Design Data

DESIGN CONSIDERATIONS

The Victaulic piping method may be used for joining a variety of piping systems for a wide variety of services. It may be utilized for varied pipe sizes, pipe materials and wall thickness. Products are available to provide rigid or flexible systems. For specific product information relating to use on varied pipe materials refer to the appropriate sections of this catalog.

As with any piping method, the nature of the method should be considered in designing the piping systems. This design data applies primarily to grooved end pipe, however, much of the information applies to other Victaulic mechanical piping products used in conjunction with grooved components.

The material presented is intended solely for piping design reference in utilization of Victaulic products for their intended application. It is not intended as a replacement for competent, professional assistance which is an obvious requisite to any specific application. Good piping practice should always prevail. Specific pressures, temperatures, external or internal loads, performance standards and tolerances must never be exceeded.

While every effort has been made to ensure its accuracy, Victaulic Company, its subsidiaries and affiliated companies, make no express or implied warranty of merchantability or fitness for a particular purpose respecting the information contained in this catalog or the materials referred to therein. Illustrations shown within this catalog are not drawn to scale and may have been exaggerated for clarity. Anyone making use of the information or material contained herein does so at his own risk and assumes any and all liability resulting from such use.

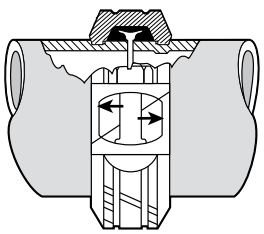
RIGID COUPLINGS

Rigid grooved end piping systems (including Styles 07, W07 (Advanced Groove System), 307, HP-70, 005, and others) provide a mechanical and frictional interlock onto the pipe ends sufficient to result in a rigid joint.

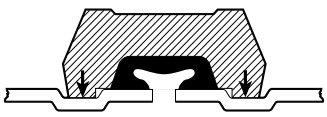
HP-70 rigid couplings grip the base of the groove providing a rigid joint.

Style 07 Zero-Flex® couplings have a unique, patented angle pad design which constricts the housing keys into the groove around the full circumference to grip the pipe rigidly. The housings slide on the angled pads rather than mating squarely.

PATENTED



ANGLED PAD STYLE COUPLINGS



HP-70 COUPLING

This sliding adjustment also forces the key sections into opposed contact on the inside and outside groove edges, pushing the joint to its maximum pipe end separation during assembly.

These products can be considered to have system behavior characteristics similar to those of welded or flanged systems, in that all piping remains in strict alignment and is not subject to deflections during operation. For this reason, these products require support techniques similar to those used in traditional flanged or welded systems.

Systems incorporating rigid couplings require the calculated thermal growth/contraction of the piping system to be fully compensated for in the design of the piping system. This requires adequate use of flexible components, (i.e. flexible couplings, expansion joints, expansion loops using flexible couplings at the elbows, etc.) such that no bending moments can be developed and imparted at the pipe joints. Please refer to Victaulic publication 26.02 for further details.

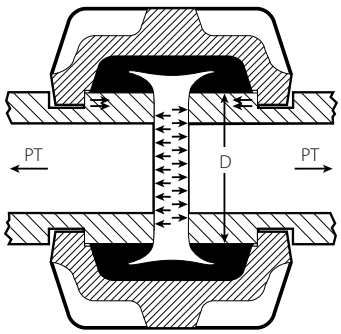
FLEXIBLE COUPLINGS

The following factors must be considered when designing or installing flexible grooved end piping systems (including Styles 75, 77, W77 [Advanced Groove System] and others).

PRESSURE THRUST

When a flexible grooved type mechanical coupling is sustaining forces trying to separate the pipe ends, the shoulder of the groove is pulled hard against the inside face of the coupling key. This is what prevents the pipes from separating.

The allowable force which a joint can sustain varies for different types of couplings, pipe wall thickness, types of pipes and grooving. The product data under the column “Maximum Permissible End Load” shows the maximum allowable end force due to internal pressure and external loading that different couplings will sustain.



