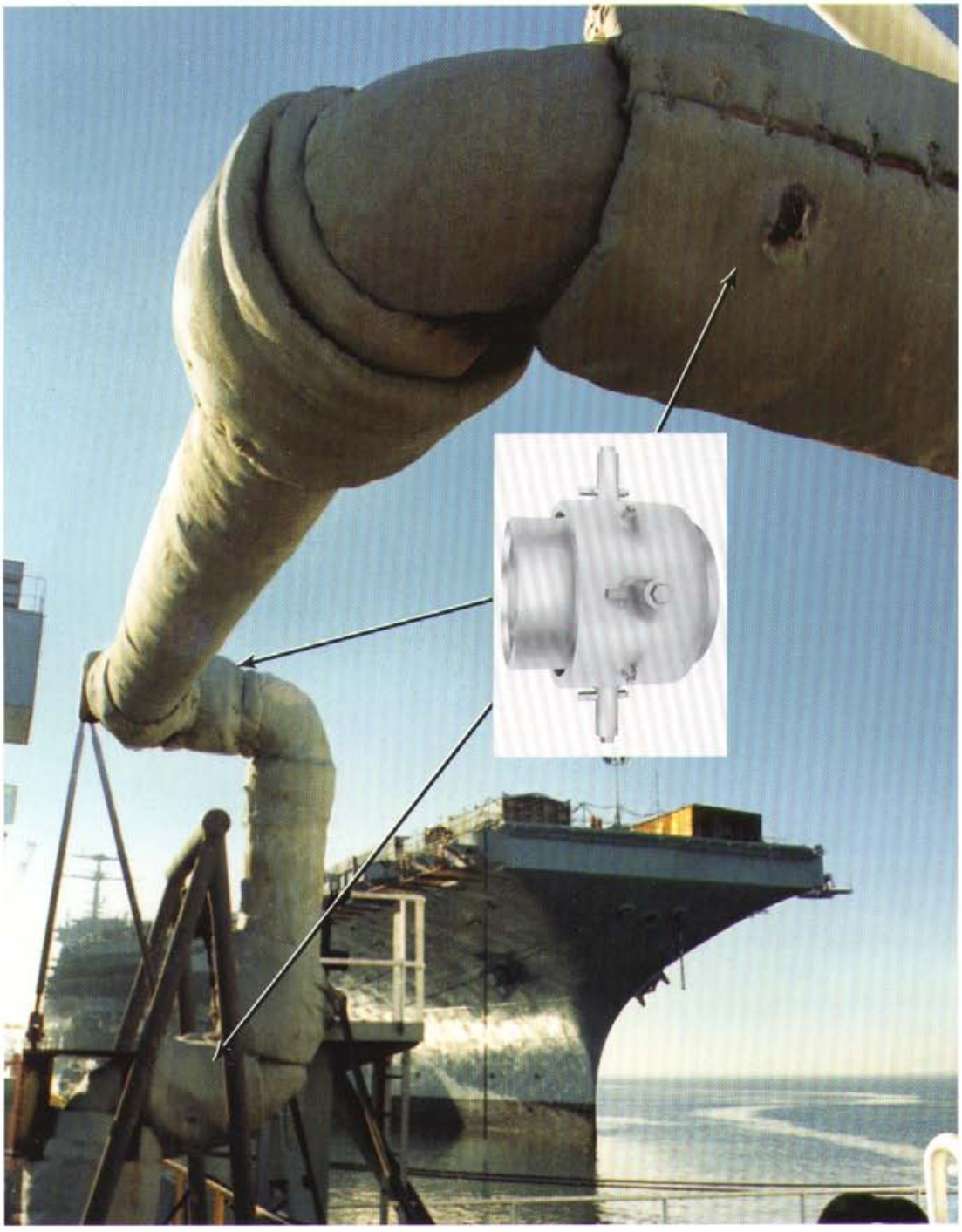
THERMAL PAK FLEXIBLE BALL JOINTS

BULLETIN BJ 499



DESIGNED FOR

PACKING

INJECTION

UNDER FULL

LINE PRESSURE

2nd GENERATION SERIES
P2 & S2 BALL JOINTS - Pg. 6

LISTED
MISCELLANEOUS FITTINGS
BALL JOINTS
3R35

ADVANCED THERMAL SYSTEMS, INC.
15 ENTERPRISE DRIVE LANCASTER NY / 716-681-1800 / FAX 716-681-0228

ADVANCED THERMAL SYSTEMS, INC.

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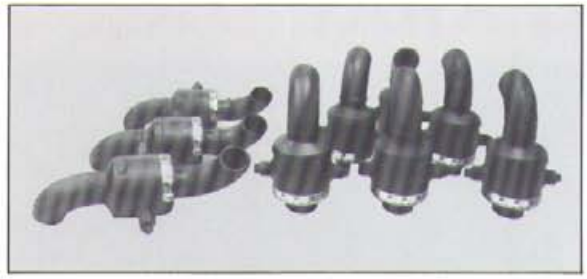
MEMBER
INTERNATIONAL DISTRICT ENERGY ASSOCIATION

CONTENTS

Six 16", four 14" and four 10" 150 lb. Flanged Series "S1" Ball Joint linkage assemblies to accommodate tank settling at the Yanbu Power and Desalinization Plant in Saudi Arabia.



2" Series "S2" Style 30 and 40 Ball Joints designed for 1700 PSIG/650° F for installation in enhanced oil recovery piping. A total of 137 Ball Joints were furnished in 1½", 2" and 2½" sizes for Chevron Oil, Bakersfield, California.

10" Steam and 4" Condensate Series "P2" Ball Joints with Type B Packing Cylinders installed in piping at a trestle over a roadway. Ball Joints are shown with ATS removable Insulation Blanket. 65 - 4" to 12" Ball Joints were furnished to NRG Energy,* Stillwater, MN.

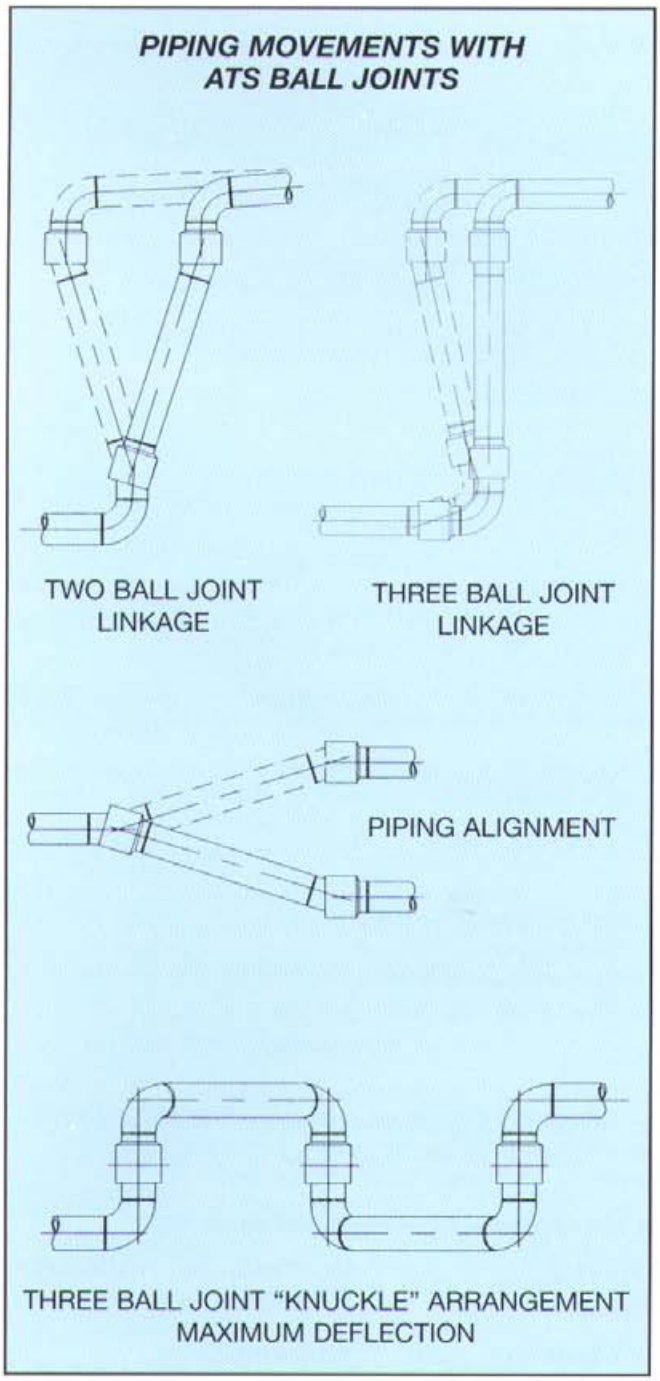
*Formerly Norenco.

Close-up of 10" Series "P2" Ball Joints with insulation blanket. Note cutouts for access to Type B Packing Cylinders. Blanket for 4" Condensate not yet in place.

Advanced Thermal Systems Ball Joints

for handling expansion, movement or stress in piping systems.

Applications



linear thermal expansion/contraction

The most common application for ATS ball joints is in long runs of piping which carry steam, hot water or other fluids at high temperatures. Long lengths of pipe can expand considerably, flexing the joints as shown in the diagram. Any twisting of the pipe is also easily handled by the ball joints. All major reactive forces of other systems are eliminated with ball joints. This installation requires less space than a pipe loop and provides a cost saving by the elimination of heavy anchors and guides.

storage tank connections

ATS ball joints handle many types of pipe movements on storage tank connections. Two ATS ball joints can be used on a pipeline connected to a tank. The joints accommodate tank settling and tilting and protect the manifold from damage whenever movement occurs. ATS ball joints can handle earthquake shock, pipe stresses and other reactive forces sometimes encountered in this type of application.

stationary piping to moving equipment

ATS ball joints can accommodate the movement of equipment in stationary piping systems. The multi-plane movement of the joints handle compound twisting motions eliminating damaging reactive forces in the system.

moving piping to stationary equipment

ATS ball joints are used when piping alignment is critical. Such alignment may occur with turbines, pumps, valves and other machinery. Misalignment coupled with expansion or other movement of the piping can seriously overstress equipment which may result in costly damage. However, the combined angular flex and swivel movement in ATS ball joints compensates for misalignment and other piping movement without developing major reactive forces.

30" Series "S1" Ball Joints installed at AMOCO OIL CO., Texas City Refinery to accommodate tank settling and thermal expansion of a pipeline containing Gas Oil at 150 PSIG/200° F. A total of 32 Ball Joints were furnished, eight each 12", 18", 24" and 30" sizes.

ABOUT THE FRONT COVER:

Piping to the Nuclear Aircraft Carrier "USS Theodore Roosevelt"

ATS ball joints installed aboard a barge which provides steam for test purposes to navy vessels under construction at Newport News Shipbuilding & Drydock Co., Newport News, Virginia.

