BHC Jílové s.r.o.
252 82 Kamenný Přívoz 291
BHC Jílové – hadice a kompenzátory

Operating manual for expansion joints (including expansion joints for pressure equipment according the Pressure Equipment Directive 2014/68/EU)

General

Type codes overview
Axial-expansion-joints: XXX / serial number

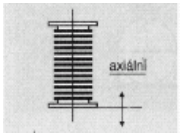
ANS = Axial-expansion-joint equipped with welding ends on both ends
ALS = Axial-expansion-joint equipped with welding ends and guiding sleeve on both ends
ANFH = Axial-expansion-joint with welded firm flange on one end, and floating flange on the other end
ANL = Axial-expansion-joint equipped with stainless steel weld-neck collars and floating flanges on both ends
AUA = Axial-expansion-joint with male union thread and outer protection sleeve on both ends
ABS = Axial-expansion-joint equipped with welding ends, outer and quiding sleeve on both ends
ABXI = Axial-expansion-joint with female union thread, outer and quiding sleeve on both ends
ANB = Axial-expansion joint with floating flanges
ADS = Axial-expansion-joint, externally pressurized, with welding ends (ADS) or male union threads (ADA) on both ends
AUS ONE = One – off axial-expansion-joint with welding ends, with outer protection tube, for district heating
ADS MUF = Axial-expansion-joint, externally pressurized, with welding ends on both ends, for district heating

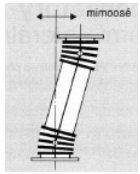
Other type codes – at request.

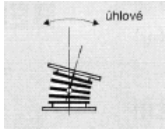
Type code = DN - PN – Movement in mm

Code designations / Markings
DN - Nominal inside diameter in mm
PN - Pressure class, i.e. design pressure, referring to the room temperature 20° C (RT)
PS - Service pressure (min. and / or max. pressure at service temperature (TS)
TS - Minimum (-) and maximum (+) service temperature
2020 - Example: Year of production or 08/20 = month/year of production
CE - Pressure equipment acc. to Category I of PED 2014/68/EU
CEXXXX - Example: product acc. to Category II, III and IV of PED 2014/68/EU
Without - Product below Category I = According to good engineering practice, or beyond the scope of the PED 2014/68/EU

Modes of operation
axial / lateral / angular







Expansion joints compensate thermal expansion of piping, equipment and structures, mechanical expansion induced by wind, settlement of buildings, seismic activity, vibration of rotary machines, noise. They are used also to reduce the force transferred from the piping to the equipment as well as the tension of the path.

The following rules are to be observed upon design and prior to assembly:

1. Determination of the required movement $\Delta l = \alpha \times \Delta t \times L$

α = Coefficient of thermal expansion mm/°C/m, Δt = Temperature difference in °C,
L = Distance between two anchor points of the piping in m

α Coefficient of thermal expansion 20 [°C] ÷ T α [mm/ m/°C]

Temperature [°C] >	100	200	300	400	500
Carbon steel	0,0111	0,0121	0,0129	0,0135	0,0139
Refractory 15	0,0131	0,0131	0,0135	0,0141	0,0143
Austenitic	0,0164	0,0171	0,0178	0,0180	0,0183

2. Determination of the required expansion joints, by observing the following:
- Always install only one expansion joint or hinged system between two anchor points.
- In case of expansions exceeding the movements provided by the expansion joint, divide the pipe length into sections.

3. Determination of anchor force and anchor construction.
Note: For each axial expansion joint, an anchor point must be present on both ends of a direct piping section!!

4. Determine pipe guides and pipe rests for pipe routes see page 5

5. Determine pre-stress of expansion joints see page 6

Intended use
The expansion joints have been designed, constructed and produced according to the customer's specifications including, among others, requirements for media, pressure, temperature and diameter. They are to be installed and operated in an appropriate manner. Operation and installation instructions contained in attached documents are to be observed.
It is necessary to observe especially the following:
- **Pressure** – (max. admissible working overpressure of the expansion joint must not be exceeded)
- **Temperature** – Stainless steel axial expansion joints are generally designed and classified according to pressure classes PN, and will be approved res. certified according to the relevant classification. This means in practice that a maximum service temperature of TS 20 °C must not be exceeded. In case the maximum service temperature TS is higher than +20 °C, the maximum service pressure and expansion must be reduced = multiplied by a temperature reducing factor Kp and Kd, see the table below:

PRESSURE Kp and expansion Kd TEMPERATURE reducing factor

Temperature [°C]>	100	200	300	400	500
Kp	0,9000	0,8000	0,6700	0,6100	0,5700
Kd	1,0000	0,9000	0,8500	0,8000	0,7500

