FLUID SEALING® ASSOCIATION FSA

Expansion Joints
PIPING

TECHNICAL HANDBOOK

general rubber

Compliments of General Rubber

8.0 EDITION

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FOREWORD

This handbook is a compilation of standards of construction and a guide for specifying and purchasing non-metallic expansion joints. The information set forth is based upon the substantial experience in research, design and application of rubber expansion joints by engineering personnel associated with the member companies of the Expansion Joints-Piping Division of the Fluid Sealing Association.

The purpose of this publication is to provide a handy reference source of pertinent information and factual data for the thousands of engineers whose daily concern is designing piping systems and overseeing installations. No portion of this handbook attempts to establish dictates in modern piping design. This handbook is widely used in customer inquiries as a reference for design and performance standards.

Neither the Association nor any of its members makes any warranty concerning the information or any statement set forth in this handbook, and both expressly disclaim any liability for incidental and consequential damages arising from damage to equipment, injury to persons or products, or any harmful consequences resulting from the use of the information or reliance on any statement set forth in the handbook.

Figure 1: Cross Sectional View Of Standard Spool "Arch" Type Expansion Joint

Careful selection of the expansion joint design and material for a given application, as well as properly engineered installation are important factors in determining performance. These factors should be fully evaluated by every person selecting and applying expansion joints for any application.

†Rubber expansion joints have been specified and used for many years by consulting engineers, mechanical contractors, pressure vessel designers, plant engineers and turn-key construction firms. They are installed to accommodate movement in piping runs, to protect piping from expansion and contraction and to insure efficient and economical on-stream operations.

Rubber expansion joints provide time-tested ways to accommodate pressure loads, relieve movement stresses, reduce noise, isolate vibration, compensate for misalignment after plants go on stream and prolong the life of motive equipment. Rubber expansion joints, designed by engineers and fabricated by skilled craftsmen, are used in all systems conveying fluids under pressure and/or vacuum at various temperatures:

- Air Conditioning, heating and ventilating systems* in commercial and institutional buildings, schools, apartments, stores, hospitals, motels, hotels and aboard ships
- Central and ancillary power-generating stations in communities, factories, buildings and aboard ships.
- Sewage disposal and water-treatment plants.
- Process piping in paper and pulp, chemical, primary metal and petroleum refining plants.

**ASHRAE Handbook and Product Directory, 1984 Systems, Chapter 32.*
†"Rubber" in this catalog refers to all types of elastomers, synthetic as well as natural rubber.

Product Description of Rubber Expansion Joints

A. DEFINITION:

A non-metallic expansion joint is a flexible connector fabricated of natural or synthetic elastomers, fluoroplastics and fabrics and, if necessary, metallic reinforcements to provide stress relief in piping systems due to thermal and mechanical vibration and/or movements.

Noteworthy performance features include flexibility and concurrent movements in either single or multiple arch type construction, isolation of vibration and noise, resistance to abrasion and chemical erosion.

B. FUNCTIONS:

Engineers can solve anticipated problems of vibration, noise, shock, corrosion, abrasion, stresses and space by incorporating rubber expansion joints into designed piping systems.

B.1. *Reduce Vibration.* Rubber expansion joints isolate or reduce vibration caused by equipment. Some equipment requires more vibration control than others. Reciprocating pumps and compressors, for example, generate greater unbalanced forces than centrifugal equipment. However, rubber pipe and expansion joints dampen undesirable disturbances including harmonic overtones and vibrations caused by centrifugal pump and fan blade frequency. This is based on actual tests conducted by a nationally recognized independent testing laboratory. Rubber expansion joints reduce transmission of vibration and protect equipment from the adverse effects of vibration.
See Appendixes F, G and Chapter VII, Section B.

B.2. *Dampen Sound Transmission.* Subsequent to going on stream, normal wear, corrosion, abrasion and erosion eventually bring about imbalance in motive equipment, generating undesirable noises transmitted to occupied areas. Rubber expansion joints tend to dampen transmission of sound because of the steel-rubber interface of joints and mating flanges. Thick-wall rubber expansion joints, compared with their metallic counterparts, reduce considerably the transmission of sound.
See Appendixes F, G and Chapter VII, Section B.

B.3. *Compensate Lateral, Torsional and Angular Movements.* Pumps, compressors, fans, piping and related equipment move out of alignment due to wear, load stresses, relaxation and settling of supporting foundations. Rubber expansion joints compensate for lateral, torsional and angular movements, preventing damage and undue downtime of plant operations.
See Tables V & VI and Chapter VII, Section. A.

B.4. *Compensate Axial Movements.* Expansion and contraction movements due to thermal changes or hydraulic surge effects are compensated for with strategically located rubber expansion joints. They act as helix springs, compensating for axial movements. *See Tables V & VI and Chapter VII, Section A.*

C. ADVANTAGES:

The industry has allied itself with designers, architects, contractors and erectors in designing and fabricating rubber expansion joints under rigid standards to meet present-day operating conditions. The industry has kept abreast of the technological advances in rubber compounding and synthetic fabrics to provide rubber expansion joints having advantages not available in other materials.

C.1. *Minimal Face-to-Face Dimensions.* Minimal face-to-face dimensions in rubber expansion joints offer untold economies, compared with costly expansion bends or loops. The relative cost of the pipe itself may be less or no more than a rubber expansion joint; however, total costs are higher when considering plant space, installation labor, supports and pressure drops.
See Tables V & VI.

C.2. *Lightweight.* Rubber expansion joints are relatively light in weight, requiring no special handling equipment to position, contributing to lower installation labor costs.

C.3. *Low Movement Forces Required.* The inherent flexibility of rubber expansion joints permits almost unlimited flexing to recover from imposed movements, requiring relatively less force to move, thus preventing damage to motion equipment. *See Tables V & VI.*

C.4. *Reduced Fatigue Factor.* Compared to steel, the inherent characteristics of natural and synthetic elastomers are not subject to fatigue breakdown or embrittlement and prevent any electrolytic action because of the steel-rubber interface of the joints and mating flanges. *See Table II.*

C.5. *Reduced Heat Loss.* Rubber expansion joints reduce heat loss, giving long maintenance-free service. The added piping required for loops, contribute to higher operating costs after going on stream due to an increase in heat losses.

C.6. *Corrosion, Erosion Resistant.* A wide variety of natural, synthetic and special purpose elastomers and fabrics are available to the industry. Materials are treated and combined to meet a wide range of practical pressure/temperature operating conditions, corrosive attack, abrasion and erosion. Standard and special sizes of rubber expansion joints are available with PTFE/TFE/FEP liners, fabricated to the configurations of the joint body, as added insurance against corrosive attack. Fluoroplastics possess unusual and unique characteristics of thermal stability, non-sticking surface, extremely low co-efficient of friction and resistance to practically all corrosive fluids and forms of chemical attack. *See Table II.*

C.7. *No Gaskets.* Elastomeric expansion joints are supplied with flanges of vulcanized rubber and fabric integrated with the tube, making the use of gaskets unnecessary. The sealing surfaces of the expansion joint equalize uneven surfaces of the pipe flange to provide a fluid and gas-tight seal. A ring gasket may be required for raised face flanges. Consult manufacturer about specific applications.

C.8. *Acoustical Impedance.* Elastomeric expansion joints significantly reduce noise transmission in piping systems because the elastomeric composition of the joint acts as a dampener that absorbs the greatest percentage of noise and vibration.
See Appendix F.

C.9. *Greater Shock Resistance.* The elastomeric type expansion joints provide good resistance against shock stress from excessive hydraulic surge, water hammer or pump cavitation.

Table I: Maximum Temperature Ratings

Reinforcing Fabric	Tube or Cover Elastomer						
	Pure Gum Rubber	Neoprene	Butyl	Nitrile	CSM	EPDM	FKM
Nylon	180°F/ 82°C	225°F/ 107°C	250°F/ 121°C	210°F/ 99°C	250°F/ 121°C	250°F/ 121°C	250°F/ 121°C
Polyester	180°F/ 82°C	225°F/ 107°C	250°F/ 121°C	210°F/ 99°C	250°F/ 121°C	250°F/ 121°C	250°F/ 121°C
Aramid	180°F/ 82°C	225°F/ 107°C	300°F/ 149°C	210°F/ 99°C	250°F/ 121°C	300°F/ 149°C	400°F/ 204°C

Note: Temperatures listed above are the typical maximum degree ratings for continuous use. All fabrics lose a percentage of their strength in relation to exposure temperature and duration. That being said, higher operating temperatures may be achieved if operation pressures are reduced and sound engineering practices are used during the design and manufacturer of a product.