Piping is subject to barge draft, list and trim conditions. The three (3) ATS ball joints accommodate the movements listed below when the barge is moored to a pier:

Movements:

Starboard	**2'0"**
Port	**2'0"**
Fore and Aft	**±6"**
Change in tide from mean	**up 7.95'**
	down 6.55'

Here are 8 solid reasons why the ATS Ball Joint systems offer major advantages over other methods for handling pipe movement:

1. The ball joint system offers cost-saving advantages by reducing the number and weight of anchors and guides required in a piping system.
2. The ball joint system permits pipe to move in two or more planes simultaneously.
3. Ball joints provide more movement in less space, taking full advantage of available space.
4. ATS ball joints can withstand heavy shock and vibration.
5. Ball joints have a pivotal movement capability as well as the ability to flex angularly for accommodating twisting movement or torsional force.
6. ATS ball joints are designed for low maintenance service in a wide range of operating conditions.
7. The ball joint system reduces end thrust after the small initial force required to flex the ball joints is exerted.
8. The ATS series "P1" and "P2" ball joints are designed for the injection of semi-plastic packing under full line pressure; thus assuring maximum reliability for uninterrupted service.

Benefits

ATS ball joints provide benefits for many industrial, commercial and institutional users, such as petroleum refineries, oil production, chemical process plants, public utilities, schools, hospitals, industrial power plants, transportation terminals, manufacturing plants and basic metals industries.

ATS ball joints provide flexibility for compensation of expansion, movement and stress in:

STORAGE TANK PIPING

- Thermal Expansion
- Earth Movement
- Settling or Tilting of Tanks

EQUIPMENT PIPING CONNECTIONS

- Movement of Equipment
- Movement of Piping
- Exhaust Lines

HEATING AND COOLING SYSTEMS

- Heating Lines
- Coolant Lines
- Boiler Connections

FIRE PROTECTION SYSTEMS

UNDERGROUND PIPING SYSTEMS

OIL RECOVERY SYSTEMS

Table 1
Standard Flexible Ball Joints

Basic Design	Ball Joint Series (Pgs. 6 & 8)	Compression Seals.... Max. Temp. °F (Field 5, Page 19)	Available Sizes (Note 1)	Packing Type (Field 4, Page 19)
Threaded[2] OR Bolted Socket/Retainer	S	Glass Filled Teflon..... 400	1¼" - 12"	NONE
	P1 & S1	Molded Composition..... 525 Aluminum Bronze..... 600 Ductile Iron..... 800	3" - 24" 3" - 12" 3" - 30"	350H to 600°F 400H to 800°F
Integral Socket/Retainer	P2 & S2	Aluminum Bronze..... 600 Ductile Iron..... 800	¾" - 12" ¾" - 30"	

1. Larger sizes on application.
2. Threaded retainer cap furnished for 1¼" to 2½" Series S.

Table 2
Pressure-Temperature Ratings
Weld End Thermal Pak Flexible Ball Joints
With Ductile Iron Compression Seals

BJ Size	Pressure Ratings, PSIG			
	SERIES "P2" & "S2"		SERIES "P1" & "S1"	
	at 650° F	at 800° F	at 650° F	at 800° F
¾"	1600	1150	NOT AVAILABLE	
1"	1600	1150		
1¼"	1500	1050		
1½"	1500	1050		
2"	1200	850		
2½"	1200	850		
3"	1200	850	600	500
4"	1000	740	600	500
5"	1000	740	600	500
6"	975	720	600	500
8"	750	550	600	500
10"	750	550	500	420
12"	600	440	500	420
14"	600	440	500	420
16"	600	440	500	420
18"	500	440	500	420
20"	450	400	400	325
24"	450	400	400	325
30"	450	350	300	200

NOTES:

1. Series "S2" Ball Joints are available on application to 3000 PSIG/800° F.
2. Series "P2" Ball Joints are limited to 1000 PSIG.
3. Higher working pressure of Series "P1" and "S1" on application.
4. Refer to Table 3, Page 11 for Packing Cylinder Pressure Ratings.
5. Series "P2" and "S2" ¾" to 2" sizes are available with threaded, weld, flanged, or socket weld ends.
6. Series "P2" and "S2" sizes 2½" and larger and Series "P1" and "S1" 3" and larger are available with weld or flanged ends.
7. When ends are beveled for welding, specify pipe schedule or preferably the "wall thickness." Bear in mind that "Standard Wall" is the same as "Sch. 40" to 10" size only and that "XH" is the same as "Sch. 80" only to "8" size." The wall thickness of "XH" pipe 8" and larger is ½".
8. Refer to Page 19 for "HOW TO ORDER."

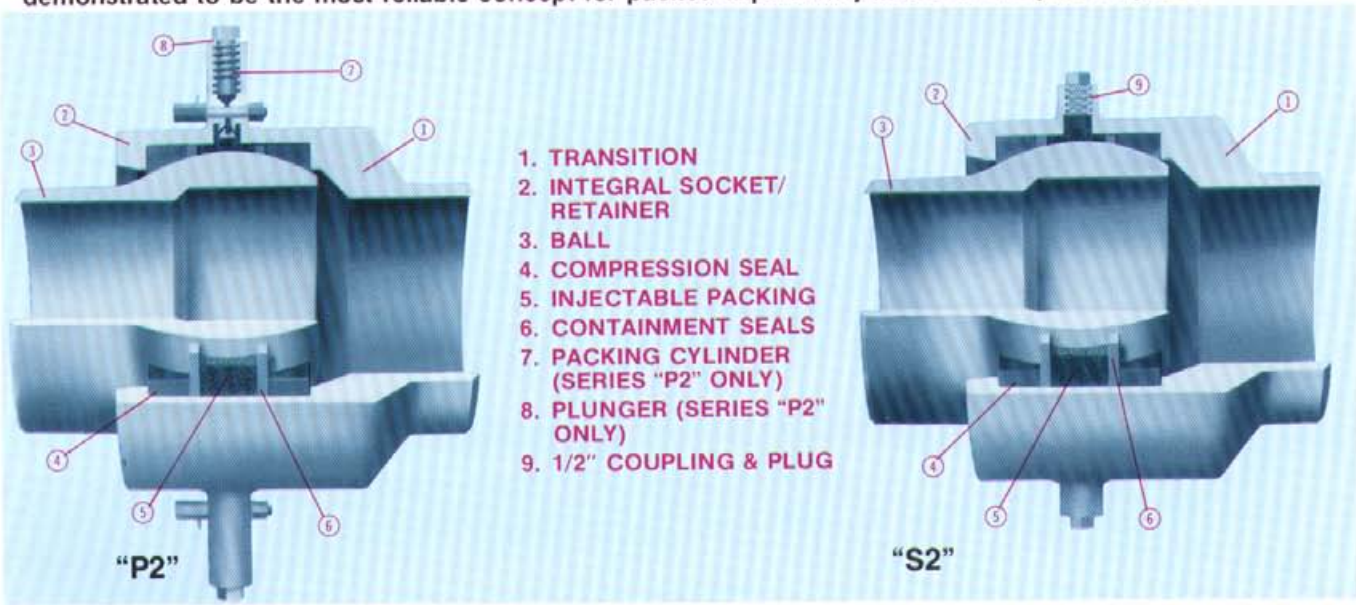
Around the Clock, Around the World,
PROVEN RELIABILITY

Initial cost of Ball Joints are minimal in comparison to future maintenance and/or replacement costs of deficient designs and/or materials of construction. ATS designs and materials of construction may not have the lowest initial cost but will have the *lowest total costs* over the life of the piping system.

Since product improvement is a continuing effort at ATS, the right is reserved to make reasonable changes of any kind without notice.

Thermal Pak Series "P2" and "S2" Flexible Ball Joints
2nd Generation Ball Joints With Injectable Packing

The integral Socket/Retainer design of the 2nd Generation Series "P2" and "S2" Ball Joint eliminates threaded retainer cap or retainer flange with associated bolting. This innovative integral Socket/Retainer can be compared with the integral guide design of the ATS Thermal Pak TP2 Packed Expansion Joint which has been demonstrated to be the most reliable concept for packed expansion joints over the past 40 years.



Series "P2" Ball Joints are furnished with packing cylinders to permit injection of packing under full line pressure to 1000 psig. The Series "P2" Ball Joint above is shown with a Type "B" Packing Cylinder rated at 850 psig (all available types of Packing Cylinders are pictured on Page 11). The plugged half couplings between the packing cylinders (Part 9, not shown) are used for initial factory charging of the injectable packing. The containment seals (Part 6) prevent by-pass of the injectable packing (Part 5) to ensure the required injectable density to contain leakage. Available only with metal compression seals (refer to Field 5, Page 19). There is never a need for a shutdown to contain leakage or replace seals.

The Series "S2" Ball Joint is identical with the Series "P2" except packing cannot be injected under pressure. The system must be depressurized to inject additional packing in the event of leakage. At that time, the plugs at the 1/2" half couplings are removed one at a time and replaced with a threaded Type "A" Packing Cylinder (purchased separately; pictured on Page 11). Once the threaded Type "A" Packing Cylinder is fully engaged at a coupling, packing can be injected. One Packing Cylinder can be used at multiple couplings. Series "S2" Ball Joints have a reduced initial cost and is the only design recommended for pressures over 1000 psig.

ADVANTAGES OF THE SERIES "P2" and "S2" INTEGRAL SOCKET/RETAINER

Patent No.: 4,671,543

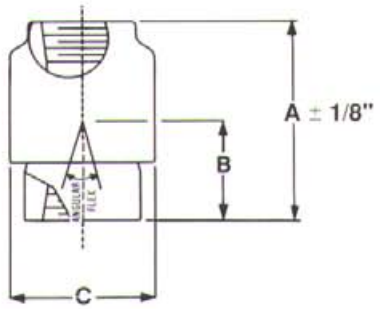
1. a. Eliminates the in-service field error of overtightening the retainer flange bolting or retainer cap which will greatly increase flex torque values and may result in freezing the ball in its socket.

   b. To contain leakage, it is best to inject additional packing vs. tightening of the retainer flange bolting or threaded cap since packing injection can be controlled to minimize the flex torque value and produces a more positive leak containment method.
2. Eliminates the need for stainless steel bolting when the ball joint is installed in a corrosive environment and/or must handle a corrosive fluid.
3. The profile dimensions are reduced permitting installation in closer quarters.
4. Thermal insulation is accomplished at lower cost.

The use of metal "only" seals in the Thermal Pak "P2" and "S2" Ball Joints produces more constant flex torque values for the life of the piping system vs. Ball Joints with pressure-molded compression seals (gaskets). In addition, the breakaway force is considerably less with the metal seals than with the molded seals. This is especially true in hot service where the ball has not moved for long periods of time.