When this end force is due to a closed end or change in direction, the pressure thrust transmitted by the joint can be computed from the formula:

$$PT = \frac{\pi}{4} D^2 P$$

Where:

PT = Pressure thrust or end load (lbs.)

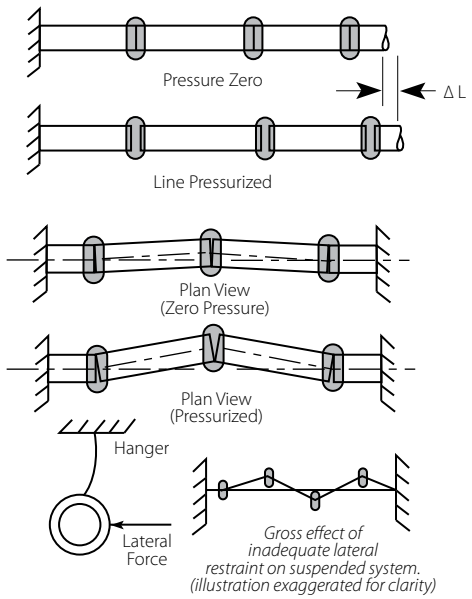
D = Outside diameter of pipe (inches)

p = Internal pressure (psi)

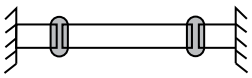
Pipe will be moved to the full extent of the available pipe end gaps when allowed to float. Ensure resulting movement of randomly installed systems is not harmful to joints at changes in directions or branch connections or to parts of structure or other equipment. Note also that thermal expansion of pipes will add to total movement in these cases.

JOB OWNER	CONTRACTOR	ENGINEER
System No. _____	Submitted By _____	Spec Sect _____ Para _____
Location _____	Date _____	Approved _____
		Date _____

Design Data

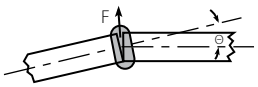


For anchored systems, where pressure thrusts do not act to hold the joints in tension, or in systems where the joints have been intentionally deflected (e.g., curves), provide lateral restraint to prevent movement of the pipes due to pressure thrusts acting at deflections. Lightweight hangers are not adequate in preventing sideways movement of pipes. It should be anticipated that small deflections will occur in all straight lines and side thrusts will be exerted on the joints.

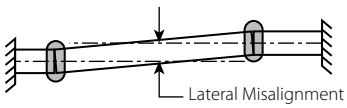


Angular deflection at butted or fully spaced joints is not possible unless the ends of the pipes are free to move as required.

Unrestrained deflected joints will straighten up under the action of axial pressure thrusts or other forces acting to pull pipes apart. If joints are to be maintained deflected, then lines must be anchored to restrain pressure thrusts and end pull forces, otherwise sufficient lateral force must be exerted to keep joint deflected.

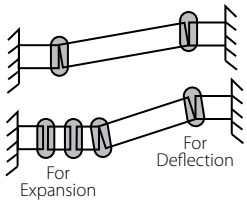


Lateral forces (F) will always act on deflected joints due to internal —pressure. A fully deflected joint will no longer be capable of providing the full linear movement normally available at the joint.



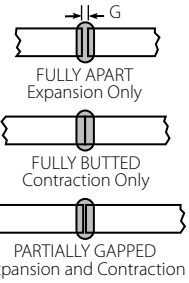
At least two flexible couplings are required to provide for lateral misalignment of pipes. Angular deflection of each joint must not exceed Maximum Deflection From Centerline published for each Victaulic coupling style.

JOINTS DEFLECTED
NO EXPANSION/CONTRACTION AVAILABLE

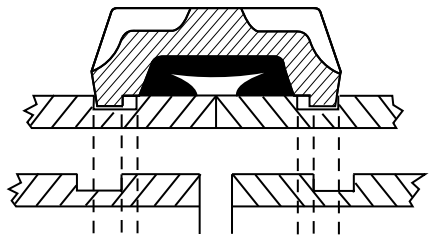


The grooved piping method will not allow both maximum linear movement and maximum angular movement simultaneously at the same joint. If both are expected simultaneously, systems should be designed with sufficient joints to accommodate both, including allowance for recommended tolerances.

