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FluoroFlow® - Expansion Joints
User Manual

CE 2820

A guide to specification, storage, installation, operation and maintenance of CRP's range of PTFE-Expansion Joints.

An EC- Declaration of Conformity is illustrated on the previous page of this manual.

If you have any questions not answered by this manual, f.e.s. will be pleased to render assistance; our contact details can be found on the front page.

1. Introduction

This document is intended to provide information to aid in the specification, storage, installation, operation and maintenance of CRP's range of lined expansion joints. While the information contained here is based upon many years of experience, test results and design calculations, it is for general guidance only and is given without guarantee, warranty, or liability. In case of uncertainty on the part of the user, please contact the manufacturer for advice on any of the contents of this document. PTFE lined expansion joints cannot be treated in the same way as unlined steel products, and personnel responsible for all aspects of them should be competent to undertake such work.

2. Storage

PTFE-Expansion Joints should be stored indoors in cool and dry conditions because the end boards are not intended for prolonged outdoor exposure.
PTFE is a relatively soft material. Therefore, to protect the lined surfaces they are supplied with end boards. These boards should only be removed immediately prior to installation. If they are removed for inspection purposes, they should be replaced immediately, or irrevocable damage and distortion may occur. During removal of the end boards care should be taken to avoid damaging the flare faces of the products, since this will likely result in leakage once the item has been installed. During transport, expansion joints should not be moved by having anything placed inside the PTFE surface, such as the forks of a forklift truck, since this may well damage the liner, resulting in failure

3. Initial Inspection

Upon receipt, a PTFE-Expansion Joint should be thoroughly inspected to ensure that it has not been damaged during transport from the factory. If possible, this inspection should be carried out in a clean, dry, covered area to avoid any potential damage during the inspection process. The specification of the expansion joint supplied should be checked against that ordered both in terms of its physical attributes (size, flange type, number of convolutions etc.) and any special elements such as root ring material etc. The flare faces should be examined to ensure that they are free from scratches or other damage that would allow the joint to leak. Also, the convolutions should be examined to look for any abrasion, nicks in the PTFE, or any other damage.

Any contamination can be removed with a clean, soft cloth. Do not use abrasives such as steel wool, wire brushes or emery paper to clean expansion joints. These can cause scratches on the PTFE leading to premature failure.
Once the expansion joint has been examined, the end boards and further protection should be refitted until the expansion joint is due to be installed.

4. Painting

Generally, expansion joints are provided with high temperature paint that will maintain a reasonable service life in most environments. If the expansion joints have been purchased unpainted or there is a desire to apply further/different coats, then the flare faces and threaded holes should be protected. Also the product data plates should be masked. After painting the end boards should be replaced for storage before installation.

5. Welding

Welding, brazing, soldering or flame cutting must not be performed on lined products. These processes may damage the liner and toxic gasses may also be generated. Weld spatter hitting the PTFE- convolutions will cause expansion joints to fail prematurely. It is therefore vital that welding is not allowed in the vicinity of expansion joints at any time.

6. Installation

6.1. Transport

If an expansion joint is to be lifted by crane or other mechanical lifting device, it should be slung from one or more of the tie rods, but ensuring that the sling does not press against the convolutions. Never lift by slinging around or through the PTFE convolutions themselves.

6.2. End Boards

All expansion joints are supplied with end boards covering both flared faces. These should be kept in place until immediately prior to installation. Afterwards

it is good practice to keep the end boards so that if the bellows are removed from service during maintenance or similar, they can be refitted to protect the flare faces.

6.3 Flange Connections

Expansion joints are supplied with threaded bolt holes as standard. These should not be drilled out to create clearance holes due to the possibility of nuts/studs hitting the PTFE convolutions, leading to movement restrictions or damage to the expansion joints during the drilling process. In some circumstances, there is no danger of nuts/studs hitting the convolutions, and so flanges for expansion joints with clearance holes can be supplied. Consult the factory if clearance holes are required. When installed, no more than two threads of the connecting studs should protrude beyond the back face of the expansion joint´s flanges.

6.4 Tie Rods

Tie rods are basically supplied to limit the axial extension of the expansion joints to the maximum allowable length. These should never be extended, although if it is desired to limit the axial movement of an expansion joints they can be shortened. The tie rods should never be removed. It should be noted that tie rods are not designed to be sufficiently strong to resist all possible axial loads that could be applied by a piping system. Rather they are designed to resist any loads generated by pressure inside the expansion joints themselves.