The "Injection of Packing at full line pressure" concept was first introduced to Ball Joints by ATS in 1979. This concept has now been proven in thousands of installations. Where leakage is apparent, it has been field proven that injectable packing will contain the leakage even when the compression seals are worn or wire-drawn. The injectable packing adjusts for wear and fills the void created by wire-drawing; thus the need to replace seals has been eliminated. As it is no longer necessary to replace seals to contain leakage, the integral design of the Thermal Pak Series "P2" and "S2" Ball Joints is the logical design extension to increase reliability and decrease initial and operating costs.

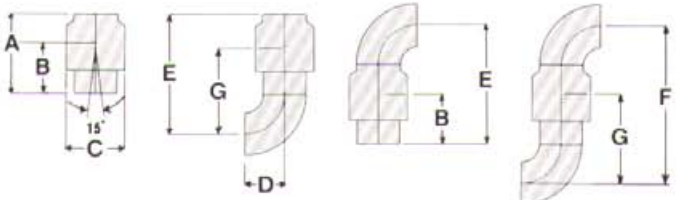
Series "P2" and "S2" Styles and Dimensions



STYLE 20		THREADED-FEMALE			WELDING ENDS		
NOM. SIZE	ANG. FLEX	A	B	C	A	B	C
¾-1	33°	6½	3 7/16	3 7/16	O/A	O/A	O/A
1¼-1½	30°	6 11/16	3⅜	3⅜	6	2 11/16	3⅜
2	33°	7 7/16	4	4 7/16	6⅝	3 3/16	4 7/16

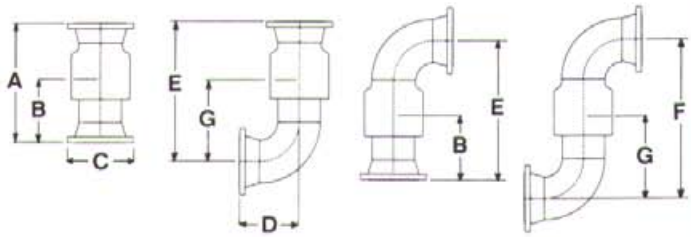
Beveled for Welding

STYLE 20 STYLE 30A STYLE 30 STYLE 40



Flanged

STYLE 20 STYLE 30A STYLE 30 STYLE 40



ALL PRESSURE CONTAINING COMPONENTS ARE CARBON STEEL

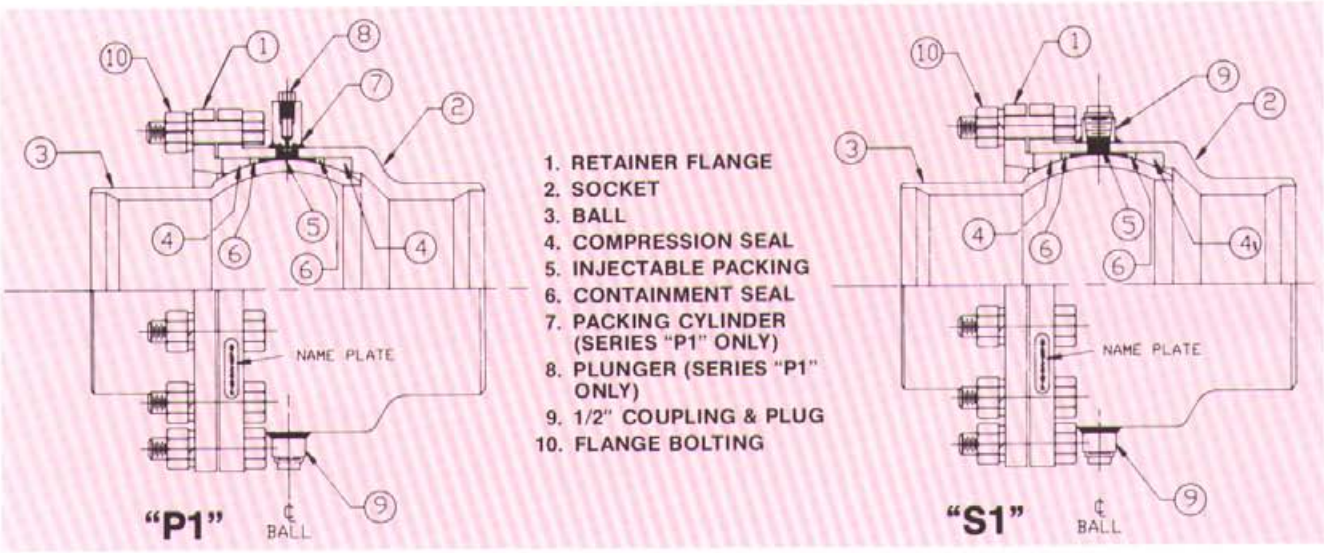
DIMENSIONS — INCHES

Nom. Size	Ang. Flex	WELD ENDS							150 LB. FLANGED							300 LB. FLANGED						
		A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
2½	15°	6 5/8	3 3/16	4 7/16	2½	9 1/8	11 5/8	5 11/16	12 1/8	5 15/16	7	5¼	11 7/8	11 5/8	5 11/16	12 5/8	6 3/16	7½	5½	12 1/8	11 5/8	5 11/16
3	15°	8 3/8	4 1/8	5 13/16	3	11 3/8	14 3/8	7 1/8	13 7/8	6 7/8	7½	5¾	14 1/8	14 3/8	7 1/8	14 5/8	7¼	8¼	6 1/8	14½	14 3/8	7 1/8
4	15°	9	4 3/8	6 11/16	4	13	17	8 3/8	15	7 3/8	9	7	16	17	8 3/8	15¾	7¾	10	7 3/8	16 3/8	17	8 3/8
5	15°	11 1/8	5¼	8 5/8	5	16 1/8	21 1/8	10¼	18 1/8	8¾	10	8½	19 5/8	21 1/8	10¼	18 7/8	9 1/8	11	8 7/8	20	21 1/8	10¼
6	15°	13 1/8	7 3/16	9 7/8	6	19 1/8	25 1/8	13 3/16	20 1/8	10 11/16	11	9½	22 5/8	25 1/8	13 3/16	20 7/8	11 1/16	12½	9 7/8	23	25 1/8	13 3/16
8	15°	14½	8	12	8	22½	30½	16	22½	12	13½	12	26½	30½	16	23¼	12 3/8	15	12 3/8	26 7/8	30½	16
10	15°	15 3/8	8¼	14	10	25 3/8	35 3/8	18¼	23 3/8	12¼	16	14	29 3/8	35 3/8	18¼	24 5/8	12 7/8	17½	14 5/8	30	35 3/8	18¼
12	15°	16¼	8 11/16	16	12	28¼	40¼	20 11/16	25¼	13 3/16	19	16½	32¾	40¼	20 11/16	26½	13 13/16	20½	17 1/8	33 3/8	40¼	20 11/16
14	15°	18 13/16	10 1/16	18 7/8	14	32 13/16	46 13/16	24 1/16	28 13/16	15 1/16	21	19	37 13/16	46 13/16	24 1/16	30 1/16	15 11/16	23	19 5/8	38 7/16	46 13/16	24 1/16
16	15°	21 3/8	11½	21 7/8	16	37 3/8	53 3/8	27½	31 3/8	16½	23½	21	42 3/8	53 3/8	27½	32 7/8	17¼	25½	21¾	43 1/8	53 3/8	27½
18	15°	23¾	12½	24 1/8	18	41¾	59¾	30½	34¾	18	25	23½	47¼	59¾	30½	36¼	18¾	28	24¼	48	59¾	30½
20	15°	23¾	11½	26 7/8	20	43¾	63¾	31½	35 1/8	17 3/16	27½	25 11/16	49 3/8	63¾	31½	36½	17 7/8	30½	26 3/8	50 1/8	63¾	31½
24	15°	26½	13	32 1/8	24	50½	74½	37	38½	19	32	30	56½	74½	37	39¾	19 5/8	36	30 5/8	57 1/8	74½	37
30	15°	32 5/8	16¾	39¾	30	62 5/8	92 5/8	46¾	42 7/8	21½	38¾	35 1/8	67¾	92 5/8	46¾	— CONSULT FACTORY —						

NOTES

1. Dimensions for Style 30, 30A and 40 are based on short radius 90° elbows.
2. Refer to Page 10 for additional Series "P2" Dimensions.
3. Overall length dimensions (A, E and F) have a tolerance of ± 1/4".
4. Flanges for 30" Ball Joints are CL 125 and AWWA C 207 CL.E.
5. Larger Flex Angle on application for sizes 2½" and larger.

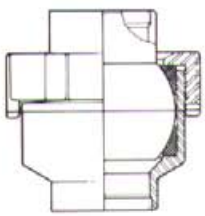
Thermal Pak Series "P1" and "S1" Flexible Ball Joints with Injectable Packing



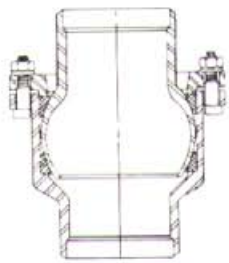
The Series "P1" pictured above was the first Ball Joint designed for packing injection under full line pressure. Available with pressure molded composition compression seals to 24 inch size or metal compression seals for all sizes (refer to Field 5 on Page 19). Welded Type "A" Packing Cylinders are shown above but Type "B" Packing Cylinders are also available (see Page 11). The plugged half couplings are used for initial factory charging of the injectable packing. A soft Containment Seal at each end of the injectable packing zone prevents by-pass of the injectable packing density required to seal leakage. Never a need for a shutdown to contain leakage.

The Series "S1" Ball Joint is identical with the Series "P1" except packing cannot be injected under pressure. System depressurization is required to inject additional packing in event of leakage. At that time the plugs at the 1/2" half couplings are removed, one at a time, and replaced with a threaded Type "A" Packing Cylinder (pictured on Page 11). Once the threaded Type "A" Packing Cylinder is fully engaged at a coupling, packing can be injected. One packing cylinder can be used at multiple couplings. As with the Series "P1" the containment seals (Part 6) prevent by-pass of the injectable packing to ensure the required injectable density to contain leakage.

Series "S" Flexible Ball Joint



1¼" to 2½"



3" to 12"

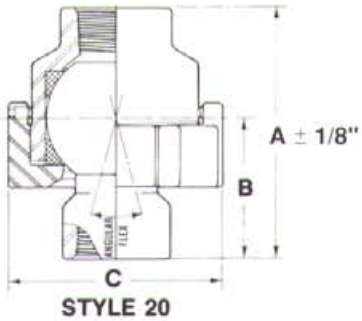
The ATS Series "S" Ball Joint does not contain injectable packing and is usually only available with glass-filled teflon compression seals (gaskets). Pressures are limited and maximum temperature is 400°F. Leakage is contained by adjustment of the retainer flange bolting or retainer cap. Available styles are the same as shown for all other Series.