Flexible couplings do not automatically provide for expansion or contraction of piping. Always consider best setting for pipe end gaps. In anchored systems, gaps must be set to handle combinations of expansion and contraction. In free floating systems offsets of sufficient length must be used to accommodate movement without overdeflecting joints.



Linear movement available at flexible grooved pipe joints is published under performance data for each Victaulic coupling style. These values are MAXIMUMS. For design and installation purposes, these figures should be reduced by the following factors to allow for pipe groove tolerances.



LINEAR MOVEMENT TOLERANCE

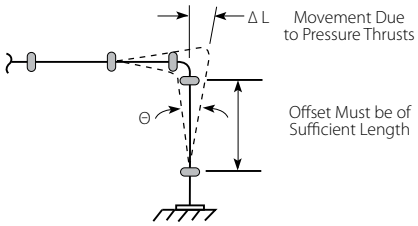
¾ – 3 ½"/20 – 90 mm – Reduce published figures by 50%

4"/100 mm and larger – Reduce published figures by 25%

Standard cut grooved pipe will provide double the expansion/contraction or deflection capabilities of the same size standard roll groove pipe.

Design Data

OFFSETS AND BRANCH CONNECTIONS



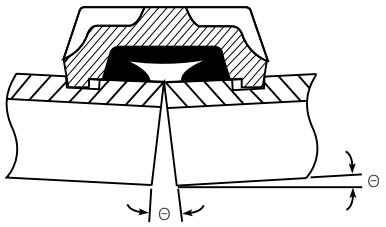
Ensure that branch connections and offsets are sufficiently long so that the maximum angular deflection of coupling (shown in Performance Data for each coupling style) is never exceeded and can accommodate anticipated total movement of pipes.

Otherwise, anchor system to direct movement away from these. Also ensure that adjacent pipes can move freely to provide anticipated movements. (Refer to page 6 for more details.)

ANGULAR DEFLECTIONS

Angular deflection available at flexible grooved pipe joints is published under Performance Data for each Victaulic coupling style. These values are MAXIMUMS. For design and installation purposes these figures should be reduced by the following factors to allow for pipe grooving tolerances.

Θ = Maximum angular deflection between center lines as shown under Performance Data.



ANGULAR MOVEMENT TOLERANCE

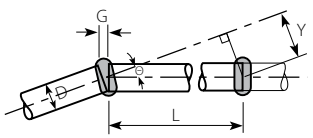
¾ – 3 ½"/20 – 90 mm – Reduce published figures by 50%

4"/100 mm and larger – Reduce published figures by 25%

Standard cut grooved pipe will provide double the expansion/contraction or deflection capabilities of the same size standard roll groove pipe.

The angular deflection available at a Victaulic flexible grooved pipe joint is useful in simplifying and speeding installation.

NOTE: Joints which are fully deflected can no longer provide linear movement. Partially deflected joints will provide some portion of linear movement. NOTE: Pressure thrusts will tend to straighten deflected pipe.



$$Y = L \sin \Theta$$

$$\Theta = \sin^{-1} \frac{G}{D}$$

$$Y = \frac{G \times L}{D}$$

Where:

Y = Misalignment (Inches)

G = Maximum Allowable Pipe End Movement (Inches) as shown under Performance Data (Published value to be reduced by Design Tolerance.)

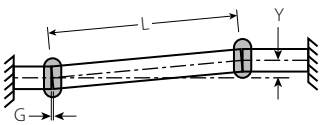
Θ = Maximum Deflection (Degrees) from Center Line as shown under Performance Data (Published value to be reduced by Design Tolerance.)