D. CONSTRUCTION DETAILS:

D.1. *Tube.* A protective, leak-proof lining made of synthetic or natural rubber as the service dictates. This is a seamless tube that extends through the bore to the outside edges of the flanges. Its purpose is to eliminate the possibility of the materials being handled penetrating the carcass and weakening the fabric. These tubes can be designed to cover service conditions for chemical, petroleum, sewage, gaseous and abrasive materials. *See Tables I and II, and Figure 1.*

D.2. *Cover.* The exterior surface of the joint is formed from natural or synthetic rubber, depending on service requirements. The prime function of the cover is to protect the carcass from outside damage or abuse. Special polymers can be supplied to resist chemicals, oils, sunlight, acid fumes and ozone. Also, a protective coating may be applied to the exterior of the joint for additional protection. *See Tables I and II, and Figure 1.*

D.3. *Carcass.* The carcass or body of the expansion joint consists of fabric and, when necessary, metal reinforcement.

D.3.A. *Fabric Reinforcement.* The carcass fabric reinforcement is the flexible and supporting member between the tube and cover. Standard constructions normally utilize high quality synthetic fabric. Natural fabrics can also be used at some pressures and temperatures. All fabric plies are impregnated with rubber or synthetic compounds to permit flexibility between the fabric plies. *See Table 1 and Figure 1.*

D.3.B. *Metal Reinforcement.* Wire or solid steel rings embedded in the carcass are frequently used as strengthening members of the joint. The use of metal sometimes raises the rated working pressure and can supply rigidity to the joint for vacuum service. *See Table IV and Figure 1.*

TABLE II: List of Elastomers Used in Expansion Joints and Rubber Pipes

MATERIAL DESIGNATION		RATING SCALE CODE	ELASTOMER PHYSICAL AND CHEMICAL PROPERTIES COMPARISON							
ANSI/ASTM D1418-77	ASTM-D-2000 D1418-77	7-Outstanding 3-Fair to good 6-Excellent 2-Fair 5-Very Good 1-Poor to Fair 4-Good 0-Poor X-Contact Mfg. COMMON NAME CHEMICAL GROUP NAME	ALKALI, CONC. ANIMAL VEG. OIL CHEMICAL WATER	OXYGENATED HYDRO. LACQUERS OIL & GASOLINE ALKALI, DILUTE	ACID DILUTE ACID, CONC. ALPHATIC HYDRO AROMATIC HYDRO	ELE. INSULATION WATER ABSORP RADIATION SWELLING IN OIL	TENSILE STRENGTH DIELECTRIC STR.	REBOUND-COLD COMP. SET REBOUND-HOT	ABRASION IMPERMEABILITY DYNAMIC	HEAT COLD FLAME TEAR	OZONE WEATHER SUNLIGHT OXIDATION
CR	BC BE	**NEOPRENE** CHLOROPRENE	4340	4401	2346	4543	5424	5245	4444	5565
NR	AA	**GUM RUBBER** POLYISOPRENE, SYNTHETIC	53XX	X004	0033	0655	6646	6627	5052	4020
IR	AA	**NATURAL RUBBER** POLYISOPRENE, SYNTHETIC	53XX	X004	0033	0655	6646	6226	5052	4020
IIR	AA	**BUTYL** ISOBUTENE-ISOPRENE	5654	4034	0046	0455	5430	5264	4045	6556
CIIR	AA BA	**CHLOROBUTYL** CHLORO-ISOBUTENE-ISOPRENE	5654	4034	0046	0455	5430	5264	4045	6556
NBR	BE BK CH	**BUNA-N/NITRILE** NITRIL-BUTADIENE	4350	4520	4644	5541	0554	4544	3034	4022
SBR	AA	**SBR/GRS/BUNA-S** STYRENE-BUTADIENE	53X2	4004	0033	0655	4544	4425	3053	2020
CSM	CE	**CSM** CHLORO-SULFONYL-POLYETHYLENE	5644	4431	2346	4543	5222	4244	3444	6767
FKM	HK	FLUOROCARBON ELASTOMER	5660	4610	6665	6553	5562	4555	2627	7777
EPR	BA CA DA	**EPDM** ETHYLENE-PROPYLENE-DIENE-TERPOLYMER	5656	6036	0046	0766	7546	6545	4056	6767
AFMU		**PTFE/TFE/FEP** FLUORO-ETHYLENE-POLYYMERS	7777	7777	7777	737X	XXXX	XXX4	XXX7	7777
SI	GE	**SILICONE**	5550	2X02	0026	2566	4036	6020	2267	6666

A. "ARCH" TYPE:

A full face integral flange design is available in both Single Arch and Multiple Arch Types. These basic types can be manufactured to meet the requirements of ASTM F1123-87 (Note: The U.S. Navy previously used MIL-E-15330D, Class A-Type I as its standard specification, but has adopted the ASTM Specification.) These types are available in several construction design series, based on the application pressure requirements. *See Table IV.*

A.1. *Single Narrow Arch Type.* Construction is of fabric and rubber, reinforced with metal rings or wire. The full face flanges are integral with the body of the joint and drilled to conform to the bolt pattern of the companion metal flanges of the pipeline. This type of rubber face flange is of sufficient thickness to form a tight seal against the metal flanges without the use of gaskets. The shortest face-to-face dimensions are available with this type of construction. **See Table V and Figure 2A.**

Figure 2A: Single Narrow Arch Type Expansion Joint

A.2. *Multiple Arch Type.* Joints with two or more arches may be manufactured to accommodate movements greater than those of which a Single Arch Type joint is capable. Multiple Arch joints of most manufacturers are composites of standard sized arches and are capable of movements of a single arch multiplied by the number of arches. *See Figure 2B.* The minimum length of the joint is dependent upon the number of arches. In order to maintain lateral stability and prevent sagging when the joint is installed in a horizontal position, a maximum number of four (4) arches is recommended. *See Table V, Note 3.*

Figure 2B: Multiple Arch Type Expansion Joint

A.3. *Lightweight Type.* Both the Single Arch and Multiple Arch Types are available in a lightweight series from most manufacturers. Dimensionally the same as the standard product, except for reduced body thickness, this series is designed for lower pressure and vacuum applications. For a No-Arch design see Section H.3, this chapter. Contact the manufacturer for specific information.

A.4. *PTFE Lined.* Spool Arch Type joints are available in many standard pipe sizes with Fluoroplastic liners of TFE and/or FEP. These liners are fabricated as an integral part of the expansion joint during manufacture and cover all wetted surfaces in the tube and flange areas. Fluoroplastic provides exceptional resistance to almost all chemicals within the temperature range of the expansion joint body construction. Filled arches are not available.

A.5. *Wide Arch Type:* This type, similar to the Narrow "Arch" Type, is available in a metallic reinforced and a non-metallic reinforced design. Generally, the Wide Arch Type features greater movements than the Standard Spool "Arch" Type. *See Table VI.*

A.5.A *Non-metallic Reinforced Design.* Constructed similar to the Spool "Arch" Type except the carcass does not contain wire or metal ring reinforcement. Pressure resistance is accomplished through the use of special external flanged retaining rings furnished with the joint. Available also in a "Filled Arch" design. *See Figure 2C.*

Figure 2C: Wide Arch Non-Metallic Reinforced Type Expansion Joint

A.5.B. *Metallic Reinforced Design.* A molded version of the Spool "Arch" Type utilizing solid steel rings in a carcass, at the base of the arch. The reduced body thickness requires special retaining rings available from the manufacturer. *See Figure 2D.*

Figure 2D: Molded Wide Arch Metallic Reinforced Type Expansion Joint

B. REDUCER TYPE: "TAPER":

Reducing expansion joints are used to connect piping of unequal diameters. They may be manufactured as a concentric reducer with the axis of each end concentric with each other or as an eccentric reducer having the axis of each end offset from each other. Tapers in excess of 20 degrees are not desirable. Recommendations concerning the degree of taper and working pressures should be obtained from the manufacturer of your choice. Normally, pressures are based on the larger of the two inside dimensions. Available with or without arches. ***See Figures 2E and 2F.***

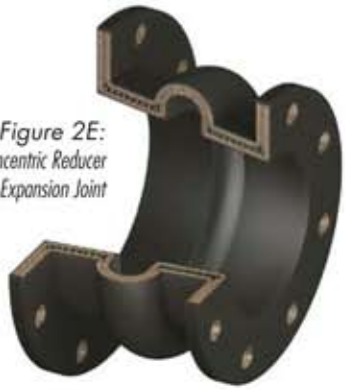

Figure 2E:
Concentric Reducer Type Expansion Joint

Figure 2F:
Eccentric Reducer Type Expansion Joint

C. CUSTOM TYPE:

Offset joints are custom built to specifications to compensate for initial misalignment and non-parallelism of the axis of the piping to be connected. Offset joints are sometimes used in close quarters where available space makes it impractical to correct misalignment with conventional piping. Generally, the industry follows the practice of drilling flanges according to pipe size of flanges when not specified otherwise. It is recommended that complete drawings and specifications accompany inquiries or orders for offset joints. ***See Figure 2G.***

Figure 2G:
Custom Type Expansion Joint

D. SLEEVE TYPE:

A sleeve design is available in both single and multiple arch types. Both types are available in several design constructions, based on the application pressure and flexibility requirements. Contact the manufacturer for movement and pressure limitations and type of sleeve ends required.