Balls are Corro-Cote Plus Plated

To provide corrosion protection, the Ball spherical surfaces of **all** ATS Ball Joints are plated as a standard with .001" of Hard Chrome applied over .001" of Crack-free Hard Chrome by the Corro-Cote Process with thickness certified by Permascope Inspection per ASTM Standard B-499 — exceeds ANSI B 650 Class 50.

Standard Materials of Construction for pressure containing components is Carbon Steel for all Sizes and Series of ATS Ball Joints. All Stainless Steel construction is available or Stainless Steel for wetted parts only.

Series "S", "S1" and "P1" Styles and Dimensions



STYLE 20

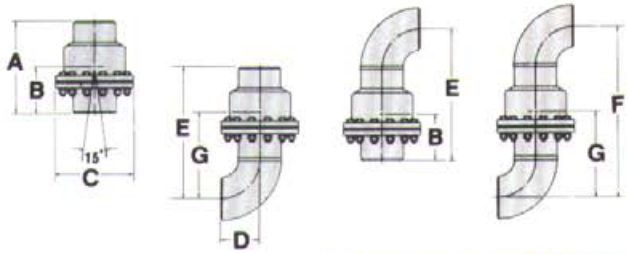
SERIES "S" ONLY

STYLE 20		THREADED-FEMALE			WELDING ENDS		
*NOM. SIZE	ANG. FLEX	A	B	C	A	B	C
1¼-1½	30°	6 1/16	3⅜	5⅛	5⅜	2 11/16	5⅛
2	33°	7 3/16	4	5¾	6⅜	3 3/16	5¾
2½	15°	Not available			6⅜	3 3/16	5¾

*Also available with flanged ends

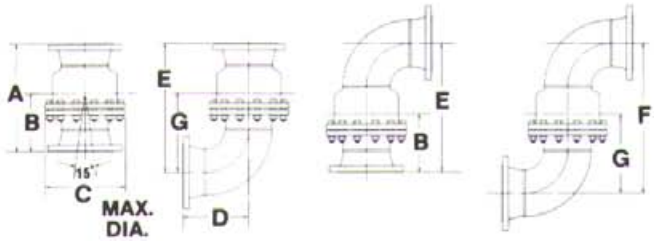
beveled for welding

STYLE 20 STYLE 30A STYLE 30 STYLE 40



flanged

STYLE 20 STYLE 30A STYLE 30 STYLE 40



ALL PRESSURE CONTAINING COMPONENTS ARE CARBON STEEL

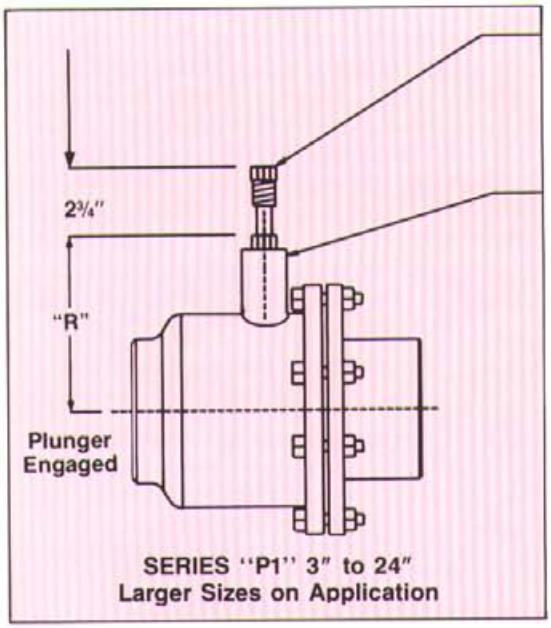
SERIES "S", "S1" and "P1" DIMENSIONS — INCHES

NOM. SIZE	ANG. FLEX	WELD ENDS							150 LB. FLANGED							300 LB. FLANGED						
		A	B	C	D	E	F	G	A	B	C	D	E	F	G	A	B	C	D	E	F	G
3	15°	7¾	4⅛	7½	3	10¾	13¾	7⅛	13¼	6⅞	7½	5¾	13½	13¾	7⅛	14	7¼	8¼	6⅛	13⅞	13¾	7⅛
4	15°	8½	4⅜	9	4	12½	16½	8⅜	14½	7⅜	9	7	15½	16½	8⅜	15¼	7¾	10	7⅜	15⅞	16½	8⅜
5	15°	10 7/16	5¼	11⅛	5	15 7/16	20 7/16	10¼	17 7/16	8¾	11⅛	8½	18 13/16	20 7/16	10¼	18 3/16	9⅛	11	8⅞	19 5/16	20 7/16	10¼
6	15°	14¼	7 3/16	12	6	20¼	26¼	13 3/16	21¼	10 11/16	12	9½	23¾	26¼	13 3/16	22	11 1/16	12½	9⅞	24⅛	26¼	13 3/16
8	15°	16	8	14¾	8	24	32	16	24	12	14¾	12	28	32	16	24¾	12⅜	15	12⅜	28⅜	32	16
10	15°	16½	8¼	17⅛	10	26½	36½	18¼	24½	12¼	17⅛	14	30½	36½	18¼	25¾	12⅞	17½	14⅝	31⅛	36½	18¼
12	15°	16	8 11/16	19¼	12	28	40	20 11/16	25	13 3/16	19¼	16½	32½	40	20 11/16	26¼	13 13/16	20½	17⅛	33⅛	40	20 11/16
14	15°	19½	10 1/16	22⅛	14	33½	47½	24 1/16	29½	15 1/16	22⅛	19	38½	47½	24 1/16	30¾	15 11/16	23	19⅝	39⅛	47½	24 1/16
16	15°	20¾	11½	24⅞	16	36¾	52¾	27½	30¾	16½	24⅞	21	41¾	52¾	27½	32¼	17¼	25½	21¾	42½	52¾	27½
18	15°	23¼	12½	28	18	41¼	59¼	30½	34¼	18	28	23½	46¾	59¼	30½	35¾	18¾	28	24¼	47½	59¼	30½
20	15°	24	11½	30 15/16	20	44	64	31½	35⅜	17 3/16	30 15/16	25 11/16	49 11/16	64	31½	36¾	17⅞	30 15/16	26⅜	50⅜	64	31½
24	15°	25	13	36¼	24	49	73	37	37	19	36¼	30	55	73	37	38¼	19⅝	36¼	30⅝	55⅝	73	37
30	15°	31½	16¾	44⅜	30	61½	91½	46¾	41¾	21⅞	44⅜	35⅛	66⅝	91½	46¾							

NOTES

1. Dimensions for Style 30, 30A and 40 are based on short radius 90° elbows.
2. Refer to Page 10 for additional Series "P2" Dimensions.
3. Overall length dimensions (A, E and F) have a tolerance of ± 1/4".
4. Flanges for 30" Ball Joints are CL 125 and AWWA C 207 CL.E.
5. Larger Flex Angle on application for sizes 2 1/2" and larger.
6. Stainless Steel for all or wetted pressure containing components only also available.

THERMAL PAK BALL JOINTS
Injectable Packing Under Pressure



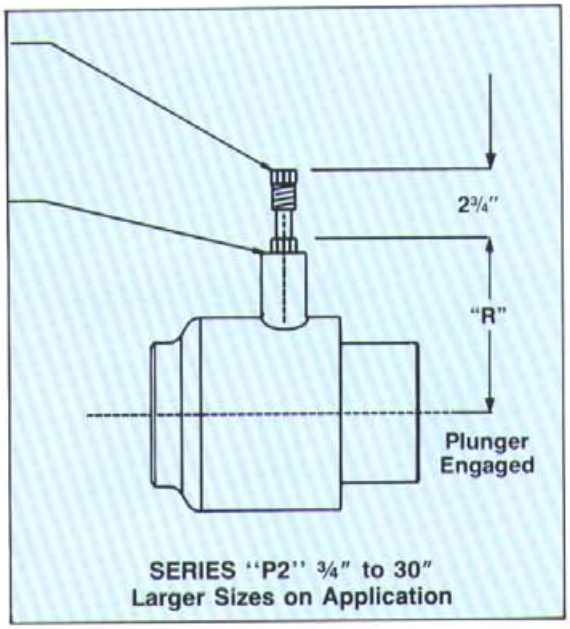
SERIES "P1" 3" to 24"
Larger Sizes on Application

Plunger, Carbon Steel
See Note 3

Type A
Packing Cylinder
Carbon Steel
See Note 2

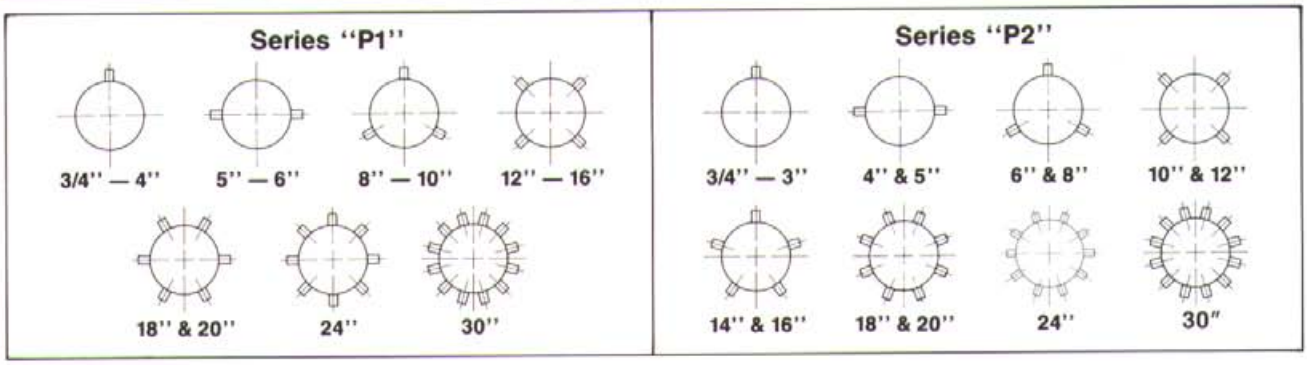
ALL PRESSURE CONTAINING COMPONENTS ARE CARBON STEEL

ALSO AVAILABLE IN STAINLESS STEEL



SERIES "P2" ¾" to 30"
Larger Sizes on Application

Packing Cylinder Orientation for Series "P1" and "P2" Thermal Pak Ball Joints



SERIES "P1" Packing Cylinder/Plunger Assembly — Clearance

SIZE	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"
R	7 5/8	8 1/4	8 3/16	8 5/8	9 3/4	10 7/8	11 7/8	13 1/4	14 5/8	15 7/8	17 3/8	19 7/8	23 7/8

SERIES "P2" Packing Cylinder/Plunger Assembly — Clearance

SIZE	¾-1"	1¼-1½"	2-2½"	3"	4"	5"	6"	8"	10"	12"	14"	16"	18"	20"	24"	30"
R	5 5/8	5 13/16	6 1/8	6 11/16	7 1/8	8 1/16	8 11/16	9 3/4	10 3/4	11 3/4	13 3/16	14 11/16	15 7/8	17 1/4	19 7/8	23 5/8

NOTES: 1. Additional dimensions for Series "P1" are shown on Page 9 and for Series "P2" on Page 7.
2. Consult factory for dimension "R" where Type "B" or "C" Packing Cylinders are used.
3. Non-corroding Aluminum Bronze Plunger can be furnished for Humid and Corrosive Applications.

