}$	
$FA_5 = \sqrt{F_3^2 + F_4^2}$ $F_3 = F_p + F_c + F_s \frac{L_2}{100}$ $F_4 = F_p + F_c$ When $F_3 = F_4 = F$ $FA_5 = (1.414)(F)$	
$FA_6 = F_5 - F_6$ $F_5 = pa_1 + KD_1 + F_{s1} \frac{L_3}{100}$ $F_6 = pa_2 + KD_2 + F_{s2} \frac{L_3}{100}$ $FA_6 = \text{See note 2}$	
$FA_7 = F_c = KD_2$ $FA_7 = \text{See note 2}$	
$FA_8 = F_c + F_s \frac{L_3}{100}$ (Valve V_2 open) $FA_8 = F_p + F_c + F_s \frac{L_3}{100}$ (Valve V_2 closed) $FA_8 = \text{See note 2}$	

$FA_9 = F_p + F_c$ (Valve V_2 open)
 $FA_9 = 0$ (Valve V_2 closed)

Intermediate Anchors

$FA_2 = F_c = KD_1$ FA_2

$FA_3 = F_c + F_s \frac{L}{100}$ FA_3

Notes

- Intermediate Anchors**— It is recommended that all intermediate anchors be designed based upon the highest calculated forces for any given intermediate anchor.
- Branch Connections**— The forces and moments at branch connections (X-X direction on piping schematic) must be considered when designing the anchors at these junctures.
- Transient load factor**— It is recommended that a transient load factor of 15% be added to the calculated forces and moments at all anchor points, to allow for system pressure surges and/or other unknown conditions which may occur during the operating life of the system.

SAMPLE CALCULATIONS OF ANCHOR FORCES A₁ TO A₉ ALONG AXIS OF PIPELINE FURNISHED ON REQUEST.

SAMPLE ANCHOR LOAD CALCULATIONS

On the adjacent page is a sample pipe layout showing locations of expansion joints, pipe anchors, pipe guides and pipe supports. The formulas for calculating the forces on each anchor is given. A more detailed example of the same model layout is available from ATS. Ask for Engineering Bulletin EJ-1091.

Key To Symbols:

F - Anchor Force, lbs.

Note: This force acts along the longitudinal axis of the pipe run.

p - System Design Pressure, psig

Note: The test pressure should be considered when designing the anchors. The stresses for steel components at the test pressure should not exceed 80% of the materials' minimum yield strength.

a - Effective Thrust Area of the expansion joint, in². See Table 3.

K - Packing Friction Constant, 1000 lbs.

Note: For systems with an operating pressure above 300 psig, consult factory for the appropriate packing friction constant.

D - Nominal Pipe Size, in.

L - Length of Pipe Run, ft.

A - Internal Area of Pipe, ft.²

ρ - Fluid Density, lbs./ft.³

V - Velocity of Fluid, ft./sec.

g - Acceleration Due To Gravity, 32.2 ft./sec.²

θ - Angle of Pipe Bend

ATS now offers pre-engineered pre-fabricated anchors. ATS factory fabricated anchors offers the assurance of knowing the anchor will be properly designed and fabricated to meet the application requirements. Designs are easily modified to accommodate various centerline height and load requirements. ATS can supply the anchor either attached to a heavy wall pipe spool section, with ends machined to match the mating pipe, or as a loose assembly for field attachment. Branch connections up to the size of the pipe run can be incorporated for simplified field installation.

See ATS Bulletin P594 for a complete description of ATS Anchors.



8" Fig. 701-SPC-B-1

8" Main Anchor Designed for 400 PSI System with
8" Schedule 80 Pipe Spool

ADVANCED THERMAL SYSTEMS, INC.

1st IN DESIGN, SERVICE, PERFORMANCE & RELIABILITY

Other Quality ATS Products:

[] THERMAL PAK FLEXIBLE BALL JOINTS:

Applications

- Linear thermal pipe movement
- Stationary piping to moving equipment
- Moving piping to stationary equipment
- Pipe isolation for seismic events



Request ATS Bulletin BJ-794
for more information on the
ATS Thermal Pak Ball Joint.

ATS Series "P2" and "S2" Ball Joints

- Integral Socket/Retainer Flange
- Injectable Packing:
 - Series "P2" - Packable at full system pressure
 - Series "S2" - Pressures to 2,500 psig
- Ductile Iron Seals - Temperatures up to 800°F



*Installations using Ball Joints require an "Off-Set" in the pipe run,
and a minimum of two ball joints.*

[] PIPE GUIDES, PIPE SUPPORTS AND PIPE ANCHORS:

- Low Friction Graphite Guides
and Supports:
 - Un-Insulated for Hot Service
 - Pre-Insulated for Cold Service
 - 1/2" Thick Graphite on both contact surfacesReduces Anchor Loading
- Radial "Spider Type" Alignment Guides
- Pre-Engineered Anchors



Request ATS Bulletin P-594
for more information on ATS
Pipe Guides - Pipe Supports
and Pipe Anchors.



10" Pre-Insulated Pipe Support

ADVANCED THERMAL SYSTEMS, INC.

15 Enterprise Drive, Lancaster, NY 14086
Phone: 716-681-1800 Fax: 716-681-0228
Internet Address: <http://www.localnet.com/~ats>
E-Mail address: ats@localnet.com
Toll Free: 800-443-9194

©ADVANCED THERMAL SYSTEMS, INC. 1998



Printed in U.S.A.