D.1. *Sleeved Arch Type.* This joint is similar to the "Arch" Type ***(See Figures 2A and 2B)*** except that the capped sleeve ends have an I.D. dimension equal to the O.D. of the pipe. These joints are designed to slip over the straight ends of the open pipe and be held securely in place with clamps. This type of joint is recommended only for low to medium pressure and vacuum service because of the difficulty of obtaining adequate clamp sealing. ***See Figure 2H.***

Figure 2H:
Sleeve Type Expansion Joint

D.2. *Lightweight Type.* Dimensionally the same as the sleeve "Spool Type", except for reduced body thickness. This series is designed for very low pressure and vacuum applications. Joints are available in single and multiple arch types. Consult the manufacturer for the types of clamps available for sealing. This type generally offers greater flexibility than the spool type.

D.3. *Enlarged End Type.* This joint can be manufactured in the same design as the spool type and lightweight type. The sleeve ends on this design are the same dimension as the O.D. of the pipe, while the rest of the joint is the same as the I.D. of the pipe.

E. SPECIAL FLANGE TYPE:

Most of the expansion joint types depicted in this chapter are available with modifications to the flanges. These modifications include enlarged flanges, different drill patterns and weld-end stubs.

E.1. *Enlarged Flange Type.* Expansion joints utilizing a full face integral flange design can be furnished with an enlarged flange on one end. (For example, an 8" (203 mm) expansion joint can be fabricated with a flange to mate to an 8" (203 mm) pipe flange on one end; and a 12" (305 mm) flange on the other end to mate to a 12" (304 mm) pipe flange.) Additionally, drilling of different specifications may be furnished. For example, an expansion joint can be furnished with one end drilled to ANSI B16.5, Class 150, and the other end drilled to MIL-F-20042C. ***See Figure 2I.***
Note: Special control rods will be required when needed.

Figure 2I:
Enlarged Flange Type Expansion Joint

E.2. *Weld-End Type.* Several manufacturers offer an expansion joint with weld-end nipples which allow the unit to be directly welded into place on the job or welded to associated equipment before final installation. The design is basically the Sleeve Type expansion joint bonded to matching steel weld-end nipples. Normally, there are steel band clamps around the periphery of the rubber sleeve end to reinforce the rubber-metal bond.

F. DESIGNS FOR REDUCTION OF TURBULENCE AND ABRASION:

The open-arch design of the Standard Spool Type Expansion Joint may be modified to reduce possible turbulence and to prevent the collection of solid materials that may settle from the solution handled and remain in the archway.

F.1. *Filled Arch Type.* Arch-type expansion joints may be supplied with a bonded-in-place soft rubber filler to provide a smooth interior bore. Filled arch joints also have a seamless tube so the arch filler cannot be dislodged during service. Filled arches, built as an integral part of the carcass, decrease the flexibility of the joint and should be used only when necessary. Movements of expansion joints with filled arches are limited to 50% of the normal movements of comparable size expansion joints with unfilled (open) arches.
See Tables V & VI and Figure 2J.

Figure 2J:
Single Arch Type Expansion Joint with Filled Arch

F.2. *"Top Hat" Liner.* This product consists of a sleeve extending through the bore of the expansion joint with a full face flange on one end. Constructed of hard rubber, metal or Fluoroplastic; it reduces frictional wear of the expansion joint and provides smooth flow, reducing turbulence. This type of sleeve should not be used where high viscosity fluids, such as tars, are being transmitted. These fluids may cause "packing-up or caking" of the open arch or arches, which reduces movements and in turn may cause premature expansion joint failure. Baffles are rarely required on rubber expansion joints. *See Figure 2K.*

Figure 2K:
Top Hat Liner

G. RECTANGULAR WITH ARCH TYPE:

A custom made flexible connector for use with rectangular flanges on low pressure service. The arch design accommodates greater movement than the "U" type joint.
See Figure 2L

Figure 2L:
Arch Type Rectangular

H. "U" TYPE:

"U" type joints are available for low pressure applications in external and internal flange design and for higher pressure service in a no-arch modification of the single arch type.

H.1. *External Full Face Integral Flange Turbine to Condenser.* This lightweight custom-made flexible joint is generally used between a turbine and condenser. It is constructed of plies of rubber and fabric usually without metal reinforcement. The joint is recommended for full vacuum service or a maximum pressure of 25 PSIG (172 kPa). Flange drilling may be staggered to facilitate installation and tightening of bolts. The joint is securely bolted in place with conventional retaining rings for vacuum service or special support rings for pressure service. The joint may be rectangular, round or oval in shape.
See Figure 2M.

Figure 2M:
External Flange Type "U" Connector

H.2. *Internal Full Face Integral Flange Turbine to Condenser.* This joint is similar to the external flange joint except that conventional retaining rings are used for pressure service and special support rings are used for vacuum service. The joint may be rectangular, round or oval in shape. *See Figure 2N* which depicts a rectangular version with special support rings. Based on installation, field splicing may be necessary.

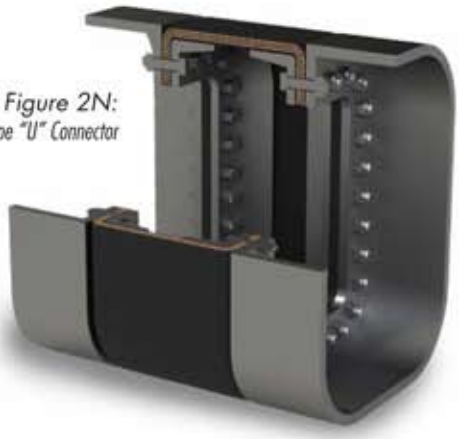

Figure 2N:
Internal Flange Type "U" Connector

H.3. *No Arch "U" Type.* The construction of this joint is similar to the Single Arch Type, except modified to eliminate the arch. This connector will absorb vibration and sound. A reducer version is shown in Figure 2D.
See Table II for pressures and Figure 2O. For alternate designs, see Chapter V.

Figure 2O:
No-Arch "U" Type Connector

I. BELT "DOGBONE" TYPE:

The belt type or "Dogbone" expansion joint is a commonly specified flexible connection used exclusively in power generating stations, to isolate low pressure steam turbines from condensers. Forming a continuous loop around the connecting ductwork, the Dogbone allows for compressive and lateral movements of the two components, as the equipment heats and expands during operation.

It is initially furnished with specially machined steel clamping fixtures, as a component of the condenser. It is designed to operate under full vacuum and at temperatures up to 250 F. Future replacement typically involves changing of the rubber element only.

Construction of the flexible element, consists of laminated fabric plies, tied to a solid bulb core, all bonded and covered in elastomer and then compression molded. Although different elastomers and fabrics are available for variable operating conditions, the application of neoprene and nylon has proven to be the most reliable and enduring combination. It is best to consult with knowledgeable and experienced manufacturers to specify the most superior materials, whether it is new construction or replacement. As a critical element whose failure will shut down a power plant, careful consideration should be given to specifying high grade materials, with built in safety and reliability features.

All Dogbone joints will require a splice to make endless, at some point. Except in unusual circumstances, only one splice per joint is necessary. For new construction, most Dogbones can be supplied with a factory splice. Subsequent replacements, most often require a field splice, due to added interference within the condenser. In any case, splicing should be done by skilled technicians that work directly for, or are approved by the manufacturer. This insures compatibility of the materials and provides a complete warranty, for the entire expansion joint. ***See Figure 2S.***

Figure 2S:
Belt Type Expansion Joint

J. SPHERICAL TYPE:

The design incorporates a long radius arch, providing additional movement capabilities when compared to other types. The arch is self-cleaning, eliminating the need of Filled Arch Type construction. ***See Chapter III for Spherical Floating Flange design.***

J.1. *Integral Flange Spherical Type.* Basically the same design as the Floating Flange Spherical Type ***(See Chapter III)***, except full face flanges are integral with the body of the joint. Pressure-resisting hoop strength is a function of the special weave fabric and its ply placement in the body, as well as the design of the retaining rings. Special retaining rings are sometimes required. Contact the manufacturer for pressure and movement rating. ***See Figure 2R.***

Figure 2R:
Spherical Type Expansion Joint with Integral Flanges

K. FAN CONNECTORS:

Industrial fans and their related ducting frequently require a flexible connector to absorb vibration, reduce noise and provide an easy access to fans when overhaul or cleaning is required. Elastomeric fan connectors have a lighter body and flanges designed to match the specific fan design. Usually their pressure and vacuum ratings are approximately ± 2 PSIG (14 kPa) to match the service. Face-to-face dimension as short as 2-1/2" (63mm) are available. Slip-over fan connectors are also frequently specified. ***See Figure 2T.***