D = Pipe Outside Diameter (Inches)

L = Pipe Length (Inches)

MISALIGNMENT

Pipe misalignment can be accommodated with a Victaulic flexible grooved piping system. Note that at least two flexible couplings must be used for the combined lateral displacement and angular deflection (Y). (Refer to 26.03 for details.)

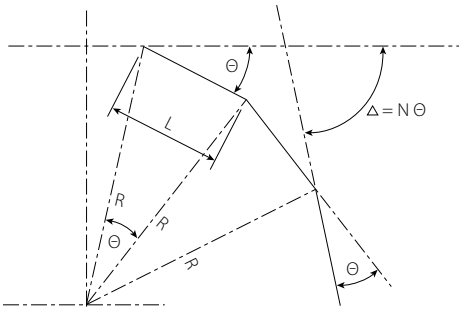


The movement available can be calculated from the flexible coupling Performance Data.

CURVE LAYOUT

Curves may be installed with straight pipe lengths utilizing the angular deflection (under performance data) available at each flexible coupling. Note that if the maximum angle of deflection at the couplings is used to lay the curve, no allowance is left for expansion/contraction.

NOTE: Pressure thrusts will tend to straighten the curve. Consideration must be given to proper anchoring.



$$R = \frac{L}{2 \sin \frac{\Theta}{2}} \qquad L = 2R \sin \frac{\Theta}{2} \qquad N = \frac{\Delta}{\Theta}$$

Where:

N = Number of Couplings

R = Radius of Curve (Feet)

L = Pipe Length (Feet)

Θ = Deflection from Centerline (°) of each Coupling (See Data Sheets – Published value to be reduced by Design Tolerance)

Δ = Combined Angular Deflection of all couplings

For curves of less than 90° total deflection, the data shown on the previous page can be used to determine:

1. The radius of curvature that can be made using pipes of a given length and utilizing either the full or partial angle of deflection available from the couplings used. Alternatively, the maximum length of pipe that can be used to negotiate a curve of a certain radius using either the maximum or partial angle of deflection available from the couplings.
2. The total number of flexible couplings required to negotiate a curve having a given deflection angle.

Design Data

PIPE SUPPORT – ANCHORAGE AND GUIDANCE

FLEXIBLE COUPLINGS – RIGID COUPLINGS

When designing anchorage, support and guidance systems for piping joined with flexible or rigid mechanical grooved type couplings, it is necessary to give consideration to certain characteristics of these couplings. These characteristics distinguish flexible grooved type couplings from other types and methods of pipe joining. When this is understood, the designer can utilize the many advantages that these coupling provide.

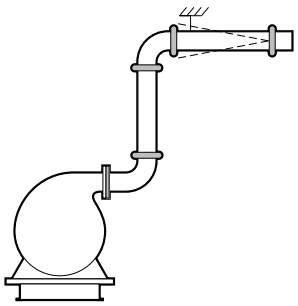
Coupling Key:

● = Rigid Coupling

● = Flexible Coupling

USE OF HANGERS AND SUPPORTS

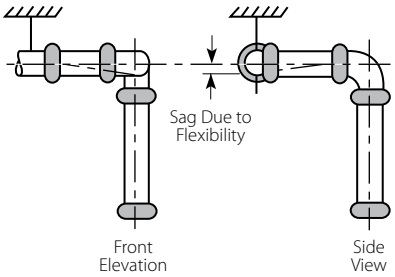
The use of hangers and supports offering freedom of movement in one or more directions has to be considered to allow pipes to move freely. Spring hangers are good practice at change of direction to allow freedom of pipe movement.



