Tech Note 27:
Expansion & Contraction

TN.27

Related Documents:
- Tech Note TN.02 Oils, Fuels & Viscous Liquid with Press-Fit
- Tech Note TN.04 Insulation & Stainless Steel (Lagging)
- Tech Note TN.20 Brackets & Supports

Allowing for Movement

As with all construction materials, pipework is no exception to the effects of expansion and contraction. In addition to understanding and allowing for live load movement, other movement changes must also be considered in the design stage.

Movement can be derived from thermal changes (hot-cold), climatic, structural, seismic, soil, vibration and impact with each requiring assessment to risk and force likely to be exerted. Note structural movements (building) is a specialised field and shall be referred to a qualified Structural or Hydraulic Engineer for assessment in these instances.

Thermal Movement

Each material has a different value attributed to how it behaves with temperature change. Temperature change can occur from conveying heated fluids, environmental influence such as direct sunlight, climatic daily min and max temperatures and other factors such as thermal bridging.

Materials in adjacent table with a small value (such as stainless) will change in length *less* than a material with a higher value (such as HDPE) in the same conditions.

Common Plumbing Materials	**Thermal Coefficient** (mm/K.m)
Carbon Steel	0.0117
Stainless Steel (316L)	0.0165
Copper	0.0168
Copper Nickel (90/10)	0.0170
PEX	0.0180
Aluminium	0.0231
uPVC	0.0504
ABS	0.0630
KG2000 (PP-MD)	0.0800
HDPE	0.1200
Polyethylene (PE)	0.1500
Values based on range 20 to 100°C.	

<u>Calculate the Thermal Movement</u>

Using the formula below, you'll need to know:
- The straight pipe length, in metres, from the nearest fixed point(s).
- The difference in temperature to be assessed, for example, 86°C hot water line from ambient install 21°C, the difference being 85-21 = **64°C**.
- The material coefficient – refer to the table adjacent or contact the supplier.

	Tube (Run) Length (m)		**Difference in Temp** (°C)		**Thermal Constant** (mm/K.m)		**Result** (mm)
Formula:	Length of tube from nearest fixed point	x	Media temp minus the ambient temp	x	Constant value (from the table above)	=	Expected expansion over the entire run length
Example:	30m	x	**64°C**	x	0.0165	=	31.68mm

Example: *A 30 metre straight, 85°C hot water line, in grade 316L stainless press-fit is being installed and the expansion amount from installation temperature (21°C) to commissioning at full temperature is required.*
Answer: *The pipe line will expand ~31.68mm over the entire 30 metre length, or around 1mm per metre.*

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Managing Movement
When assessed as part of a whole hydraulic system, the fittings and tube contribute to the overall dynamic nature of pipe system, along with suitable bracketing and design layouts to avoid undue force on the fixed pipework system and specifically the press-fit connections.

Knowing the expected change, various methods can be used to manage the movement(s) including:

- Bracketing: to direct material increases away from fixed bracket (FB) points and sliding brackets (SB) to maintain the pipework alignment.
- Expansion Loops: Using standard press-fit fittings to the calculations charted below, movement can be accommodated in the form or Z, T, U expansion loops.
- Specialised Fittings: Specific fittings such as Axial Expansion Bellows, flexible annular fittings or expansion couplings designed specifically to accommodate axial movements in pipework.
- Drainage Socket Design: Our drainage systems are design with each socket joint acting as a small expansion socket, allowing small movement whilst maintaining the water seal.
- A combination of all available methods.

Press-Fit Methods

	Axial Expansion Bellow	**Expansion Loops**
Description	A single piece semi-flexible press-fit fitting installed inline to the pipework.	A series of fittings in a measured shape with specific bracketing types and positions.
Application	Where small changes in length are expected in a straight in-line section of pipework.	Where larger changes are expected in three dimensions.
Movement Ability	Depending on the diameter; for example 54mm fitting -20 to +10mm movement. Refer to the product catalogue fitting *type 28* for movement extents.	Various depending on the length of the offset, up to ~90mm maximum. Refer to the charts in the *Expansion Loop* section below.
Bracketing (refer TN.20)	Install only 1x bellow fitting between two fixed brackets (anchor points). Support inline alignment with sliding wall brackets.	Positioned fixed & sliding type brackets to direct the expected movement and support the assembly.
Installation	By a licenced plumber to AS 3500.1. Above ground. Accessible for inspection. Recommend tagging or dating when installed and/or replaced.	By a licenced plumber to AS 3500.1 and/or AS 5601. Above ground. Clearance to allow for expected movement. Horizontal for hot water services.
Positive	Suits small and constricted situations. Single piece stainless steel fitting. Non-directional flow.	Permanent design element. Can be as a single large or multiple smaller loops.
Consider	Lower movement ability. Avoid tortional (rotational) forces. Movable component requires inspection and maintenance. Pressure rating.	Occupy a large space ~4.0m in some cases. Industrial appearance. Increases length of the system (flow). Increase in the number of joins. Installed horizontally to avoid thermal and air locks forming.
Maintenance	Ensure corrugations are clear of debris and allow free movement.	No special maintenance required.