Figure 2T:
Rectangular Fan Connector

L. HINGED TYPE:

Hinged type rubber expansion joints are designed to permit angular rotation in one plane. The arrangement consists of a pair of hinge plates connected with pins and attached to the expansion joints' external or internal hardware. The hinge assembly must be designed for the internal pressure thrust forces of the system. Hinged type rubber expansion joints can be used in sets of two or three to absorb lateral movement in one plane. *See Figure 2U.*

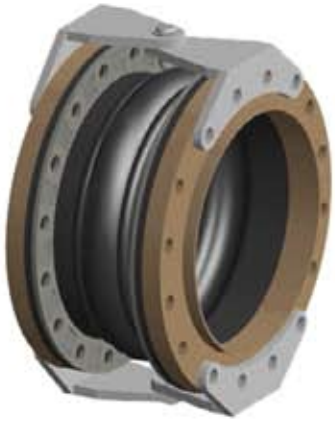

Figure 2U:
Hinged Type Joint

M. GIMBAL TYPE:

Gimbal type rubber expansion joints are designed to permit angular rotation in multiple planes. The arrangement consists of two pairs of hinge plates connected with pins to a common gimbal ring and attached to the expansion joints' external or internal hardware. The gimbal assembly must be designed for the internal pressure thrust forces of the system. Gimbal type rubber expansion joints can be used in sets of two, or sets of two with a single hinge type joint to absorb lateral movement in multiple planes. *See Figure 2V.*

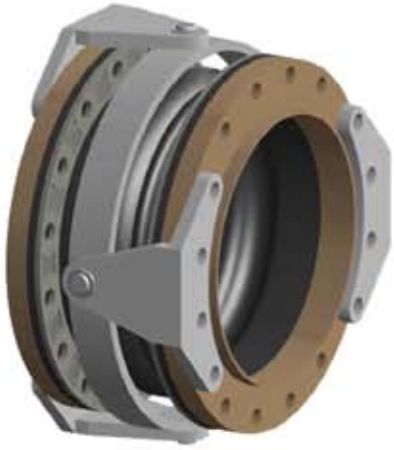

Figure 2V:
Gimbal Type Joint

N. UNIVERSAL TYPE:

Universal type rubber expansion joints are designed to permit extension, compression, lateral and angular movements. The arrangement consists of two rubber expansion joints connected by a center spool with restraint hardware.
See Figure 2W.

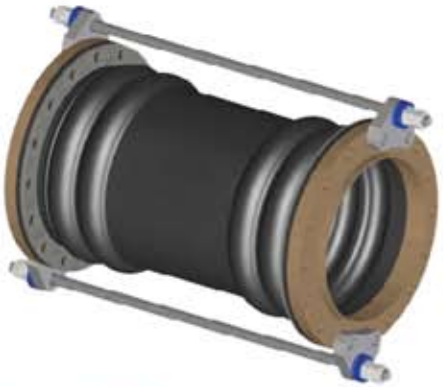

Figure 2W:
Universal Type Joint

O. PRESSURE BALANCED:

Pressure Balanced type rubber expansion joints are designed to absorb compression, lateral and angular movements while restraining the pressure thrust force. The arrangement consists of two or three rubber expansion joints and interconnecting hardware, attached to the external or internal interconnecting hardware.

O.1. *In-line Configuration Type.* This configuration is designed to function in a straight pipeline with no provision for anchors. The balancing rubber expansion joint needs to be twice the effective area as the main rubber expansion joint.
See Figure 2X.

Figure 2X:
In-Line Pressure Balanced Joint

O.2. *Elbow Configuration Type.* This configuration is designed to function with incorporation of an elbow. The balancing rubber expansion joint can be the same effective area as the main rubber expansion joint. *See Figure 2Y.*

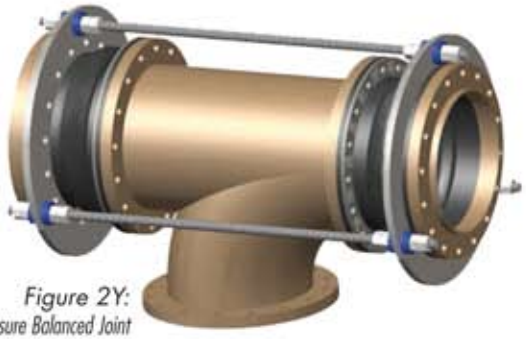

Figure 2Y:
Elbow Pressure Balanced Joint

Table V: Typical Narrow Arch Expansion Joint Movement/Spring Rate Capabilities

Nominal Pipe Size Expansion Joint		Nominal Face-to-Face Minimum Length		MOVEMENTS								SPRING RATES							
				AXIAL COMPRESSION		AXIAL EXTENSION		LATERAL DEFLECTION		DEGREES OF ANGULAR MOVEMENT	DEGREES OF TORSIONAL MOVEMENT	AXIAL COMPRESSION		AXIAL EXTENSION		LATERAL DEFLECTION		ANGULAR MOVEMENT	
in	mm	in	mm	in	mm	in	mm	in	mm			lbs/in	N/mm	lbs/in	N/mm	lbs/in	N/mm	ft-lbs/ deg	Nm/deg
1*	25	6	150	7/16	11	1/4	6	1/2	13	27.5	3	235	41	304	53	350	61	.04	.05
1-1/4*	32	6	150	7/16	11	1/4	6	1/2	13	22.5	3	294	51	383	67	438	77	.10	.13
1-1/2*	40	6	150	7/16	11	1/4	6	1/2	13	18.5	3	353	62	459	80	524	92	.15	.20
2	50	6	150	7/16	11	1/4	6	1/2	13	14.5	3	423	74	552	97	700	123	.30	.41
2-1/2	65	6	150	7/16	11	1/4	6	1/2	13	11.5	3	530	93	689	121	762	133	.50	.68
3	75	6	150	7/16	11	1/4	6	1/2	13	10.0	3	635	111	828	145	824	144	.80	1.10
3-1/2	88	6	150	7/16	11	1/4	6	1/2	13	8.3	3	742	130	965	169	888	155	1.3	1.8
4	100	6	150	7/16	11	1/4	6	1/2	13	7.5	3	848	148	1104	193	952	167	1.9	2.6
5	125	6	150	7/16	11	1/4	6	1/2	13	6.0	3	1058	185	1376	241	1092	191	3.7	5.0
6	150	6	150	7/16	11	1/4	6	1/2	13	5.0	3	1271	223	1652	289	1234	216	6.4	8.7
8	200	6	150	11/16	18	3/8	10	1/2	13	5.5	3	1412	247	1837	322	1506	264	12.7	17.2
10	250	8	200	11/16	18	3/8	10	1/2	13	4.5	3	1766	309	2296	402	1618	283	24.2	32.8
12	300	8	200	11/16	18	3/8	10	1/2	13	3.75	3	2118	371	2755	482	1896	332	42.1	57.1
14	350	8	200	11/16	18	3/8	10	1/2	13	3.25	2	1853	325	2411	422	2234	391	19.2	80.3
16	400	8	200	11/16	18	3/8	10	1/2	13	2.75	2	2118	371	2755	482	2572	450	76	103
18	450	8	200	11/16	18	3/8	10	1/2	13	2.5	1	2382	417	3101	543	2840	497	106	144
20	500	8	200	13/16	21	7/16	11	1/2	13	2.5	1	2649	464	3440	602	3176	556	152	206
22	550	10	250	13/16	21	7/16	11	1/2	13	2.25	1	2913	510	3785	663	3296	577	205	278
24	600	10	250	13/16	21	7/16	11	1/2	13	2.0	1	3178	557	4130	723	3412	597	274	371
26	650	10	250	15/16	24	1/2	13	1/2	13	2.3	1	3060	536	3980	697	3658	641	292	396
28	700	10	250	15/16	24	1/2	13	1/2	13	2.0	1	3296	577	4286	751	3904	684	382	518
30	750	10	250	15/16	24	1/2	13	1/2	13	2.0	1	3532	619	4594	804	4150	727	437	592
32	800	10	250	15/16	24	1/2	13	1/2	13	1.8	1	3769	660	4899	858	4876	854	555	752
34	850	10	250	15/16	24	1/2	13	1/2	13	1.75	1	4002	701	5602	981	5602	981	645	874
36	900	10	250	15/16	24	1/2	13	1/2	13	1.5	1	4238	742	5512	965	6328	1108	844	1144
38	950	10	250	15/16	24	1/2	13	1/2	13	1.5	1	4475	784	5818	1019	6502	1139	943	1278
40	1000	10	250	15/16	24	1/2	13	1/2	13	1.5	1	4708	824	6124	1072	6676	1169	1042	1413
42	1050	12	300	1-1/16	27	9/16	14	1/2	13	1.5	1	4452	780	5783	1013	6846	1199	1163	1577
44	1100	12	300	1-1/16	27	9/16	14	1/2	13	1.5	1	4664	817	6057	1061	7142	1251	1270	1722
46	1150	12	300	1-1/16	27	9/16	14	1/2	13	1.3	1	4870	853	6339	1110	7436	1302	1680	2278
48	1200	12	300	1-1/16	27	9/16	14	1/2	13	1.25	1	5087	891	6608	1157	7732	1354	1825	2474
50	1250	12	300	1-1/16	27	9/16	14	1/2	13	1.25	1	5300	928	6884	1206	8024	1405	1968	2668
52	1300	12	300	1-1/16	27	9/16	14	1/2	13	1.25	1	5512	965	7166	1255	8314	1456	2138	2899
54	1350	12	300	1-1/16	27	9/16	14	1/2	13	1.25	1	5724	1002	7435	1302	8606	1507	2308	3129
56	1400	12	300	1-1/16	27	9/16	14	1/2	13	1.25	1	5936	1039	7717	1351	8896	1558	2464	3341
58	1450	12	300	1-1/16	27	9/16	14	1/2	13	1.0	1	6148	1076	7992	1400	9184	1608	3310	4488
60	1500	12	300	1-1/16	27	9/16	14	1/2	13	1.0	.5	6360	1114	8268	1448	9472	1659	3537	4795
66	1650	12	300	1-1/16	27	9/16	14	1/2	13	1.0	.5	6996	1225	9095	1593	10216	1789	4288	5813
72	1800	12	300	1-1/16	27	9/16	14	1/2	13	0.9	.5	7632	1337	9922	1738	10954	1918	5681	7702
78	1950	12	300	1-1/16	27	9/16	14	1/2	13	0.9	.5	8268	1448	10748	1882	11902	2084	7022	9520
84	2100	12	300	1-1/16	27	9/16	14	1/2	13	0.8	.5	8904	1559	11575	2027	12850	2250	8641	11715
96	2400	12	300	1-1/16	27	9/16	14	1/2	13	0.70	.5	10176	1782	13228	2317	14750	2538	13441	18223
102	2550	12	300	1-1/16	27	9/16	14	1/2	13	0.66	.5	10812	1893	14056	2462	15700	2749	16967	23003
108	2700	12	300	1-1/16	27	9/16	14	1/2	13	0.62	.5	11448	2005	14883	2606	16652	2916	21855	29630
120	3000	12	300	1-1/16	27	9/16	14	1/2	13	0.56	.5	12720	2228	16537	2896	18550	3249	29871	40498
132	3300	12	300	1-1/16	27	9/16	14	1/2	13	0.51	.5	13992	2450	18190	3185	20288	3553	33547	45481
144	3600	12	300	1-1/16	27	9/16	14	1/2	13	0.47	.5	15264	2673	19843	3475	22026	2857	42902	58164