PUMP OCILLATION

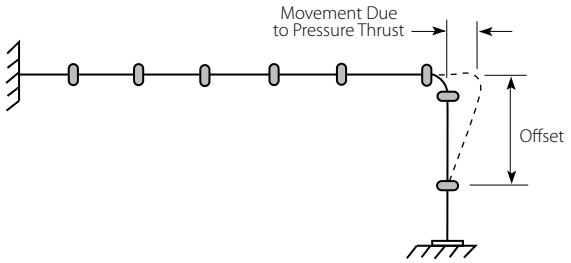
ACCOMMODATING COUPLING FLEXIBILITY

Flexible grooved type couplings allow angular flexibility and rotational movement to take place at joints. These features provide advantages in installing and engineering piping systems, but must be considered when determining hanger and support spacing.



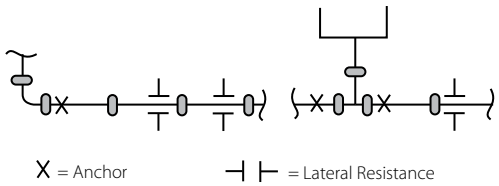
As illustrated, it is obvious that this system would require further hangers to eliminate the drooping of the pipes that would occur. Hanger positions must therefore be considered in relation to the angular and rotational movement that will occur at joints.

Good use can be made of rigid Zero-Flex Style 07 couplings in boiler and machinery rooms. These will increase rigidity where needed.



In the system illustrated, if the joints had all been installed butted or only partially open when pressurized, the pipe ends would all move to the maximum extent allowed by the coupling and this movement would all accumulate at the end of the system. The offset would have to be capable of deflecting sufficiently, otherwise harmful bending moments would be induced in the joints of the offset. Note, if the pipes were to expand due to thermal changes, then further growth of the pipes would also take place at the ends.

ANCHORAGE AND SUPPORT



Ensure anchorage and support is adequate. Use anchors to direct movement away from or to protect critical changes in direction, branch connections and structure. Spacing and types of supports should consider anticipated pipe movements.

If rigid couplings are used, consideration must be given to use of expansion joints if thermal movement is expected.

RULES APPLICABLE TO LONG RUNS OF PIPE

For long pipe runs incorporating flexible couplings, it is normal practice to anchor or block all changes in direction of piping to prevent pressure thrusts from creating linear growth at the flexible joints. It may be necessary to guide the pipe to prevent lateral movement of the pipe between the anchors.

Intermediate anchors can be installed to control pipe movement in selected areas and to reduce pipe end forces on joints.

When changes in direction are located in a structure (i.e. pump room) a main anchor can be used at the change in direction to handle loads created by pressure thrusts. The anchor would also prevent unwanted movement of the piping at equipment connections.

Design Data

PIPE SUPPORT

FLEXIBLE COUPLINGS – RIGID COUPLINGS

Piping joined with grooved type couplings, like all other piping systems, requires support to carry the weight of pipes, equipment and fluid. Like all other methods of joining pipes, the support or hanging method must be such as to eliminate undue stresses on joints, piping and other components. Additionally, the method of support must be such as to allow movement of the pipes where required and to provide for other special requirements such as drainage, etc. as may be required by the designer. The support system for flexible mechanical grooved type pipe couplings must consider some of the special requirements of these couplings.

The tables show suggested maximum span between pipe supports for horizontal straight runs of standard weight steel pipe carrying water or similarly dense liquids. They are not intended to be used as specifications for all installations. These DO NOT apply where critical calculations are made or where there are concentrated loads between supports.

Do not attach supports directly to the couplings. Support adjoining pipe and equipment only.

RIGID SYSTEMS

For Victaulic rigid coupling Styles 07, W07, 307, HP-70, 005, 009, and others, the Maximum Hanger Spacing below may be used.