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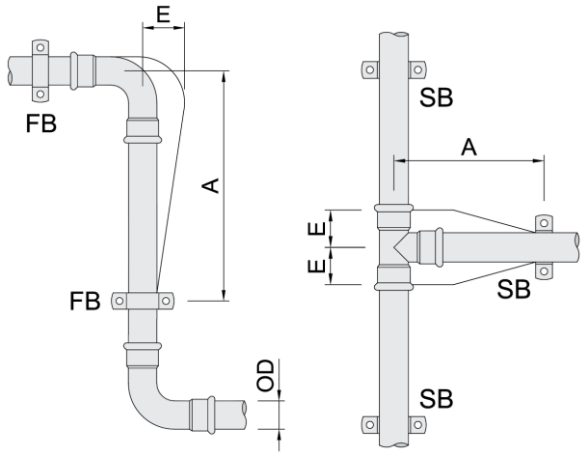
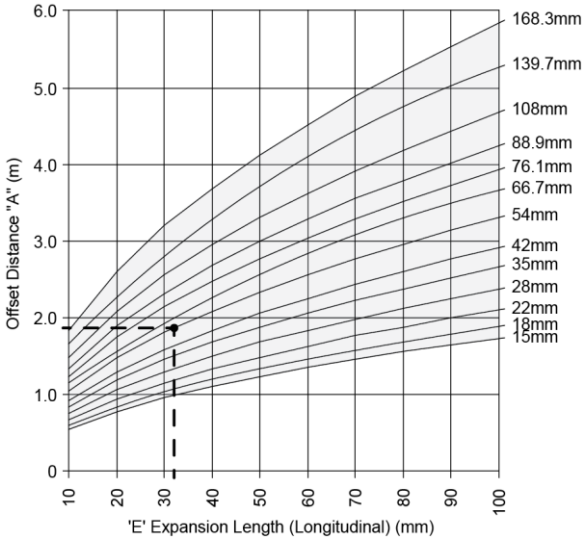
Expansion Loops / Deflection Legs

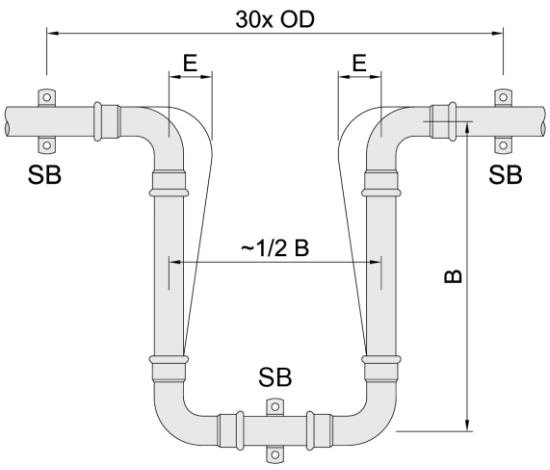
Depending on the shape to be installed, different offset lengths of tube are required to produce sufficient movement without placing undue force on the press joins. In the diagrams below, two types of brackets are described to support the pipework in different ways:

- FB: A fixed bracket acts as an anchor point and movement is *away* from these points.
- SB: A sliding bracket holds to the pipework while allowing movement in a controlled direction while still carrying the weight and supporting the pipework.