**Items are normally furnished with "Filled Arch" construction.*

NOTES:

A. MOVEMENT CAPABILITY

1. *"Filled Arch" construction reduces above movement by 50%.*
2. *The degree of Angular Movement is based on the maximum extension shown.*
3. *If greater movements are desired, expansion joints can be supplied with two, three or four arches. Relatively longer "Face-to-Face" length dimensions are incorporated into designs of Multiple Arch Type expansion joints.*
4. *To calculate approximate movement of Multiple Arch expansion joints, take the movement shown in the above table and multiply by the number of arches.*
5. *Movements shown above are based on proper installation practice. (See Chapter VIII, Section D).*

B. SPRING RATE

1. *Forces required to move expansion joints are based on zero pressure conditions and room temperature in the pipe line.*
2. *These forces should be considered only as approximates which may vary with the elastomers and fabrics used in fabrication and the specific construction design of an individual manufacturer.*
3. *See Chapter III, Section F for definition of values shown.*
4. *To calculate the approximate Spring Rate for Multiple Arch Joints, divide the single arch values by the number of arches.*
5. *For Pressure Thrust Forces see Chapter VIII, Section A.2.*

C. FORCE POUNDS

1. *Is the force required to move an expansion joint its rated movement.*
2. *To calculate the force pounds required to move an expansion joint its rated movement: Multiply the rated movement by the corresponding spring rate.*

Table VI: Typical Wide Arch Expansion Joint Movement/Spring Rate Capabilities

Nominal Pipe Size Expansion Joint		Nominal Face-to-face Minimum Length		MOVEMENTS								SPRING RATES							
				AXIAL COMPRESSION		AXIAL EXTENSION		LATERAL DEFLECTION		DEGREES OF ANGULAR MOVEMENT	DEGREES OF TORSIONAL MOVEMENT	AXIAL COMPRESSION		AXIAL EXTENSION		LATERAL DEFLECTION		ANGULAR MOVEMENT	
in	mm	in	mm	in	mm	in	mm	in	mm			lbs/in	N/mm	lbs/in	N/mm	lbs/in	N/mm	ft-lbs/ deg	Nm/deg
1*	25	6	150	3/4	19	7/16	11	5/8	16	34.4	3	176	31	228	39	262	46	.03	.04
1-1/4*	32	6	150	3/4	19	7/16	11	5/8	16	28.1	3	220	38	287	50	328	57	.075	.10
1-1/2	40	6	150	3/4	19	7/16	11	5/8	16	23.1	3	265	46	344	60	393	69	.11	.15
2	50	6	150	3/4	19	7/16	11	5/8	16	18.1	3	317	55	414	72	525	92	.22	.30
2-1/2	65	6	150	3/4	19	7/16	11	5/8	16	14.4	3	397	69	517	90	571	100	.375	.51
3	75	6	150	3/4	19	7/16	11	5/8	16	12.5	3	476	83	621	109	618	108	.60	.81
3-1/2	88	6	150	3/4	19	7/16	11	5/8	16	10.4	3	556	97	724	127	666	117	.975	1.32
4	100	6	150	3/4	19	7/16	11	5/8	16	9.4	3	636	111	828	145	714	125	1.425	1.93
5	125	6	150	3/4	19	7/16	11	5/8	16	7.5	3	793	139	1032	181	819	143	3	4
6	150	6	150	3/4	19	7/16	11	5/8	16	6.2	3	953	167	1239	217	925	162	5	7
8	200	6	150	1-3/16	30	11/16	17	5/8	16	6.9	3	1059	185	1378	241	1129	198	10	13
10	250	8	200	1-3/16	30	11/16	17	3/4	19	5.6	3	1324	232	1722	302	1213	212	18	24
12	300	8	200	1-3/16	30	11/16	17	3/4	19	4.7	3	1588	278	2066	362	1422	249	32	43
14	350	8	200	1-3/16	30	11/16	17	3/4	19	4.1	2	1390	243	1808	317	1675	293	14	19
16	400	8	200	1-3/16	30	11/16	17	3/4	19	3.4	2	1588	278	2066	362	1929	338	57	77
18	450	8	200	1-3/16	30	11/16	17	3/4	19	3.1	1	1786	313	2326	407	2130	373	80	108
20	500	8	200	1-7/16	37	3/4	19	3/4	19	3.1	1	1987	348	2580	452	2382	417	114	155
22	550	10	250	1-7/16	37	3/4	19	3/4	19	2.8	1	2185	383	2839	497	2472	433	154	209
24	600	10	250	1-7/16	37	3/4	19	3/4	19	2.5	1	2383	417	3097	542	2559	448	205	278
26	650	10	250	1-5/8	41	1	25	3/4	19	2.9	1	2295	402	2985	523	2743	480	219	297
28	700	10	250	1-5/8	41	1	25	3/4	19	2.5	1	2472	433	3214	563	2928	513	286	388
30	750	10	250	1-5/8	41	1	25	3/4	19	2.5	1	2649	464	3445	603	3112	545	328	445
32	800	10	250	1-5/8	41	1	25	3/4	19	2.2	1	2827	495	3674	643	3657	640	416	564
34	850	10	250	1-5/8	41	1	25	3/4	19	2.2	1	3001	525	4201	736	4201	736	484	656
36	900	10	250	1-5/8	41	1	25	3/4	19	1.9	1	3178	556	4134	724	4746	831	633	926
38	950	10	250	1-5/8	41	1	25	3/4	19	1.9	1	3356	588	4363	764	4876	854	707	959
40	1000	10	250	1-5/8	41	1	25	3/4	19	1.9	1	3531	618	4593	804	5007	877	781	1059
42	1050	12	300	1-7/8	48	1	25	3/4	19	1.9	1	3339	585	4337	759	5134	899	872	1182
44	1100	12	300	1-7/8	48	1	25	3/4	19	1.9	1	3498	613	4543	796	5356	938	952	1291
46	1150	12	300	1-7/8	48	1	25	3/4	19	1.6	1	3652	640	4754	832	5577	977	1260	1708
48	1200	12	300	1-7/8	48	1	25	3/4	19	1.6	1	3815	668	4956	868	5799	1016	1369	1856
50	1250	12	300	1-7/8	48	1	25	3/4	19	1.6	1	3975	696	5163	904	6018	1054	1476	2001
52	1300	12	300	1-7/8	48	1	25	3/4	19	1.6	1	4134	724	5374	941	6235	1092	1603	2173
54	1350	12	300	1-7/8	48	1	25	3/4	19	1.6	1	4293	752	5576	976	6454	1130	1731	2347
56	1400	12	300	1-7/8	48	1	25	3/4	19	1.6	1	4452	780	5787	1013	6672	1168	1848	2505
58	1450	12	300	1-7/8	48	1	25	3/4	19	1.2	1	4611	807	5994	1050	6888	1206	2482	3365
60	1500	12	300	1-7/8	48	1	25	3/4	19	1.2	1	4770	835	6201	1086	7104	1244	2653	3597
66	1650	12	300	1-7/8	48	1	25	3/4	19	1.2	1	5247	919	6821	1194	7662	1342	3216	4360
72	1800	12	300	1-7/8	48	1	25	3/4	19	1.1	.5	5724	1002	7441	1303	8215	1439	4261	5777
78	1950	12	300	1-7/8	48	1	25	3/4	19	1.1	.5	6201	1086	8061	1412	8926	1563	5266	7140
84	2100	12	300	1-7/8	48	1	25	3/4	19	1.0	.5	6678	1169	8681	1520	9637	1688	6481	8787
96	2400	12	300	1-7/8	48	1	25	3/4	19	.87	.5	7632	1337	9921	1737	11062	1937	10081	13668
102	2550	12	300	1-7/8	48	1	25	3/4	19	.82	.5	8109	1420	10542	1846	11775	2062	12725	17253
108	2700	12	300	1-7/8	48	1	25	3/4	19	.77	.5	8586	1503	11162	1955	12489	2187	16391	22223
120	3000	12	300	1-7/8	48	1	25	3/4	19	.70	.5	9540	1670	12403	2172	13912	2436	22403	30374
132	3300	12	300	1-7/8	48	1	25	3/4	19	.64	.5	10494	1838	13642	2389	15216	2665	25160	34112
144	3600	12	300	1-7/8	48	1	25	3/4	19	.59	.5	11448	2005	14882	2606	16519	2893	32176	43625