6.5 Limit Sleeves

The limit sleeves are supplied to prevent the expansion joints from being over compressed. These should never be removed.

6.6 Movement Range Settings

Ideally an expansion joint should be fitted such, the movements it experiences will be located as near as possible to its neutral length, since this will ensure its life is maximised. It may, however, be appropriate to install expansion joints

extended or compressed compared to their neutral lengths so that at operating temperature it will almost return to its given neutral length.

For example, if an expansion joint is to cope with a movement say of 20 mm axially, it would be better to rearrange the adjacent pipework so that the movement is +/-10mm around the neutral length rather than the installation length +20/-0 mm.

6.7 Gaskets

Typically, gaskets are not required when PTFE lined items are being connected to similar products. Where components are connecting to dissimilar materials such as glass, ceramic or exotic metal the use of PTFE envelope gaskets or similar sealing material is recommended.

6.8 Bolting

Bolting materials should be of good quality, clean and well lubricated. The use of washers is recommended to ensure correct and even torque. Bolts should be tightened by use of a torque wrench in strict sequence of diagonally opposite pairs. This, and all subsequent torquing of bolts should be undertaken at ambient temperature. It is strongly recommended that all bolts are re-torqued a minimum of 24 hours after commissioning or following the initial full process cycle. The torque of all bolted joints should then be rechecked at least annually thereafter.

The following table displays recommended torque levels for ASME- and DIN-Types of flange-to-flange connections:

Torque and Bolting Details

Nominal Bore		ASME 150				PN10			PN16		
Inch	DN	Quantity	Bolts/Studs UNC	Bolts/Studs metric	Torque Nm	Quantity	Bolts/Studs metric	Torque Nm	Quantity	Bolts/Studs metric	Torque Nm
½"	15	4	1/2"	M12	7	4	M12	16	4	M12	16
¾"	20	4	1/2"	M12	15	4	M12	32	4	M12	32
1"	25	4	1/2"	M12	19	4	M12	40	4	M12	40
1.¼"	32	4	1/2"	M12	24	4	M16	55	4	M16	55
1.½"	40	4	1/2"	M12	27	4	M16	60	4	M16	60
2"	50	4	5/8"	M16	47	4	M16	66	4	M16	66
2.½"	65	4	5/8"	M16	53	8	M16	45	8	M16	45
3"	80	4	5/8"	M16	73	8	M16	50	8	M16	50
4"	100	8	5/8"	M16	54	8	M16	55	8	M16	55
5"	125	8	3/4"	M20	83	8	M16	74	8	M16	74
6"	150	8	3/4"	M20	108	8	M20	103	8	M20	103
8"	200	8	3/4"	M20	136	8	M20	137	12	M20	91
10"	250	12	7/8"	M24	127	12	M20	99	12	M24	118
12"	300	12	7/8"	M24	145	12	M20	104	12	M24	148
14"	350	12	1"	M27	182	16	M20	142	16	M24	191
16"	400	16	1"	M27	173	16	M24	197	16	M27	247
18"	450	16	1.1/8"	M30	262	20	M24	173	20	M27	245
20"	500	20	1.1/8"	M30	231	20	M24	197	20	M30	332
24"	600	20	1.1/4"	M30	331	20	M27	257	20	M33	494
28"	700	40	3/4"	M20	70*	24	M27	295	24	M33	337
30"	750	44	3/4"	M20	51*	Not applicable					
32"	800	48	3/4"	M20	66*	24	M30	385	24	M36	435
36"	900	44	7/8"	M24	77*	28	M30	365	28	M36	415

* Note that for 28" and 32" ASME 150 torque for Series B flanges are quoted.

The torque values given above should be understood as guidance line; they may be exceeded by a value of 50 % as effective seal. If once this torque level has been reached and a tight connection has not been achieved, it is likely that some other source of failure, such as scratched flare faces, is operating.

Note: When bolting together dissimilar materials, always tighten to the lowest recommended torque of the components in the joint. Using higher torques may result in damage to the softer material in the joint.