Series "P1" and "P2" Ball Joint Packing Cylinders For Applications To 1000 PSIG

Three (3) designs of ATS Packing Cylinders are available for applications to 1000 PSIG. Standard construction is C-1018 Carbon Steel to 800° F. Stainless Steel Packing Cylinders and Aluminum Bronze Plungers are available for corrosive applications; i.e., salt water, etc. and for higher temperature applications.

TABLE 3

B.J. Series	Packing Cylinder Type	Maximum Pressure PSIG	Available For B.J. Series
P1	A	300	3" & larger
	B	850	8" & larger
P2	A	300	¾" & larger
	B	850	2" & larger
	C	1000	6" & larger

Consult factory for Ball Joint/Packing Cylinder combinations not shown.

NOTE:
Unless otherwise specified, P1 and P2 Ball Joints will be furnished with the packing cylinder that meets the lowest pressure shown in Table 3 that also meets the maximum design pressure specified for the Ball Joints.

☐ Type "A" Packing Cylinder

An essential feature of the Type A and all ATS packing cylinders is the design of the discharge tip which not only provides a check-valve effect to prevent blow-back when its plunger is removed under full line pressure to 300 PSIG but allows the build-up of the injectable packing density to resist leakage. The three variations of the Type A packing cylinder shown all have interchangeable plungers.

☐ Type "B" Packing Cylinder

An integral stainless steel safety valve supplements the check-valve effect offered by the 300 PSIG design of the discharge tip. The safety valve provides complete safety for operating personnel when the plunger is removed under full line pressure to 850 PSIG.

☐ Type "C" Packing Cylinder Assembly

The upper component of the Type C Packing Cylinder assembly consists of a packing injector with heavy-duty internal and external acme threads with a mating plunger. The discharge tip of the lower component, a 2½" diameter retainer, provides a check-valve effect to prevent blow-back when the plunger is removed under full line pressure to 300 PSIG plus an integral stainless steel safety valve to provide positive assurance from blow-back at pressures to 1000 PSIG. In operation a cap plug is engaged with each retainer in lieu of the packing injector/plunger assembly. Unless otherwise specified a packing injector plunger assembly will be furnished in sufficient quantity to accommodate the retainers located at the largest size Series P2 Ball Joint on any single order. Additional injector/plunger assemblies will be furnished on specification at additional cost. Unlike other designs, the packing injector is easily replaced under full line pressure in the event of damage to its internal acme threads.

☐ Packing Plunger Torque

When the impacted injectable packing at the tip of the packing cylinder is not removed or loosened, the torque required to inject additional packing in event of leakage may be excessive. In most designs the plunger torque should not exceed 150 ft. lbs. Using excessive torque at the plunger may cause damage to the Packing Cylinder Plunger and/or discharge tip.

SAF-T-PACKER® Solution To Safe And Effective Packing Injection (Patent No.: 4,711, 013)

To contain leakage in the Series P1 and P2 Ball Joint necessitates the injection of additional packing. To assure uninterrupted service, this additional packing must be injected under full line pressure.

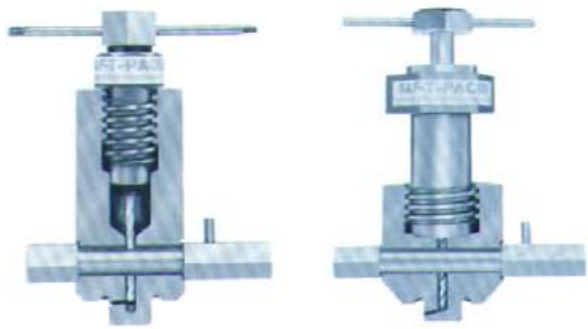
A Packing Cylinder or Retainer with a positive shutoff to prevent blow-back is recommended for pressures above 300 PSIG but offer maximum safety at all pressures to 1000 PSIG.

When subjected to heat, the impacted injectable packing remaining in the lower portion of the packing cylinder or retainer above the discharge tip will lose much of its flow characteristics. This column of packing adds to the effectiveness of the discharge tip design in preventing blow-back; however, it also adds considerably to the torque required to inject additional packing in event of leakage.

Any attempt to clean out the impacted packing below the safety valve with a pointed device may subject maintenance personnel to unnecessary safety risks.

The only **safe** and **effective** method to accomplish the removal or loosening of the injectable packing below the safety valve is with the use of an ATS SAF-T-PACKER (Patent Pending).

Detailed instructions for use of the SAF-T-PACKER is furnished with all Ball Joints equipped with Type "B" or "C" Packing Cylinders. With caution the Safety Packer can also be used with Type "A" Packing Cylinders.



Model "GB" and "GC" SAF-T-PACKER
Fully engaged with the Type "B" and "C" Packing Cylinders

Engineering Information

ATS Ball Joints provide 15°-33° total angular flex

Because the angular flex is substantial, the amount of expansion accommodated by a relatively short offset is large compared to expansion allowed by natural offsets, loops or bellows type expansion joints. Inasmuch as the fluid pressure thrust is contained by the Ball Joint's retainer, anchor forces are greatly reduced. Pipe anchors need only withstand the forces due to Ball Joint frictional torque and frictional resistance of pipe supports (and guides if required). The frictional forces due to supports and guides are greatly reduced when ATS Low Friction Graphite Slide Type Pipe Supports and Guides are used (see back cover of this Bulletin).

Table 4 tabulates the thermal expansion of steel pipe based on a datum temperature of 70° F which is considered the average installation temperature.

The total thermal expansion capabilities "e" of a Ball Joint offset link ℓ in Figure 1 (distance between pipe line centers) depends on the distance L between ball centerlines; thus for any value of e, within the recommended total angular flex capabilities, L can easily be determined by trigonometric sine calculation:

$$\text{SIN}\frac{\theta}{2} = \frac{e/2}{L} \qquad \text{THUS: } L = \frac{e/2}{\text{SIN}\ \frac{\theta}{2}}$$

*Total Angular Flex θ	
SIZE	θ
¾" to 1½"	30°
2"	33°
2½" and Larger	15°

*Total Angular Flex can only be obtained by Cold Positioning — See Page 15.

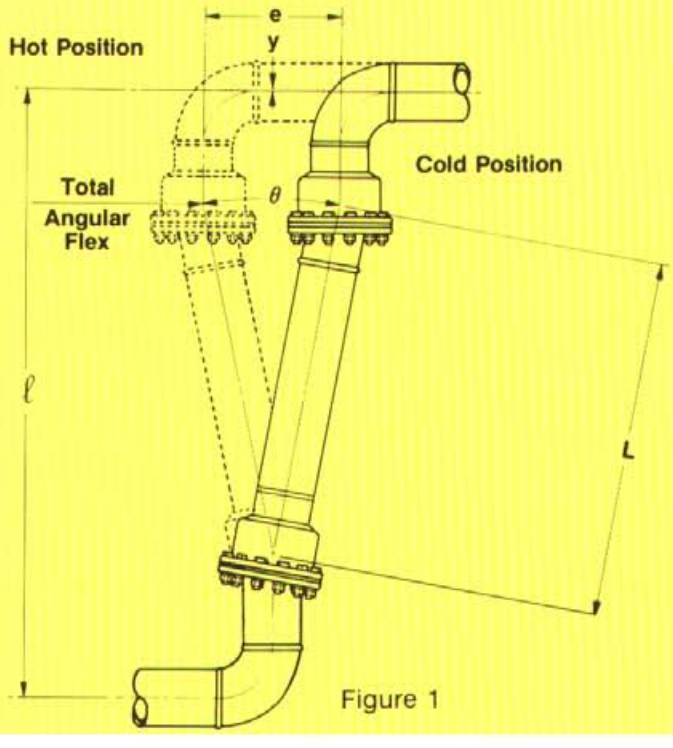


Figure 1

TABLE 4

THERMAL EXPANSION OF STEEL PIPE

eμ, inches per 100 ft. from 70° F ambient temp.

Saturated Steam Vacuum in HG below 212° F., Pressure psig above 212° F.	Temperature Degrees Fahrenheit	Carbon & Carbon Molybdenum Steel
	-20	-0.66
	0	-0.51
	20	-0.37
	32	-0.28
	40	-0.21
29.39	60	-0.07
29.18	70	0
28.89	80	.07
27.99	100	.24
26.48	120	.40
24.04	140	.55
20.27	160	.69
14.63	180	.85
6.45	200	1.01
0	212	1.10
2.5	220	1.17
5.0	227	1.22
10.3	240	1.33
20.7	260	1.51
25.0	267	1.56
34.5	280	1.67
50.0	298	1.82
52.3	300	1.84
74.9	320	2.02
103.3	340	2.19
125.0	353	2.30
138.3	360	2.37
150.0	366	2.42
180.9	380	2.55
200.0	388	2.61
232.4	400	2.72
250.0	406	2.77
293.7	420	2.91
300.0	422	2.92
366.1	440	3.08
400.0	448	3.11
451.3	460	3.27
500.0	470	3.36
550.3	480	3.44
600.0	489	3.53
664.3	500	3.64
795.3	520	3.83
945.3	540	4.01
1115	560	4.22
1308	580	4.42
1525	600	4.62
1768	620	4.82
2041	640	5.02
2346	660	5.24
2705	680	5.44
3080	700	5.65
	720	5.85
	740	6.06
	760	6.28
	780	6.49
	800	6.72

To determine the net expansion from a temp. below 70° F to a temp. above 70° F, the unit expansion at the lower temp. must be added to the unit expansion at the higher temp.

Example: expansion from 40 to 340°F = 2.19 -(-.21) = 2.40"/100 ft.

To Determine L Dimensions: Distance between Ball Joint centers

ATS recommends that the total angular flex subjected to all Ball Joint applications include a safety factor of approximately 10% for the following reasons:

1. The minimum and/or installation temperatures used in the design calculations may have been based on the erroneous assumption that the metal temperature of the pipe is the same as the ambient temperature.
2. During erection of the piping, it may be necessary to relocate some of the anchor points due to problems encountered.
3. During operation, the systems may be subjected to temperature surges and/or temperature range other than the designer anticipated.
4. Misalignment in fabrication of the expansion link offset and accumulation of tolerances in manufacture of the ball joints.