**Items are normally furnished with "Filled Arch" construction.*

NOTES:

A. MOVEMENT CAPABILITY

1. *Filled Arch reduces movement.*
2. *The degree of Angular Movement is based on the maximum extension shown.*
3. *If greater movements are desired, expansion joints can be supplied with two, three or four arches. Relatively longer "Face-to-Face" length dimensions are incorporated into designs of Multiple Arch Type expansion joints.*
4. *To calculate approximate movement of Multiple Arch expansion joints, take the movement shown in the above table and multiply by the number of arches.*
5. *Movements shown above are based on proper installation practice. (See Chapter VIII, Section D).*

B. SPRING RATE

1. *Forces required to move expansion joints are based on zero pressure conditions and room temperature in the pipe line.*
2. *These forces should be considered only as approximates which may vary with the elastomers and fabrics used in fabrication and the specific construction design of an individual manufacturer.*
3. *See Chapter III, Section F for definition of values shown.*
4. *To calculate the approximate Spring Rate for Multiple Arch Joints, divide the single arch values by the number of arches.*
5. *For Pressure Thrust Forces see Chapter VIII, Section A.2.*

C. FORCE POUNDS

1. *Is the force required to move an expansion joint its rated movement.*

Appendix B: Common Flange Dimensions/Drilling Chart *(For: Expansion Joints, Rubber Pipe, Retaining Rings, Control Units)*

25/125/150 LB. DRILLING

Specifications

- ANSI B16.1-1975 Class 25 ..... B
- ANSI B16.1-1975 Class 125 ..... A
- ANSI B16.24-1971 ..... A
- AWWA C207-07 Tbl 2 & 3 Class D ..... D
- ANSI B16.5 Class 125/150 C
- AWWA C207-07, Tbl 2 & 3, Class D. Tbl 4, Class E..... C
- MSS SP-44 1975 Class 150 ..... A
- SS SP-51 1965 MSS 150# ..... A
- 1914-Amor Std for Ranges ..... E

250/300 DRILLING

Specifications

- ANSI B16.1-1975 Class 250
- ANSI B16.24-1971 300 lb
- ANSI B16.5-1973 Class300
- MSS SP-44-1975 Class 300

NAVY DRILLING

Specifications

- MIL-F-20042C - 50 lb.
- MIL-F 20042C - 150 lb
- BU Ships Drawing B.176

NOMINAL PIPE SIZE EXPANSION JOINT I.D.	COMMON SIZE			BOLT HOLE SIZE											
				Drilling Column											
	O.D.	B.C.	No. Of Holes	A	B	C	D	E	O.D.	B.C.	No. Of Holes	Hole Dia.	O.D.	B.C.	No. Of Holes	Hole Dia.
1/4	2-1/2	1-11/16	4	7/16									3-1/4	2-1/8	3	9/16
3/8	2-1/2	1-11/16	4	7/16				9/16					3-3/8	2-1/4	3	9/16
1/2	3-1/2	2-3/8	4	5/8		5/8		9/16	3-3/4	2-5/8	4	5/8	3-9/16	2-7/16	3	9/16
3/4	3-7/8	2-3/4	4	5/8		5/8			4-5/8	3-1/4	4	3/4	3-13/16	2-11/16	4	9/16
1	4-1/4	3-1/8	4	5/8		5/8			4-7/8	3-1/2	4	3/4	4-1/4	3-1/8	4	9/16
1-1/4	4-5/8	3-1/2	4	5/8		5/8			5-1/4	3-7/8	4	3/4	4-1/2	3-3/8	4	9/16
1-1/2	5	3-7/8	4	5/8		5/8		5/8	6-1/8	4-1/2	4	7/8	5-1/16	3-15/16	6	9/16
2	6	4-3/4	4	3/4		3/4		3/4	6-1/2	5	8	3/4	5-9/16	4-7/16	6	9/16
2-1/2	7	5-1/2	4	3/4		3/4		3/4	7-1/2	5-7/8	8	7/8	6-1/8	5	6	9/16
3	7-1/2	6	4	3/4		3/4		3/4	8-1/4	6-5/8	8	7/8	6-5/8	5-1/2	8	9/16
3-1/2	8-1/2	7	8	3/4		3/4			9	7-1/4	8	7/8	7-3/16	6-1/16	8	9/16
4	9	7-1/2	8	3/4	3/4	3/4	3/4	3/4	10	7-7/8	8	7/8	7-11/16	6-9/16	8	9/16
4-1/2	9-1/4	7-3/4	8					7/8					8-3/16	7-1/16	10	9/16
5	10	8-1/2	8	7/8	3/4	7/8	3/4	7/8	11	9-1/4	8	7/8	9-1/16	7-13/16	10	11/16
5-1/2													9-9/16	8-5/16	10	11/16
6	11	9-1/2	8	7/8	3/4	7/8	3/4	7/8	12-1/2	10-5/8	12	7/8	10-1/8	8-7/8	12	11/16
6-1/2													10-5/8	9-3/8	12	11/16
7	12-1/2	10-3/4	8					7/8					11-5/16	10	12	11/16
7-1/2													11-7/8	10-9/16	12	11/16
8	13-1/2	11-3/4	8	7/8	3/4	7/8	3/4	7/8	15	13	12	1	12-3/8	11-1/16	14	11/16
8-1/2													12-15/16	11-5/8	14	11/16
9	15	13-1/4	12					7/8					13-15/16	12-3/8	14	13/16
9-1/2													14-1/2	12-15/16	14	13/16
10	16	14-1/4	12	1	3/4	1	3/4	1	17-1/2	15-1/4	16	1-1/8	15	13-7/16	15	13/16
11													16-9/16	15	16	13/16
12	19	17	12	1	3/4	1	3/4	1	20-1/2	17-3/4	16	1-1/4	17-5/8	16-1/16	18	13/16
14	21	18-3/4	12	1-1/8	7/8	1-1/8	7/8	1-1/8	23	20-1/4	20	1-1/4	19-1/8	17-3/8	19	15/16
15	22-1/4	20	16					1-1/8								
16	23-1/2	21-1/4	16	1-1/8	7/8	1-1/8	7/8	1-1/8	25-1/2	22-1/2	20	1-3/8	21-3/16	19-7/16	20	15/16
18	25	22-3/4	16	1-1/4	7/8	1-1/4	7/8	1-1/8	28	24-3/4	24	1-3/8	23-1/4	21-1/2	22	15/16
20	27-1/2	25	20	1-1/4	7/8	1-1/4	7/8	1-1/4	30-1/2	27	24	1-3/8	25-13/16	23-13/16	24	1-1/16
22	29-1/2	27-1/4	20			1-3/8	7/8	1-3/8	33	29-1/4	24	1-5/8	27-7/8	25-7/8	26	1-1/16
24	32	29-1/2	20	1-3/8	7/8	1-3/8	7/8	1-3/8	36	32	24	1-5/8	30	28	28	1-1/16
25													31-1/2	29-1/4	29	1-3/16
26	34-1/4	31-3/4	24			1-3/8	7/8	1-3/8	38-1/4	34-1/2	28	1-3/4	32-9/16	30-6/16	30	1-3/16
28	36-1/2	34	28			1-3/8	7/8	1-3/8	40-3/4	37	28	1-3/4	34-11/16	32-7/16	32	1-3/16
30	38-3/4	36	28	1-3/8	1	1-3/8	1	1-1/2	43	39-1/4	28	2*	36-13/16	34-9/16	35	1-3/16
32	41-3/4	38-1/2	28			1-5/8	1	1-5/8	45-1/4	41-1/2	28	2	39	36-3/4	36	1-3/16
33													40	37-3/4	36	1-3/16
34	43-3/4	40-1/2	32			1-5/8	1	1-5/8	47-1/2	43-1/2	28	2	41	38-3/4	36	1-3/16
35													42-7/8	40-3/8	36	1-5/16
36	46	42-3/4	32	1-5/8	1	1-5/8	1	1-5/8	50	46	32	2-1/4*	43-7/8	41-3/8	36	1-5/16
38	48-3/4	45-1/4	32			1-5/8	1	1-3/4	56	43	32	1-5/8	46-1/8	43-5/8	36	1-5/16
40	50-3/4	47-1/4	36	1-5/8	1-1/8	1-5/8	1	1-3/4	48-3/4	45-1/2	32	1-3/4	48-1/8	45-5/8	36	1-5/16
42	53	49-1/2	36			1-5/8	1-1/8	1-3/4	57*	52-3/4*	36*	2-1/4*	50-1/4	47-3/4	38	1-5/16
44	55-1/4	51-3/4	40			1-5/8	1-1/8	1-3/4	53-1/4	49-3/4	32	1-5/8				
46	57-1/4	53-3/4	40			1-5/8	1-1/8	1-3/4	55-3/4	52	28	2	54-1/2	52	40	1-5/16
48	59-1/2	56	44	1-5/8	1-1/8	1-5/8	1-1/8	1-3/4	65*	60-3/4*	40*	2-1/4*				
50	61-3/4	58-1/4	44			1-7/8	1-1/4	1-7/8	60-1/4	56-1/4	32	2-1/8				
52	64	60-1/2	44			1-7/8	1-1/4	1-7/8	62-1/4	58-1/4	32	2-1/8				
54	66-1/4	62-3/4	44	2	1-1/8	1-7/8	1-3/8	1-7/8	65-1/4	61	28	2-3/8				
56	68-3/4	65	48			1-7/8		1-7/8	67-1/4	63	28	2-3/8				
58	71	67-1/4	48			1-7/8		1-7/8	69-1/4	65	32	2-3/8				
60	73	69-1/4	52	2	1-1/4	1-7/8	1-3/8	1-7/8	71-1/4	67	32	2-3/8				
62	75-3/4	71-3/4	52					2								
64	78	74	52					2								
66	80	76	52			1-7/8	1-3/8	2								
68	82-1/4	78-1/4	56					2								
70	84-1/4	80-1/2	56					2								
72	86-1/2	82-1/2	60	2	1-1/4	1-7/8	1-3/8	2								
74	88-1/2	84-1/2	60					2								
76	90-3/4	86-1/2	60					2								
784	93	89	64			2-1/8	1-5/8									
80	95-1/4	91	60					2-1/8								
82	97-1/2	93-1/4	60					2-1/8								
84	99-3/4	95-1/2	64	2-1/4	1-3/8	2-1/8	1-5/8	2-1/8								
86	102	97-3/4	64					2-1/8								
88	104-1/4	100	68					2-1/8								
904	106-1/2	102	68			2-3/8	1-7/8									
92	108-3/4	104-1/2	68					2-1/4								
94	111	106-1/4	68					2-1/4								
96	113-1/4	108-1/2	68	2-1/4	1-3/8	2-3/8	1-7/8	2-3/8								
98	115-1/2	110-3/4	68					2-3/8								
100	117-3/4	113	68					2-3/8								
102	120	114-1/2	72			2-5/8	2-1/8									
108	126-3/4	120-3/4	72			2-5/8	2-1/8									
120	140-1/4	132-3/4	76			2-7/8	2-3/8									
132	153-3/4	145-3/4	80			3-1/8	2-5/8									
144	167-1/4	158-1/4	84			3-3/8	2-7/8									