6.8.1 Disassembly

The bolts on lined systems must not be loosened while the system temperature is above 60°C otherwise flare distortion or irrevocable damage may occur. Always secure end covers to the flanges of lined components which have been removed from a system, this will prevent damage, the ingress of dirt and allows trouble free re-assembly.

6.8.2 Stud/Bolt Length Calculator

To calculate the length of stud/bolt required for any joint, it is necessary to calculate the half joint length for the two flanges that make up the joint, and then add them together. In addition, allowance must be made for any wafer pattern item, such as an instrument tee, that is included in the joint. The information overleaf provides half joint thickness for expansion joints.

Data of Expansion Joints

Nominal Bore		Half Joint Total Thickness
Inch	DN	
1"	25	14.5
1.¼"	32	14.5
1.½"	40	18.5
2"	50	18.5
2.½	65	18.5
3"	80	18.5
4"	100	20
5"	125	24
6"	150	25
8"	200	27.5
10"	250	26
12"	300	26
14"	350	28.5
16"	400	27
18"	450	29.5
20"	500	33
24"	600	33.5
28"	700	36.5
30"	750	40.5
32"	800	40.5
36"	900	40.5

Please note: As Standard, expansion joints are supplied with threaded flange holes

Nut/Stud Data

Metric Thread	Threaded Pitch (mm)	Nut Thickness (mm)
M12	1.75	10
M16	2	13
M20	2.5	16
M24	3	19
M27	3	22
M33	3.5	26
M36	4	29

UNC Thread	Threaded Pitch (mm)	Nut Thickness* (mm)	
		Ordinary	Heavy
½"	2	11	13
⅝"	2.3	14	16
¾"	2.5	17	19
⅞"	2.8	19	23
1"	3	22	26
1.⅛"	3.6	25	29
1.¼"	3.6	28	32
1.½"	4.2	33	38

*Assuming nuts are faced on one side

If using an item with threaded holes, no nuts are required. If the threaded holes are blind, no clear threads need to be added for that side of the joint. If the threaded holes are through holes, clear threads may also be added if required.

6.9 Safety Shields

For all PTFE- Expansion joints, excluding those with a metallic outer shell, there is only one layer of PTFE between the contained media and the outside environ. Therefore, CRP recommends the use of safety shields on expansion joints for hazardous duties.

6.10 Pipe Supports

Expansion joints should not be fitted and the system pressure tested until all necessary supports on the adjacent pipework have been installed. Not considering this could overexert the expansion joint beyond its allowable limits, enabling the risk of premature failure.

Almost all pipework systems are subject to a variety of forces, such as thermal expansion, vibration, internal pressure etc. which can give rise to unwanted pipework movements.

To ensure the longevity of the pipework system it is critical that these movements are considered and suitable measures, including pipework supports are taken to accommodate them. PTFE bellows can provide one part of the solution in accommodating such movements. It is beyond the scope of this document to define suitable pipe supports, however regarding expansion joints the designer must take account of the following:

Pipework adjacent to expansion joints must be suitably supported to prevent inappropriate loads being transferred to the expansion joints.

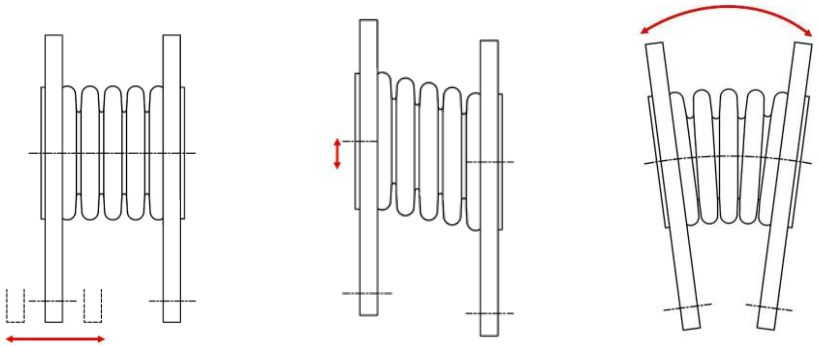
E. g. a vertically mounted expansion joint should not be considered to support the weight of the pipework mounted above or below it.

Expansion joints have significant spring rates and can exert significant loads on adjacent pipework as they are expanded or compressed. As expansion joints are pressurised, this creates end loads on the adjacent pipework.