Therefore, this 10% factor of safety will reduce the ball joint total angular flex capabilities θ as follows:

BJ Size	100% Utilization of θ	90% Utilization of θ	Thus: $\theta/2$
1¼" and 1½"	30°	27.0°	±13.50°
¾", 1" and 2"	33°	29.7°	±14.85°
2½" and Larger	15°	13.5°	±6.75°

With Cold Positioning
(see Note 1)

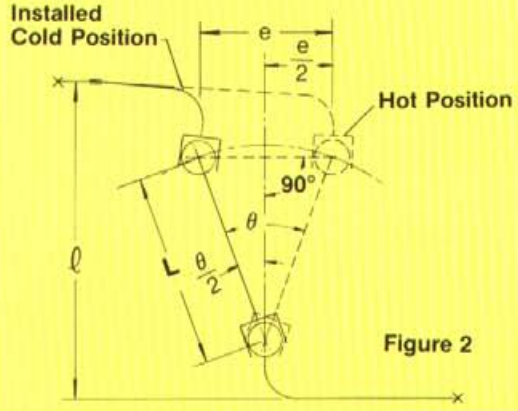


Figure 2

Without Cold Positioning
(see Note 1)

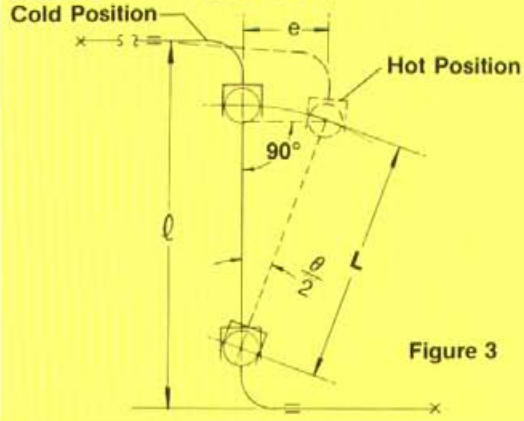


Figure 3

Following applicable to two-ball joint expansion links only.
Values of L and e in inches.

With Cold Positioning	Without Cold Positioning
$\text{SIN}\frac{\theta}{2} = \frac{e/2}{L}$ Or $L = \frac{e/2}{\text{SIN } \theta/2}$	$\text{SIN}\frac{\theta}{2} = \frac{e}{L}$ Or $L = \frac{e}{\text{SIN } \theta/2}$

1. Sizes 2½" and larger: $\theta/2 = \pm 6.75°$ SIN 6.75° = 0.1175
With Cold Positioning L = 4.25e **Without Cold Positioning L = 8.5e**
2. Sizes ¾", 1" and 2" only: $\theta/2 = \pm 14.85°$ SIN 14.85° = 0.2563
With Cold Positioning L = 1.95e **Without Cold Positioning L = 3.90e**
3. Sizes 1¼" and 1½": $\theta/2 = \pm 13.50°$ SIN 13.5° = 0.2334
With Cold Positioning L = 2.14e **Without Cold Positioning L = 4.28e**

Use the longest L dimension permissable within space available and good piping practice to reduce anchor loads and/or reactions on equipment.

Note: 1. Refer to Page 15 for information for installation with and without cold position.
2. Consult your nearest ATS Representative or Factory Direct for recommendations on Three-Ball Joint links.

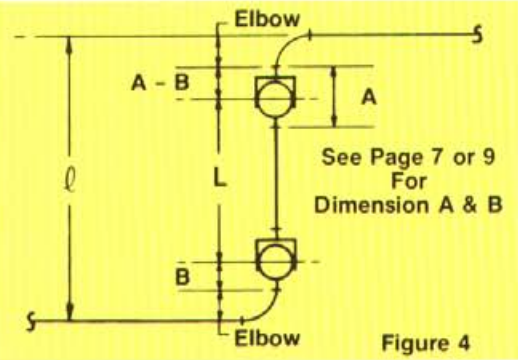


Figure 4

Where L dimension is known, the ℓ dimension is determined as follows:

ℓ = L + A + 2 elbows

Note: A = OAL of 1 Ball Joint as shown on Page 7 or 9.

Where ℓ is known, the L dimension is determined as follows:

L = ℓ -(A + 2 elbows)

Note: Short radius elbows = 1 NOM pipe diam.
Long radius elbows: 1½ NOM pipe diam.

Determination of Deflection "y"

In order for the expansion link to flex angularly in accommodating the pipe expansion, the adjacent piping must deflect by bending in a two ball joint system. The magnitude of this deflection is represented by the dimension y in Figure 5.

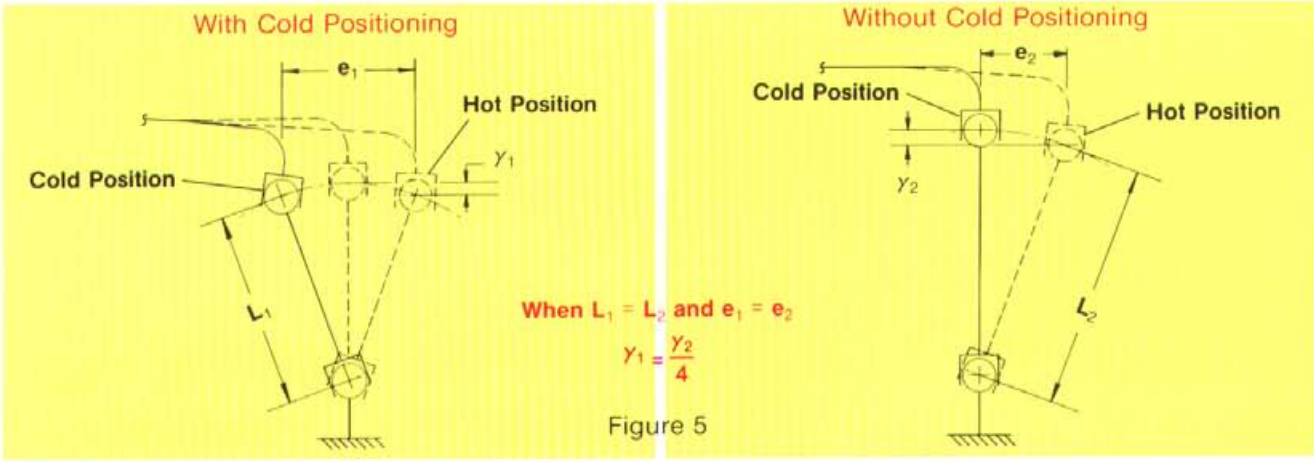


Figure 5

Based on the expansion e and the distance between ball centers L, the corresponding deflection y for a two-ball expansion link is given by:

With Cold Positioning $y_1 = L - \frac{1}{2}\sqrt{4L^2 - e^2}$ (Eqn. 1)

Without Cold Positioning $y_2 = L - \sqrt{L^2 - e^2}$ (Eqn. 2)

ALL VALUES OF y, L and e IN INCHES

Consideration should be given to the thermal growth of the expansion link (Distance between pipe centers) in determining the net deflection y of the adjacent piping.

Determination of Minimum Distance "X" to First Rigid Support

The expansion link, in flexing angularly, will deflect the pipe ends to which it is attached. The resulting bending stress of the deflected pipe must be limited by locating rigid supports **not less than a minimum distance** from the expansion link. Figure 6, case A-1, represents a situation which may be encountered when one end of an expansion link is attached to a relatively rigid support, such as a tank or turbine. Case A-2 represents a similar situation except pipe movement is encountered from two directions with a guide or anchor located at or near one elbow which in turn imposes a deflection only at the opposite elbow. Case B is representative of an expansion link installed for expansion absorbtion in a long run of pipe where both elbows are allowed to deflect.

The distance "X" may be greater to minimize pipe stress and reaction forces at supports. If space or other considerations do not permit this minimum distance to the fixed support, then consideration should be given to installation of a third Ball Joint in the long pipe run.

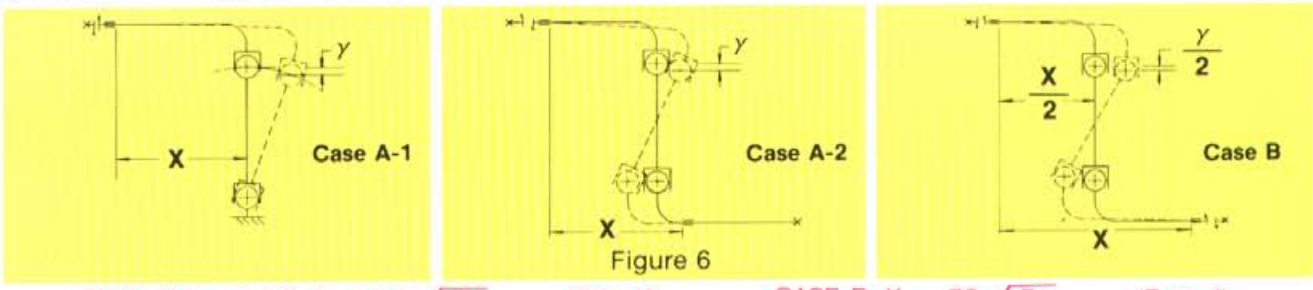


Figure 6

CASE A-1 and A-2: $X = 5.5\sqrt{Dy}$ (Eqn. 3) CASE B: $X = 7.8\sqrt{Dy}$ (Eqn. 4)

Where X = Minimum distance between rigid supports, ft.; D = Pipe outside diam., inches; y = Deflection, inches.

Equations 3 and 4 are based on a cantilever beam analogy free to rotate using a modulus of elasticity of 29,000,000 and an allowable stress in the pipe of 10,000 psi.

If the deflection of a two-joint expansion link system is too great and space or other factors do not permit increasing the link length "L" dimension, a third Ball Joint in the system should be considered. ATS's Engineering Department will provide recommendations for three-ball joint systems upon receipt of piping layout details and conditions. In addition to providing design service, including anchor calculations, support and guide recommendations, ATS will provide field inspection on request. Contact the nearest ATS Representative or FAX or write factory direct.