*DIMENSIONS SHOWN DO NOT MEET SMM SP-44

NOTICE:
Most manufacturers can furnish products meeting the drilling/flange standards of:

1. *British Standard 10:1962*
2. *EJMA, Tables 2-3-5-5/1962*
3. *ISO, International Std. 2084*
4. *ISO, International Std. 2536*
5. *NBS Product Standard PS 15-69*
6. *API Standard 605*
7. *DIN-ND 2501 Tbls 6-10-16*
8. *SMS 2033*
9. *DIN 2633*
10. *RSF 1583*
11. *NEE 29-201 PN 6-10-16 and many others.*

NOTES:

1. *When ordering/specifying: Expansion Joints, Rubber Pipe, Retaining Rings or control Unit Assemblies, always note the mating flange drilling specification or the actual dimensions if specification is unknown. In the absence of this data, these products will be drilled to ANSI B16.1, Class 125 or to the individual manufacturer's printed drilling specification.*
2. *When products are manufactured to ASTM F1123-87 . They should be drilled to MIL-F-20042C or ANSI B16.5, Class 150 as specified by the customer.*
3. *AWS= American War Standard*
   ASA= American Standards Association, changed to USAS
   USAS=United States of America Standards Institute, changed to ANSI
   ANSI= American National Standards Institute
   AWWA = American Water Works Association
   API = American Petroleum Institute
4. *Drilling is available, but not shown for the following: 1914—78", 90"; AWWA C207-78-114", 126", 138".*

Appendix C: Control Unit Dimensions and Ratings

CONTROL UNIT						Nominal Pipe Size Exp. Jt. ID		MAXIMUM SURGE OR TEST PRESSURE OF THE SYSTEMS				
Plate Thickness		Rod Diameter		Standard Control Unit Assembly of:				Number of Control Rods Recommended				
in.	mm	in.	mm	Rods	Plates	in.	mm	2	3	4	6	8
3/8	10	1/2	13	2	4	1/2	15	1328	•	•	•	•
3/8	10	1/2	13	2	4	3/4	20	1106	•	•	•	•
3/8	10	1/2	13	2	4	1	25	949	•	•	•	•
3/8	10	1/2	13	2	4	1-1/4	32	830	•	•	•	•
3/8	10	1/2	13	2	4	1-1/2	40	510	•	•	•	•
3/8	10	5/8	16	2	4	2	50	661	•	•	•	•
3/8	10	5/8	16	2	4	2-1/2	65	529	•	•	•	•
3/8	10	5/8	16	2	4	3	75	441	•	•	•	•
3/8	10	5/8	16	2	4	3-1/2	88	365	547	729	•	•
3/8	10	5/8	16	2	4	4	100	311	467	622	•	•
3/8	10	5/8	16	2	4	5	125	235	353	470	•	•
1/2	13	5/8	16	2	4	6	150	186	278	371	•	•
1/2	13	3/4	19	2	4	8	200	163	244	326	•	•
3/4	19	7/8	22	2	4	10	250	163	244	325	488	•
3/4	19	1	25	2	4	12	300	160	240	320	481	•
3/4	19	1	25	2	4	14	350	112	167	223	335	•
3/4	19	1-1/8	29	2	4	16	400	113	170	227	340	453
3/4	19	1-1/8	29	2	4	18	450	94	141	187	281	375
3/4	19	1-1/8	29	2	4	20	500	79	118	158	236	315
1	25	1-1/4	32	2	4	22	550	85	128	171	256	342
1	25	1-1/4	32	2	4	24	600	74	110	147	221	294
1	25	1-1/4	32	2	4	26	650	62	93	124	186	248
1-1/4	32	1-3/8	35	2	4	28	700	65	98	130	195	261
1-1/4	32	1-1/2	38	2	4	30	750	70	105	141	211	281
1-1/4	32	1-1/2	38	2	4	32	800	63	94	125	188	251
1-1/2	38	1-5/8	41	2	4	34	850	72	107	143	215	286
1-1/2	38	1-3/4	44	2	4	36	900	69	103	138	207	276
1-1/2	38	1-3/4	44	2	4	38	950	63	94	125	188	251
1-1/2	38	1-1/2	38	3	6	40	1000	42	63	85	127	169
1-1/2	38	1-5/8	41	3	6	42	1050	48	72	96	144	192
1-1/2	38	1-5/8	41	3	6	44	1100	44	66	88	133	177
1-1/2	38	1-5/8	41	3	6	46	1150	41	61	82	122	163
1-1/2	38	1-5/8	41	3	6	48	1200	40	60	81	121	161
1-1/2	38	1-5/8	41	3	6	50	1250	37	56	75	112	150
1-1/2	38	1-5/8	41	3	6	52	1300	35	53	70	105	140
1-1/2	38	2	51	3	6	54	1350	43	64	86	128	171
1-1/2	38	2	51	3	6	56	1400	40	60	80	120	160
1-1/2	38	2	51	3	6	58	1450	38	56	75	113	150
1-3/4	44	2	51	3	6	60	1500	35	53	71	106	141
1-3/4	44	2	51	4	8	62	1550	33	50	66	100	133
1-7/8	48	2	51	4	8	66	1650	30	44	59	89	119
1-7/8	48	2	51	4	8	72	1800	25	38	50	75	101
2	51	2-1/4	57	4	8	78	1950	28	42	56	84	112
2-1/4	57	2-1/4	57	4	8	84	2100	24	37	49	73	98
2-1/2	63	2-1/2	63	4	8	90	2250	26	40	53	79	106
2-1/2	63	2-3/4	70	4	8	96	2400	29	43	58	86	115
2-1/2	63	2-3/4	70	4	8	102	2550	25	33	51	76	102
2-1/2	63	2-3/4	70	4	8	108	2700	23	34	46	75	92
2-1/2	63	2-3/4	70	4	8	120	3000	18	28	37	56	75
2-1/2	63	2-3/4	70	4	8	132	3300	15	23	31	46	62
2-1/2	63	2-3/4	70	6	12	144	3600	13	19	26	39	52