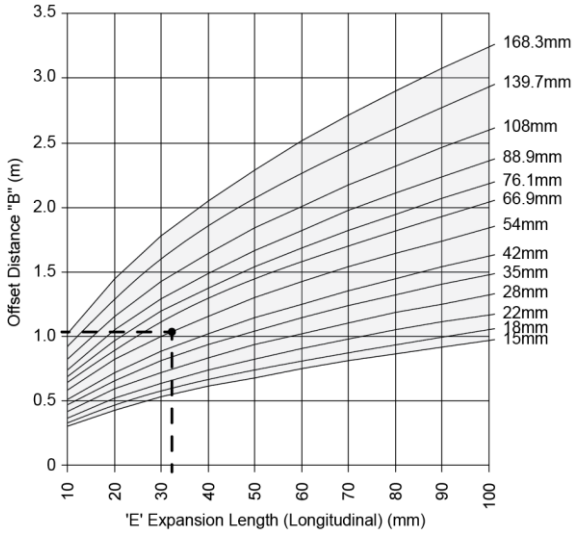


Z & T Shape Arrangements





U Shape Arrangement



Example: From the initial formula on page 1, where the pipe run is expected to grow by 31.68mm, the expansion loop shapes can be incorporated within the 30m run to absorb the movement.

Expansion distance (ie 31.68mm) is shown as dimension “E”, and the required design length of the leg shown as “A” for Z & T offset shapes, and “B” for U shape loops are found by using the charts and the pipe diameter (for this scenario 54mm diameter, A=1.8m offset or B=1.1m offsets are shown on the charts dashed).

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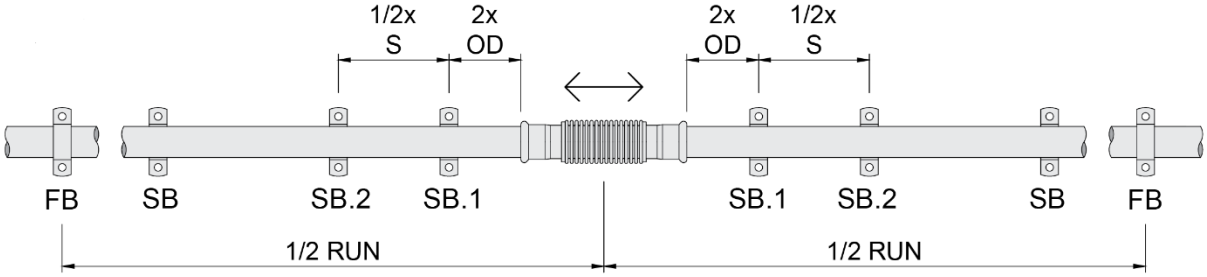
Bracket Systems

The type of brackets used influence the movement and support of the pipework. Suspended brackets on threaded rod will behave differently that wall mounted brackets. Insulated brackets or ferrules offer some movement too depending on the bracket. Refer to our Tech Note TN.20 for more information.

- Consider the material suitability with pipe materials and any bracketing or isolation strips.
- Suspended brackets on threaded rod can have inherited movement that can help or hinder the pipework and should be considered as part of the design.
- How the bracket is fixed to the structure is to be considered for suitability of forces.

Axial Expansion Bellows

Key to the performance of this flexible fitting is to ensure brackets maintain the pipework either-side inline and prevent misalignment. The distance between the fixed brackets (FB) is considered the 'run' for the expansion fitting. Position the fitting mid-way between the fixed brackets. Confirm the expected expansion distance (using the formula) is within the ability of the fitting. Ensure the fixed brackets (FB) are designed to withstand the forces from the pipework expanding (both temperature and water pressure). Arrangement is suitable for horizontal or vertical situations.



- Ensure brackets and supports are installed, aligned and correct before pressure testing.
- Avoid stretching or compressing the fitting when first installing from the delivered pre-set length, changes may affect the movement ability of the fitting.
- The first bracket support (SB.1) is to be positioned within 2x the tube diameter of the press socket, on the tube, both sides of the fitting (ie a 54mm fitting, bracket set back 54Ø x2 = 108mm from the press socket end.
- The next bracket support (SB.2) is to be spaced half the recommended maximum span for the tube size (ie for 54mm diameter, this second bracket is set back 1.5m from the first bracket SB.1). Maximum spans for each diameter are listed in Tech Note TN.20.
- Subsequent brackets are to be installed at spacings less than the maximum spans in Tech Note TN.20 (ie for 54mm diameter the remaining brackets at 3.0m centres) until the fixed bracket (FB) at the end of the 'run'.

Further Information

AS/NZS 3500.4 Heated Water Services considers the provision of expansion in Clause 4.13.3 and Appendix N where a nominated max length of 18m of straight pipe between two fixed anchor points requires provision for expansion.

For additional or specific information, please contact technical@auspress.com.au

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