Positioning:

The ATS Ball Joint expansion link may be installed exactly perpendicular to the pipe run (see Fig. 7B). This type installation is said to be "without cold positioning." In this case, only half of the total flexibility of the joints is utilized; however, **it is not necessary to be concerned with contraction as a result of the operating temperature going below the installation temperature.**

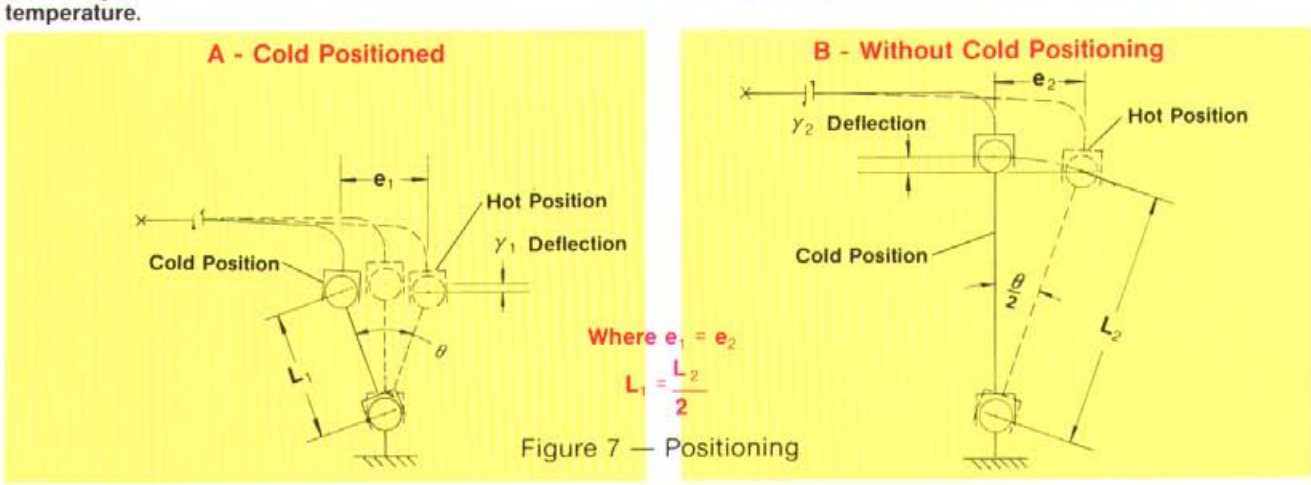


Figure 7 — Positioning

"Cold Positioning," i.e. prepositioning the link at installation with one-half the total expected expansion in the contracted position as in Fig. 7A results in utilization of twice the angular flex available without cold positioning.

The expansion need not be the same on both sides of the expansion link. For example, if the expansion of the pipe on one side of the link is 4 inches and on the other side 2 inches, the expansion link may be cold-positioned by one-half of the total or 3 inches as in Fig. 8.

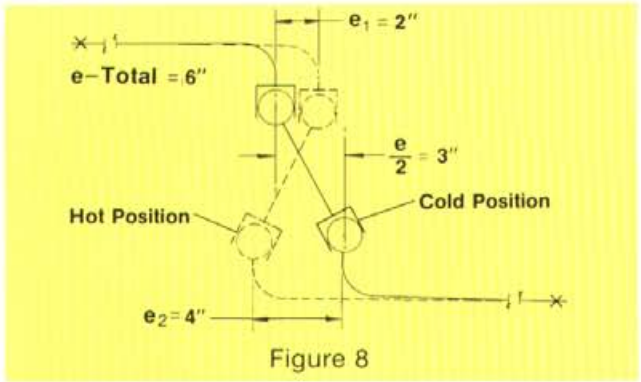


Figure 8

Example:

In a straight run of 6 inch steel piping 255 feet between anchors, it is desired to install a two-joint expansion link of **minimum length** to absorb thermal expansion. The operating temperature is to be 300°F. maximum with a minimum design temperature of 20°F. A pipe temperature of 90°F. is expected at installation. Determine proper positioning for maximum utilization of angular flex available.

Solution:

1. From Table 4, Page 12 obtain the unit expansion
   70°F. to 20°F, eu = -0.37"/100'
   70°F. to 300°F, eu = 1.84"/100'
   70°F. to 90°F, eu = .16"/100' (by interpolation)

   Net Unit Expansions Are:
   20°F. to 300°F. = 1.84 - (-0.37) = 2.21"/100'
   20°F. to 90°F. = .16 - (-0.37) = 0.53"/100'

   The Total Critical Expansion Will Be:

   $$e \text{ operating} = 20°F. \text{ to } 300°F. = 2.21 \times \frac{255}{100} = 5.64"$$

   $$e \text{ installation} = 20°F. \text{ to } 90°F. = 0.53 \times \frac{255}{100} = 1.35"$$

2. Since the 90°F. installation temperature is above the 20°F. minimum design temperature, the link must be positioned at installation to allow for contraction at the 20°F. minimum temperature (to allow for maximum utilization of total angular flex available). Also, the minimum offset requirements dictates cold positioning of the expansion link (minimum L = 4.25e or L = 4.25 x 5.64 = 24" or 2.0') — see NOTE below.

   The amount of cold positioning is the net of the following:

   $$\text{Cold Positioning} = \frac{e}{2} \text{ operating less } e \text{ installation}$$

   $$\text{Cold Positioning} = \frac{5.64}{2} - 1.35 = 1.47 \text{ (call } 1\tfrac{1}{2}\text{")}.$$

3. In making the installation at 90°F., the made-up link should be fabricated to Pipe A in Fig. 9 with the expansion link positioned at 90° to Pipe A, Pipe B should be cut 1½" short. The link should then be skewed around to close the gap and square the elbow with Pipe B. Needless to say, anchors in both lines A and B must first be installed. It will often be more convenient, especially in larger sizes, to leave the gap one or more pipe lengths away from Elbow B. Attach the length(s) of pipe to Elbow B and then pull the link with attached pipe into position and make the final weld in the line.

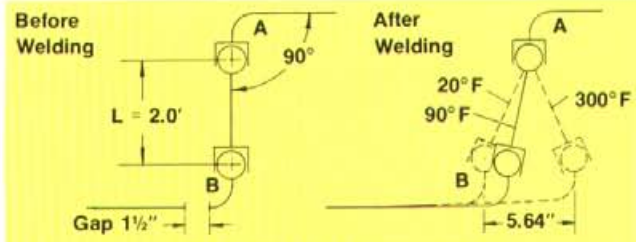


Figure 9 — Cold Positioning

NOTE: In all applications of Ball Joints the designer should always use the longest L dimension practicable within available space limits and good piping practice. A longer L dimension not only results in reducing the angular flex but also reduces anchor forces or reactions on equipment. Refer to Page 16 for Ball Joint Torque and anchor thrust load.

Ball Joint Torque "T" and Thrust Load (Force at Anchor) "F"

TABLE 5

2½" - 10"			12" - 30"		
Nom. Pipe Size (in.)	Steam Pressure (psig)	Typical Torque "T" (ft.-lbs.)	Nom. Pipe Size (in.)	Steam Pressure (psig)	Typical Torque "T" (ft.-lbs.)
2½	125	220	12	125	6,350
	250	250		250	7,900
3	125	310	14	125	9,600
	250	380		250	11,500
4	125	580	16	125	16,100
	250	700		250	19,300
5	125	840	18	125	21,100
	250	1050		250	25,300
6	125	1,800	20	125	26,000
	250	2,200		250	31,200
8	125	2,800	24	125	42,000
	250	3,450		250	49,000
10	125	4,800	30	125	80,000
	250	6,050		250	94,000

Flex torque values are based on a new Ball Joint. For design purposes a minimum safety factor of 50% is recommended.

The use of metal compression seals (Field 5, Page 19) will produce more constant Flex Torque values over the life of the piping system.

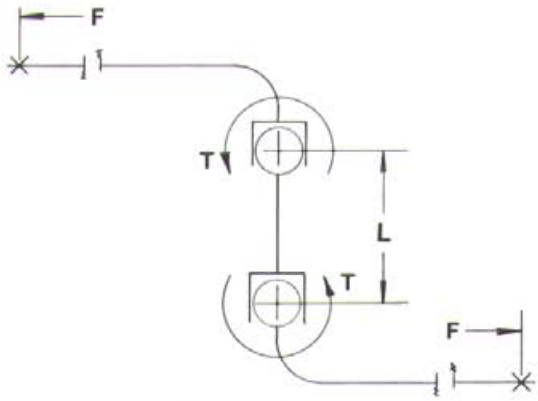


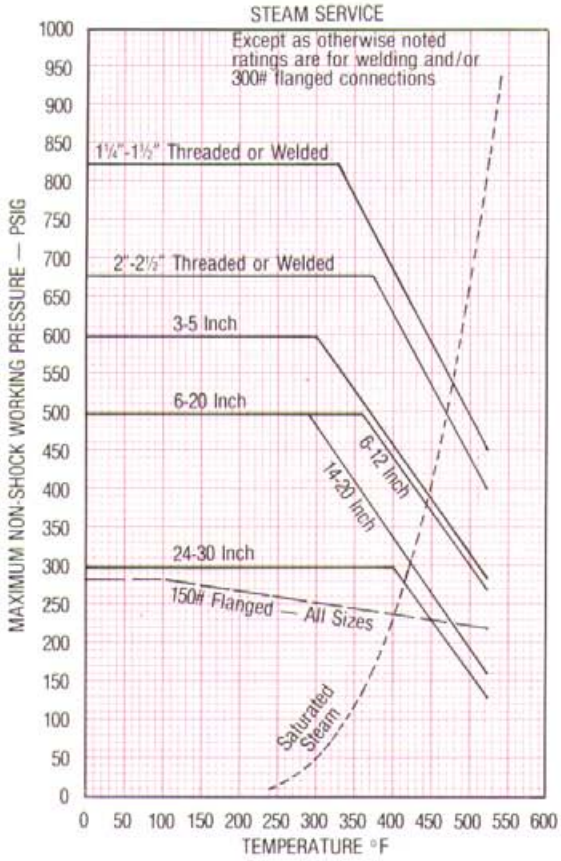
Figure 10 Anchor Thrust Load

$$F = \frac{2T}{L} \qquad \text{(Eqn. 5)}$$

Where:

F = Anchor Thrust Load (lbs.)
T = Ball Joint Torque (ft. lbs.)
L = Distance Between Ball Joint Centers (ft.)

Ball Joint Pressure-Temperature Ratings With Code 50 Compression Seals



Flex Torque Test Stand

Each ATS Series "P2" and "S2" Ball Joint is Flex Tested after completion of the assembly process. The ball joints are flexed through their full flex angle, and the force to move the ball is measured via a load cell and a digital readout and recorded. **Shown above is a 20" P2 Ball Joint on the test fixture.** This production test ensures every ball joint is properly packed and the flex torque values are within the established range.

High Performance
Series "P2" Specification Guide

( ): Insert as Required or Select one of Options Shown
Yellow: General Information — Do not include in Specification

1.0 General

1.1 Flexible Ball Joints shall be Advanced Thermal Systems, Thermal Pak Series "P2" with integral socket/retainer without bolting, Style (20, 30A, 30, 40). Ball Joints shall be factory charged with self-lubricating injectable packing and provide for 360° rotation and total angular flex of 30° for sizes ¾" to 1½", 33° for 2" size and 15° for sizes 2½" and larger (see Note).

2.0 Packing Cylinders

2.1 Heavy-Duty Type (A, B or C) Packing Cylinders having 1¾" minimum diameter to 4" BJ size and 2" minimum diameter for 5" and larger sizes and shall be designed with a discharge tip that provides a check valve effect to prevent blow-back when plunger is removed under full line pressure to 300 PSIG. For design pressure above 300 PSIG all Packing Cylinders shall be designed with an integral stainless steel safety valve for positive assurance from blow-back (also available for lower pressure where desirable).