Size		Suggested Maximum Span Between Supports Feet/meters					
		Water Service			Gas or Air Service		
Nominal Size In./mm	Actual Outside Dia. In./mm	*	†	‡	*	†	‡
1 25	1.315 33.7	7 2.1	9 2.7	12 3.7	9 2.7	9 2.7	12 3.7
1 ¼ 32	1.660 42.4	7 2.1	11 3.4	12 3.7	9 2.7	11 3.4	12 3.7
1 ½ 40	1.900 48.3	7 2.1	12 3.7	15 4.6	9 2.7	13 4.0	15 4.6
2 50	2.375 60.3	10 3.1	13 4.0	15 4.6	13 4.0	15 4.6	15 4.6
3 80	3.500 88.9	12 3.7	15 4.6	15 4.6	15 4.6	17 5.2	15 4.6
4 100	4.500 114.3	14 4.3	17 5.2	15 4.6	17 5.2	21 6.4	15 4.6
6 150	6.625 168.3	17 5.2	20 6.1	15 4.6	21 6.4	25 7.6	15 4.6
8 200	8.625 219.1	19 5.8	21 6.4	15 4.6	24 7.3	28 8.5	15 4.6
10 250	10.750 273.0	19 5.8	21 6.4	15 4.6	24 7.3	31 9.5	15 4.6
12 300	12.750 323.9	23 7.0	21 6.4	15 4.6	30 9.1	33 10.1	15 4.6
14 350	14.000 355.6	23 7.0	21 6.4	15 4.6	30 9.1	33 10.1	15 4.6
16 400	16.000 406.4	27 8.2	21 6.4	15 4.6	35 10.7	33 10.1	15 4.6
18 450	18.000 457.0	27 8.2	21 6.4	15 4.6	35 10.7	33 10.1	15 4.6
20 500	20.000 508.0	30 9.1	21 6.4	15 4.6	39 11.9	33 10.1	15 4.6
24 600	24.000 610.0	32 9.8	21 6.4	15 4.6	42 12.8	33 10.1	15 4.6

* Spacing corresponds to ASME B31.1 Power Piping Code.

† Spacing corresponds to ASME B31.9 Building Services Piping Code.

‡ Spacing corresponds to NFPA 13 Fire Sprinkler Systems.

FLEXIBLE SYSTEMS

For coupling Styles including 75, 77, W77, 770, and others. Standard grooved-type couplings allow angular, linear and rotational movement at each joint, to accommodate expansion, contraction, settling, vibration, noise and other piping system movement. These features provide advantages in designing piping systems but must be considered when determining hanger and support bracing and location.

Maximum Hanger Spacing

For straight runs without concentrated loads and where full linear movement is required.

PIPE SIZE	Pipe Length in Feet/meters									
Nominal Inches/ mm	7 2.1	10 3.0	12 3.7	15 4.6	20 6.1	22 6.7	25 7.6	30 9.1	35 10.7	40 12.2
	*Average Hangers per Pipe Length Evenly Spaced									
¾ – 1 20 – 25	1	2	2	2	3	3	4	4	5	6
1 ¼ – 2 32 – 50	1	2	2	2	3	3	4	4	5	5
2 ½ – 4 65 – 100	1	1	2	2	2	2	2	3	4	4
5 – 8 125 – 200	1	1	1	2	2	2	2	3	3	3
10 – 12 250 – 300	1	1	1	2	2	2	2	3	3	3
14 – 16 350 – 400	1	1	1	2	2	2	2	3	3	3
18 – 24 450 – 600	1	1	1	2	2	2	2	3	3	3
28 – 42 700 – 1050	1	1	1	1	2	2	2	3	3	3

*No pipe length should be left unsupported between any two couplings.

NOTE: 14 – 16" maximum hanger spacing values apply to 377 mm and 426 mm Style 77 couplings

Maximum Hanger Spacing

For straight runs without concentrated loads and where full linear movement is not required.

PIPE SIZE RANGE	Suggested Maximum Span Between Supports
Nominal Inches/mm	Feet/meters
3/4 - 1 20 - 25	8 2.4
11/4 - 2 32 - 50	10 3.0
21/2 - 4 65 - 100	12 3.7
5 - 8 125 - 200	14 4.3
10 - 12 250 - 300	16 4.9
14 - 16 350 - 400	18 5.5
18 - 24 450 - 600	20 6.1
28 - 42 700 - 1050	21 6.4

NOTE: 14 – 16" maximum hanger spacing values apply to 377 mm and 426 mm Style 77 couplings

Design Data

Light-Wall, Stainless Steel Rigid System Hanger Spacing

Light-wall, stainless steel piping requires hangers to meet the following spacing requirements. For flexible systems, refer to the preceding tables under the "Flexible Sysems" section. For rigid systems, refer to the table below for maximum hanger spacing.