Nb. For the above reasons, vertically mounted expansion joints should not be attached directly to vessels on load cells.

6.11 Allowable Movements of Expansion Joints

Expansion joints are designed to allow axial, lateral and angular movements, and combinations of those travels.



Axial Movement Lateral Movement Angular Movement

It is inacceptable to combine the maximum amount of any single movement together with further amounts of other possible travels. The following is a useful rule of thumb in trying to assess situations where a combination of movements is required:

$\mathbf{D_x}$ = axial movement
$\mathbf{D_y}$ = lateral movement
$\mathbf{D_a}$ = angular movement

$$\frac{\mathbf{D_x}}{\mathbf{D_{x\,max}}} + \frac{\mathbf{D_y}}{\mathbf{D_{y\,max}}} + \frac{\mathbf{D_a}}{\mathbf{D_{a\,max}}} \leq \mathbf{1}$$

Nb. Expansion Joints are not designed to allow torsional movements (rotation around their axis). If such type of movements occur this will compromise the integrity of the bellows and lead to immediate or premature failure.

7. Post Installation Inspection

After installation, and again after the first process cycle, the expansion joints should be re-inspected particularly to detect any increased misalignment compared to the original assembly. If any increase has occurred appropriate action should be taken to remedy the situation.

7. System Pressure Testing

In deciding upon the appropriate line test pressure, this should be calculated to be 1.5 times the rated pressure of the lowest rated lined piping component in the system, unless some other constraint from another item in the system requires a lower test pressure to be used.
In undertaking a pressure test, care should be taken to ensure that (a) a pressure test of the complete system is made and (b) all the test pressure has been removed from the system at the end of the test.

9. Maintenance and Routine inspection

9.1 General Product Specification

First check that the chosen expansion joint is that which was specified for the duty. Are the process conditions still valid and is the expansion joint suitable for it? If the expansion joint has no identification plates, then you should be alert.

If there is any leakage around the expansion joints or any significant damage or discolouration of the PTFE convolutions, then this should be investigated. Take precautions not to endanger personnel during these examinations.

9.2 Steelwork Inspection

Check that the connecting bolts of the expansion joints are in place, are not corroded and do not (and do not have the potential to) damage the convolutions. Ensure the flanges are undamaged. That the tie rods are present, move freely and are undamaged with the limit bolts set correctly. Make sure that the limit sleeves are present and undamaged and that the root rings are similarly undamaged and show no signs of corrosion. Check that the material of construction of the root ring is correct for the chemical service. In particular, make sure that if it is stainless steel, that these could not be subject to chloride attack – either from permeation or atmospheric corrosion.

9.3 Installation Inspection

Make sure the expansion joint is not subject to loads beyond that intended for the management of expansion or vibration and that they are installed for the right reason – that is not to correct misalignment or poor engineering design. Check that the movements required are within the specification of the expansion joints and that the tie rods and limit sleeves are fulfilling their purpose. Ensure that there is no rotational movement.

9.4 Convolution Inspection

Check the outer surface of the expansion joints for physical damage. Look for any signs of permeation and for damage from deformation of the expansion joints or any other evidence of damage or stress.

9.5 Internal Inspection

Look for any signs of mechanical damage or chemical attack – most likely through permeation resulting in blistering or delamination. Make sure there is not solid material held up between the convolutions. If there are internal vacuum support rings, then check that they are in good condition.

10. Design Considerations

10.1 General

Expansion joints are not designed to accommodate incorrect pipework installation. In fact, they should be fitted with as much care as a pump and similar equipment. In assessing the required movements from an expansion joint, evident construction tolerances should be considered. Under no circumstances should maximum and minimum allowable operating temperatures and pressures be exceeded. If there is a possibility of temperature or pressure surges, beyond the operating range of the expansion joints, systems must be put in place to prevent such surges from occurring and if appropriate monitoring devices should be used.

10.2 Chemistry

It is the responsibility of the user to ensure that the products are suitable for conveying the intended chemical(s) and for the intended operating conditions. In addition, these products are not approved for conveying unstable fluids.