2.2 The number of Packing Cylinders shall be as follows:

B.J. SIZE	QTY.
¾" to 3"	1
4" & 5"	2
6" & 8"	3
10" & 12"	4

B.J. SIZE	QTY.
14" & 16"	5
18" & 20"	8
24"	10
30"	12

3.0 Injectable Packing and Seals

3.1 The injectable packing shall be self-lubricating Type H Flake Graphite, HPI, to 800°F.

3.2 For each Packing Cylinder furnish a minimum of two spare injectable Packing Plugs ⅝" diameter by ⅞" long or packing plugs having an equivalent volume.

3.3 To prevent by-pass of the injectable packing, a pressure molded soft containment seal compatible with operating fluid pressure and temperature shall be placed at each side of the injectable packing zone adjacent to compression seals. Compression seals shall be ductile iron.

4.0 Materials

4.1 All pressure containing components shall be carbon steel meeting ASTM requirements as specified in section VIII of ASME Code and ANSI B31.1. Ball Sphere shall be Corro-Cote Plus plated - a duplex Chrome Plate consisting of one mil of Hard Chrome applied over one mil of Crack-Free Hard Chrome per ANSI B 650 Class 50 with thickness certified by Permascope Inspection per ASTM Standard B-499.

4.2 Ball Joint shall be designed for (specify fluid) at ( ) PSIG - ( )°F.

4.3 Sizes 2" and smaller shall have (threaded ends, ends beveled for welding to - specify wall thickness or pipe schedule).

4.4 Sizes 2½" and larger shall be furnished with (ends beveled for welding to - specify wall thickness or pipe schedule) or with (150 lb., 300 lb., or _____ lb.) ANSI forged steel flanges.

5.0 Testing

All Ball Joints shall be suitable for hydrostatic testing to 1.5 times design pressure.

6.0 Performance

Submittals with proposal and for approval shall include the manufacturer's published five year Warranty and Service Guarantee and a five year Leak-Free Warranty. (Leak-Free Warranty available only to 400 PSIG/800°F.)

NOTE:

For applications above 300 PSIG, include specification for one or more SAF-T-PACKERS (see Page 11).

High Performance
Series "S2" Specification Guide

( ): Insert as Required or Select one of Options Shown
Yellow: General Information — Do not include in Specification

1.0 General

1.1 Flexible Ball Joints shall be Advanced Thermal Systems, Thermal Pak Series "S2" with integral socket/retainer without bolting, Style (20, 30A, 30, 40). Ball Joints shall be factory charged with self-lubricating injectable packing and provide for 360° rotation and total angular flex of 30° for sizes ¾" to 1½", 33° for 2" size and 15° for sizes 2½" and larger.

2.0 Field Injection Connections

2.1 To contain leakage, if any, provide plugged half couplings about the Ball Joint Socket Centerline for engagement of threaded Type A Packing Cylinders which are employed to inject packing with system depressurized.

B.J. SIZE	NO. OF COU-PLINGS
¾" to 3"	2
4" & 5"	2
6" & 8"	3
10" & 12"	4

B.J. SIZE	NO. OF COU-PLINGS
14" & 16"	5
18" & 20"	8
24"	10
30"	12

2.2 A minimum of one (1) Type A Threaded Packing Cylinder with six (6) spare Packing Plugs shall be furnished for every ten (10) Ball Joints. Packing Plugs shall be ⅝" diameter by ⅞" long or packing plugs having an equivalent volume. Additional quantity of Type A Packing Cylinders and/or Packing Plugs will be furnished on specification.

3.0 Injectable Packing and Seals

3.1 The injectable packing shall be self-lubricating Type H Flake Graphite, HPI, to 800°F.

3.2 To prevent by-pass of the injectable packing, a pressure molded soft containment seal compatible with operating fluid pressure and temperature shall be placed at each side of the injectable packing zone adjacent to compression seals. Compression seals shall be ductile iron.

4.0 Materials

4.1 All pressure containing components shall be carbon steel meeting ASTM requirements as specified in section VIII of ASME Code and ANSI B31.1. Ball Sphere shall be Corro-Cote Plus plated - a duplex Chrome Plate consisting of one mil of Hard Chrome applied over one mil of Crack-Free Hard Chrome per ANSI B 650 Class 50 with thickness certified by Permascope Inspection per ASTM Standard B-499.

4.2 Ball Joint shall be designed for (specify fluid) at ( ) PSIG - ( )°F.

4.3 Sizes 2" and smaller shall have (threaded ends, ends beveled for welding to - specify wall thickness or pipe schedule).

4.4 Sizes 2½" and larger shall be furnished with (ends beveled for welding to - specify wall thickness or pipe schedule) or with (150 lb., 300 lb., or _____ lb.) ANSI forged steel flanges.

5.0 Testing

All Ball Joints shall be suitable for hydrostatically tested to 1.5 times design pressure.

6.0 Performance

Submittals with proposal and for approval shall include the manufacturer's published five year Warranty and Service Guarantee.

How To Order ATS Ball Joints

TO ORDER ATS BALL JOINTS:
State Fields 1 to 7 shown in Table 6 Below.

TABLE 6

Field	Item	Available	For More Data Refer To:
1	Pipe Size	¾" to 30"	Table 1, Pg. 5
2	Series	S, S1, S2, P1, P2	Table 1, Pg. 5 and Pgs. 6 & 8
3	End Preparation	Threaded, Weld, Flanged	Field 3 Below
4	Injectable packing/ Containment Seals	350H, 400H	Field 4 at Right
5	Compression Seal	See Table1, Page 4	Field 5 at Right
6	Style	20, 30A, 30, 40	Page 7 or 9
7	Type of Packing Cylinder	A, B, C	Table 3, Page 11

EXAMPLE:
10" Weld End Series P2, Style 20 Ball Joint for continuous operation at 300 PSIG Steam at 550° F. Designed for 400 PSIG/600° F.

10" - P2 - SWW - 400H - 70 - 20 - B

- Field 1, Pipe Size
- Field 2, Ball Joint Series
- Field 3, End Preparation
- Field 4; Containment Seals and Injectable Packing (OMIT for Series S)
- Field 5, Compression Seal Material
- Field 6, Ball Joint Style
- Field 7, Type of Packing Cylinder, Series P1 & P2 Only

FIELD 3: END PREPARATION

Code	Type
SWW	Standard Wall Weld Ends
EHW	Extra Strong Weld Ends
TT	Female Threaded (to 2" size only)
15F	150 lb. Flanged
30F	300 lb. Flanged
40F	400 lb. Flanged
XXX	Other and Combination - Specify for both Ball and Socket Ends

FIELD 4: CONTAINMENT SEALS AND INJECTABLE PACKING (OMIT for Series "S" Only)

Code	Containment Seals	Injectable Packing	Max. Continuous Temp °F	Max. Continuous Temp °C
350H	#350 Reinforced Graphite	Type H = HPI Flake Graphite	600	315
400H	#400 Reinforced Graphite	Type H = HPI Flake Graphite	800	427

FIELD 5: INNER AND OUTER COMPRESSION SEALS (ONLY for B.J. Series shown)

Code	Seal Material		Max. Temp. °F	Seals For B.J. Series				
	Inner Seal	Outer Seal		S	S1	P1	S2	P2
20	Glass Filled Teflon	Glass Filled Teflon	400	X				
50	Mineral Filled Composition	Mineral Filled Composition	525		X	X		
70	Ductile Iron	Ductile Iron	800		X	X	X	X
75	Mineral Filled Composition	Ductile Iron	525		X	X		
80	Aluminum Bronze	Aluminum Bronze	600		X	X	X	X
85	Mineral Filled Composition	Aluminum Bronze	525		X	X		
90	TO BE SPECIFIED	TO BE SPECIFIED	O/A					

NOTE:
To assure the proper selection of seals and/or injectable packing always specify the fluid to be transmitted plus design and operating pressure and temperature.

SPARE PARTS & ACCESSORIES

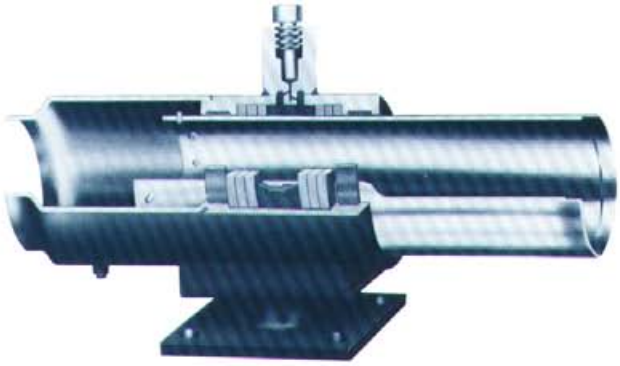
1. **Injectable Packing Plugs:**
   One or more tubes of spare injectable packing plugs are furnished with each Series "P1" and "P2" order. Type "H" Packing Plugs are available in tubes of six plugs per tube.

2. **Threaded Type "A" Packing Cylinder w/Plunger:**
   Threaded Type A Packing Cylinder with mating plunger is available for all sizes of Series S1 and S2 Ball Joints.

3. **Packing Cylinder Plunger Only:**
   Plungers for Type "A", "B" and "C" Packing Cylinders are interchangeable. Carbon Steel Plungers are furnished as standard but Aluminum Bronze Plungers are also available.

4. **Lubricant:**
   Threads of Packing Plunger must be lubricated with an anti-seize compound and the safety valve of Type B and C Packing Cylinders must be lubricated with a Molybdenum Disulfide dry film lubricant. Both are available from ATS.

Other ATS Products:



Thermal Pak Model TP2 packed Expansion Joint
5 YEAR LEAK-FREE WARRANTY FOR
APPLICATIONS TO 300 PSIG/800° F
Higher Pressures Available on Application

Fig. 101 — Graphite Guided Supports

Fig. 201 — Graphite Non-Guided Supports

Reusable, Removable and Resilient Insulation Blankets available for all sizes of ATS Flexible Ball Joints.
NOTE: Cutouts in Blanket provides ready access to Packing Cylinder of Series "P2" Ball Joint shown.

SERIES "P1" AND "P2"
5 YEAR WARRANTY and SERVICE GUARANTEE

• WARRANTY TERMS

Advanced Thermal Systems, Inc. Series "P1" and "P2" Flexible Ball 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 Series "P1" and "P2" Flexible Ball Joints for a period of five years from date of shipment, provided only, that the Ball Joints are installed, operated and serviced in accordance with ATS prescribed standards. ATS will either replace or repair, without charge, FOB ATS factory any Series "P1" and "P2" Flexible Ball Joint which fails to give five years' service under these prescribed conditions.

5 YEAR LEAK-FREE WARRANTY
FOR APPLICATIONS TO 400 PSIG/800° F

In the event of leakage in the series "P1" or "P2" Flexible Ball Joint, spare packing plugs will be furnished at no charge for a period of five years from the original date of shipment.