P IPE SIZE	Suggested Maximum Span Between Supports Feet/meters	
Nominal Size Inches (mm)	Schedule 10S	Schedule 5S
2 50	10 3.1	9 2.7
3 80	12 3.7	10 3.1
4 100	12 3.7	11 3.4
6 150	14 4.3	13 4.0
8 200	15 4.6	13 4.0
10 250	16 4.9	15 4.6
12 300	17 5.2	16 4.9
14* 350	21 6.4	—
16* 400	22 6.7	—
18* 450	22 6.7	—
20* 500	24 7.3	—
24* 600	25 7.6	—

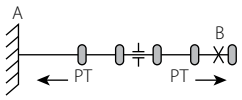
*Hanger spacing for these sizes applies to Style W89 and Style W489 AGS Rigid Couplings

ANCHORS

FLEXIBLE COUPLINGS – RIGID COUPLINGS

Anchors can be used to prevent movement due to pressure thrust. There are two types of anchors which are commonly used:

A. Main anchors
B. Intermediate anchors

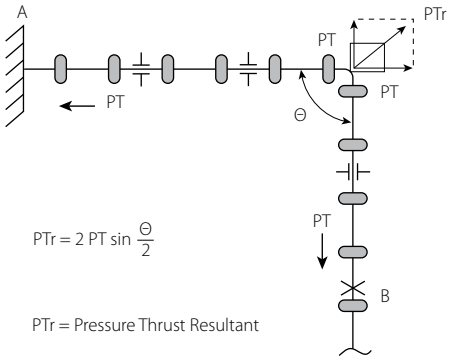


A. Main Anchors

Main anchors are installed at or near terminations and changes of direction of a pipe line. The forces acting on a main anchor will result from internal pressure thrust. These forces can generate substantial loads which may require structural analysis.

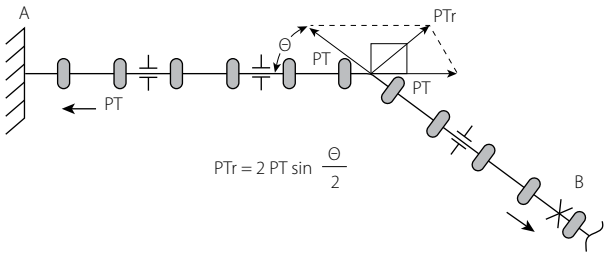
PT = Pressure Thrust (Pounds)
D = Outside Diameter of Pipe (Inches)
p = Internal Pressure (psi)

$PT = \frac{\pi}{4} D^2 p$



$PTr = 2\ PT \sin \frac{\Theta}{2}$

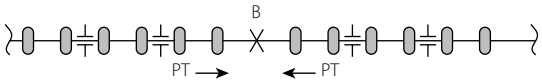
PTr = Pressure Thrust Resultant



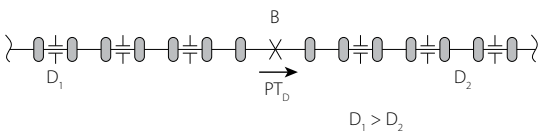
$PTr = 2\ PT \sin \frac{\Theta}{2}$

B. Intermediate Anchors

Intermediate anchors divide a long pipe run, with main anchors at each end, into individual expanding sections. The pressure thrust on the intermediate anchors cancel each other out.



Where there is a change in pipe diameter, there will be a differential pressure thrust acting on an intermediate anchor.



$D_1 > D_2$

Design Data

WCAS-67UH2J