10.3 Erosion

Specifically, consideration must be given to the effects of corrosion, erosion/wear, including potential effects from turbulence and vortices etc. It should be noted that while PTFE has outstanding corrosion resistance, it has limited erosion resistance, and contained fluid velocities should be kept below 15m/s.
If an expansion joint is to be used with abrasive slurries or solids, a smooth bore internal sleeve should be used to ensure smooth flow through the item to minimise the risk to the PTFE convolutions from abrasion by the contained fluid.
The following provides general guidance on the handling of slurries. However, the degree of erosion is dependent on the nature of the solids being handled, and therefore in cases of doubt, it is recommended that testing be carried out to prove the suitability of lined piping.

Ideally, the flow velocity should be kept at 0.6 to 1.2 m/sec but in any case, should not be more than 2.1 m/sec. Consideration must be given to components where the flow path is convoluted, since this may give rise to local flow velocities more than the general flow velocity.
To minimize erosion, particle sizes should be less than 60 microns. Particle sizes greater than 150 microns will likely result in unacceptable levels of erosion. Intermediate particle sizes will likely result in acceptable levels of erosion.

Regular inspections of the insides of expansion joints system should be conducted to ensure that no excessive erosion has occurred.

10.4 ATEX & Static Charge Build up in Lined Pipework

All products manufactured by CRP have been assessed against the requirements of ATEX Directive 2014/34/EU. None contain any potential sources of ignition and so fall outside the scope of this directive and are not CE marked according to it. However, the user must be aware that when using certain (non-conductive) media at certain flow velocities a potential for static charge can arise. Under the requirements of the ATEX Directive 1999/92/EC, the user must consider this possibility and address any hazard that may result. When relevant, CRP recommends the use of static dissipating PTFE-Types, and suitable earthling devices as required.

10.5 Other

In designing the support structure, the user must consider the following factors in both operating and test conditions, and the possibility of more than one of these loads occurring simultaneously:

- Internal Pressure from contained media
- Mass of contained media
- Traffic wind and earthquake load
- Potential to overstress flanges
- Vibration

- Reaction forces and moments which result from the supports, attachments, thermal movement, other piping etc.
- Fatigue etc.

In earthquake conditions, CRP is unable to guarantee the integrity of its products, and the user must take suitable precautions to guard against potential product failure and its consequences in these circumstances.

It is the responsibility of the user to ensure that suitable pressure relief and other appropriate safety devices have been included in the design of the entire pressure system, and that discharges from such equipment have been considered, including draining facilities to prevent liquid build up in gas lines which may give rise to water hammer.

If the products are to reach temperatures during operation or test which would be harmful to individuals and they may come in contact with the products in these conditions, it is the user's responsibility to overcome this hazard.

The user is responsible for ensuring that suitable provision is made to allow for any necessary draining and venting of the system.

The user is responsible for ensuring that suitable provision is made to allow for isolation of take-off pipes if these are of a size to present a significant risk. In addition, the risk of inadvertent discharge must be minimised, and the take-off points must be clearly marked on the permanent side, indicating the fluid contained.

By their nature, PTFE-Expansion joints are not fireproof (PTFE tends to soften and will denaturise under extremes of heat). Therefore, if appropriate, the user must consider how to meet any damage limitation requirements in the event of a fire.

If expansion joints are to be placed underground, it is recommended that, as a minimum, their position and route be recorded in the technical documentation to facilitate safe maintenance, inspection and repair.

If expansion joints are to be used to for wet chlorine duty, the maximum temperature must not exceed 150°C. Above this temperature, any chlorine that permeates the liner may react with the steel shell, giving rise to cause fire.

EC Declaration of Conformity
We hereby declare that the CRP FluoroFlow range of PTFE-Bellows DN 25 - DN 900, comply with the requirements of the relevant sections of the Pressure Equipment Directive 2014/68/EU.
Manufactured by:
CRP Ltd, Todmorden Road, Littleborough, OL15 9EG, UK.
Assessed by the Notified Body:
Irish Engineering Service, RSA House, Dundrum Town Centre, Sandyford Rd, Dublin 16, Ireland. Notified Body No.: **2820** **Certificate No.: CAT000530371/PED/v1.0**
Assessed against the requirements of the Conformity Assessment Procedure:
Module H
Designed & manufactured to meet the appropriate requirements of the following standards as relevant:
ASME B31.3 ASTM F1545 DIN 2848 DIN 2874

Signed ……. David MacGregor, Engineering Manager