NOTICE:
1. NMEJ Division recommended plate thickness and rod diameter based in a yield strength of 36,000 PSI (248,211 kPa) with a maximum allowable stress of 23,400 PSI (161,337 kPa)(65% of yield.) Rod and plate load based on thrust, calculated using diameter "D." See Figure 4 and Chapter VIII, Section A.2. Dimensions can vary with a manufacturer's grade of steel and material.
2. A "Standard Control Unit Assembly" is generally furnished when ordered. If specifications and/or order does not call out a specific number of control rods or a design/test pressure of system.
3. For Control Unit length see Appendix D.
4. Pressures listed above do not relate to the actual design pressure of the expansion joint products (see Table IV), but are the maximum pressure for a specific control rod number/dimension.
5. All values based upon arch height of 2-1/2 inches (63.5 mm).
6. Reducer Type (Taper) Expansion Joints may require specially designed control rod assemblies; i.e.

Appendix D: Mating Flange Thickness

NOMINAL PIPE SIZE		ANSI B16.1 CLASS 25	ANSI B16.1 CLASS 125	ANSI B16.24 150LB CLASS 25	ANSI B16.5 CLASS 150	AWWA C207 TABLE 1, CLASS B	AWWA C207 TABLE 1, CLASS D	AWWA C207 TBL 2, CLASS A&B	AWWA C207 TABLE 3, CLASS E	MSS SP-44 CLASS 150
in.	mm									
1/4	5	•	•	9/32	•	•	•	•	•	•
3/8	10	•	•	9/32	•	•	•	•	•	•
1/2	15	•	•	5/16	7/16	•	•	•	7/16	•
3/4	20	•	•	11/32	1/2	•	•	•	1/2	•
1	25	•	7/16	3/8	9/16	•	•	•	9/16	•
1-1/4	32	•	1/2	13/32	5/8	•	•	•	5/8	•
1-1/2	40	•	9/16	7/16	11/16	•	•	•	11/16	•
2	50	•	5/8	1/2	3/4	•	•	•	3/4	•
2-1/2	65	•	11/16	9/16	7/8	•	•	•	7/8	•
3	75	•	3/4	5/8	15/16	•	•	•	15/16	•
3-1/2	88	•	13/16	11/16	15/16	•	•	•	15/16	•
4	100	3/4	15/16	11/16	15/16	•	•	•	15/16	•
5	125	3/4	15/16	3/4	15/16	5/8	5/8	1/2	15/16	•
6	150	3/4	1	13/16	1	11/16	11/16	9/16	1	•
8	200	3/4	1-1/8	15/16	1-1/8	11/16	11/16	9/16	1-1/8	•
10	250	7/8	1-3/16	1	1-3/16	11/16	11/16	11/16	1-3/16	•
12	300	1	1-1/4	1-1/16	1-1/4	11/16	13/16	11-16	1-1/4	1-1/4
14	350	1-1/8	1-3/8	•	1-3/8	11/16	15/16	3/4	1-3/8	1-3/8
16	400	1-1/8	1-7/16	•	1-7/16	11/16	1	3/4	1-7/16	1-7/16
18	450	1-1/4	1-9/16	•	1-9/16	11/16	1-1/16	3/4	1-9/16	1-9/16
20	500	1-1/4	1-11/16	•	1-11/16	11/16	1-1/8	3/4	1-11/16	1-11/16
22	550	•	•	•	•	3/4	1-3/16	1	•	1-13/16
24	600	1-3/8	1-7/8	•	1-7/8	3/4	1-1/4	1	1-7/8	1-7/8
26	650	•	•	•	•	13/16	1-5/16	1	2	2-11/16
28	700	•	•	•	•	7/8	1-5/16	1	2-1/16	2-13/16
30	750	1-1/2	2-1/8	•	•	7/8	1-3/8	1	2-1/8	2-15/16
32	800	•	•	•	•	15/16	1-1/2	1-1/8	2-1/4	3-3/16
34	850	•	•	•	•	15/16	1-1/2	1-1/8	2-5/16	3-1/4
36	900	1-5/8	2-3/8	•	•	1	1-5/8	1-1/8	2-3/8	3-9-16
38	950	•	•	•	•	1	1-5/8	1-1/8	2-3/8	3-7/16
40	1000	•	•	•	•	1	1-5/8	1-1/8	2-1/2	3-9/16
42	1050	1-3/4	2-5/8	•	•	1-1/8	1-3/4	1-1/4	2-5/8	3-13/16
44	1100	•	•	•	•	1-1/8	1-3/4	1-1/4	2-5/8	4
46	1150	•	•	•	•	1-1/8	1-3/4	1-1/4	2-11/16	4-1/16
48	1200	2	2-3/4	•	•	1-1/4	1-3/4	1-3/8	2-3/4	4-1/4
50	1250	•	•	•	•	1-1/4	2	1-3/8	2-3/4	4-3/8
52	1300	•	•	•	•	1-1/4	2	1-3/8	2-7/8	4-9/16
54	1350	2-1/4	3	•	•	1-3/8	2-1/8	1-3/8	3	4-3/4
56	1400	•	•	•	•	•	•	•	•	4-7/8
58	1450	•	•	•	•	•	•	•	•	5-1/16
60	1500	2-1/4	3-1/8	•	•	1-1/2	2-1/4	1-1/2	3-1/8	5-3/16
66	1650	•	•	•	•	1-5/8	2-1/2	1-1/2	3-3/8	•
72	1800	2-1/2	3-1/2	•	•	1-3/4	2-5/8	1-1/2	3-1/2	•
78	1950	•	•	•	•	2	2-3/4	1-3/4	3-7/8	•
84	2100	2-3/4	3-7/8	•	•	2	2-3/4	1-3/4	3-7/8	•
96	2400	3	4-1/4	•	•	2-1/4	3	2	4-1/4	•
102	2550	•	•	•	•	2-1/2	3-1/4	2-1/4	4-5/8	•
108	2700	•	•	•	•	2-1/2	3-1/4	2-1/4	4-5/8	•
120	3000	•	•	•	•	2-3/4	3-1/2	2-1/2	5	•
132	3300	•	•	•	•	3	3-3/4	2-3/4	5-3/8	•
144	3600	•	•	•	•	3-1/4	4	3	5-3/4	•

NOTICE:
1. When ordering/specifying control units, always note the mating flange thickness or specification. In the absence of this data, control units will be sized to flanges meeting ANSI B16.5 or AWWA C207 Table 3, Class E.
2. 3 or more rods are better for 20" or higher as minimum.

EXPANSION JOINTS-PIPING DIVISION

For current Members and Associate Members, please go to the Expansion Joints-Piping Division section of the Fluid Sealing Association website:

www.fluidsealing.com

Acknowledgments

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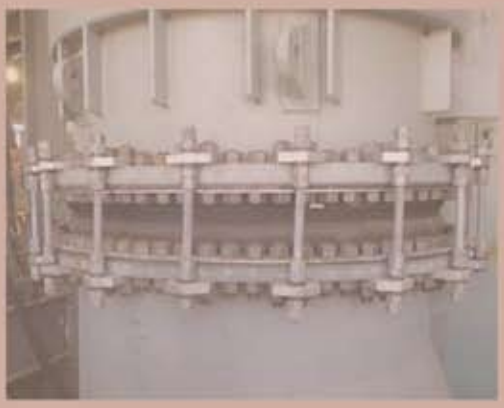

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