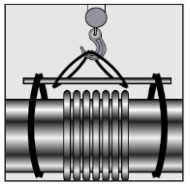
Cycle KL reducing factor for higher number of cycles

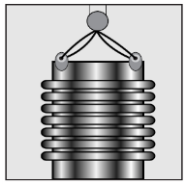
Number of cycles	1000	2000	3000	5000	10000
KL	1,0	0,82	0,73	0,63	0,51

- **Resistance** – All bellows materials have to be resistant in operation against the transported media under the specified operating conditions. If necessary, this has to be checked against the resistance charts (the maximum allowable temperature depending on the media must not be exceeded).
  Note: If a material standard is specified in the order, the expansion joint must be

marked with the material numbers on all parts in touch with the medium. In all cases the manufacturer must carry out risk analysis for the medium specified in the order. In case of doubts about the specified material, the operator has to be informed for clarification. If the medium is not clearly indicated in the order specification, the manufacturer is not able to carry out a risk analysis for the chemical resistance of the materials. Basically, according to the labour protection laws, the operator is obliged, to verify (within the risk analysis) whether the material will be resistant against the given medium.
- In order to operate the expansion joints safely, technical, organizational and personal protective measures are to be carried out. Priority is always to be given to technical and organizational measures. If not all dangers can be avoided, effective personal protective equipment is to be provided and used.

Manipulation
- In the pictures below is indicated the only way of manipulation with expansion joints with pipe ends, i.e. lifting by pipe ends only. Connecting rods, tie rods and other equipment of expansion joint cannot be used for manipulation.
- It is needed to be careful during lifting, to prevent damage the bellows and any connecting elements (connecting rods, tie rods, etc.).
- Flanged expansion joints can be lifted by the flanges only.





Storage prior to installation
For the storage of expansion joints, especially the following must be observed:
- Store in a cool, dry and low-dust area; cover all adjacent and close heat sources.
- Cover the expansion joint ends (incl. the flared ends) with protection caps, in order to protect the inside from soiling and corrosion (after final evacuation res. cleaning).

Assembly
In order to ensure the serviceability of the expansion joints and not to shorten their service time by additional strains, the following is to be observed;
- The expansion joints have to be installed in a way that their natural position and movement are not constricted. Make sure that during assembly and later during operation, the bellows is not loaded with a torsion greater than the expansion joint allows to transmit.
- Arrange all sealing of expansion joints equipped with flanges in a centric pattern, and ensure a crosswise bolting of the counter flanges. If necessary, use a torque wrench (this is necessary for certain sealing -see manufacturer indications).
- The expansion joints must not be stressed in operation by additional outside influences that were not mentioned in the design data and for which they are not designed.
- Tightening of all unlockable joints must be checked before operation.
- The bellows movement data indicated by the manufacturer must not be exceeded (see catalogue figures).
- The bellows must be protected against outside mechanical (see above), thermal, or chemical influences, also during installation, e.g. when welding the fittings.
- The bellows convolutions must be free of soiling and must not be constricted in their movement (any constriction would reduce the service time!)
- Check and adjust, if necessary, the piping and bearings close to the expansion joint.
- Do not start operation of the expansion joint in case outside damages of the bellows are visible
- In case of pre-stressed expansion joints secured by a transport lock – do not remove the pre-stress device/locking rods before the installation is finished. Locking rods are usually painted yellow.

Issued: 5.6.2024

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Special guidelines for installing expansion joints with externally pressurized bellows

- Expansion joints shall be installed in pre-stressed condition, i.e. with the pre-stress devices.
- Once the expansion joint has been installed, the pre-stress devices should be removed.
- In case the expansion joint is put into operation in a steam system, the system should be started up slowly enough, in order to evaporate the condensate collected in the expansion joint during the system cooling, or after a piping pressure test, without pressure shocks. Pressure shocks of any origin pose threat to expansion joints and may even lead to their destruction.
- Expansion joints can be mounted in any position. However, if installed in vertical position, the side provided with the fixed pipe coupling shall point downward.

Service, maintenance, inspection
Depending on the installation and service conditions (relevant here: medium, min. / max. service pressure, min. / max. service temperature, flow characteristics under all conditions, external influences, e.g. mechanical, corrosion, temperature and vibrations) the serviceability of the expansion joints is to be checked within appropriate intervals. Especially in case of aggressive, poisonous and highly inflammable media, these checkups are to be carried out in short intervals.

Cleaning
Expansion joints have to be cleaned and rinsed after service and before each inspection. In case of cleaning with steam or chemical additives, the resistance of each component is to be observed (the use of steam jets is not allowed).

Inspection intervals
The safe condition of expansion joints subject to regular inspections is to be verified by a qualified person:

- Before initial operation (expansion joints delivered ready for service: random checks)
- At regular intervals after initial operation (each expansion joint). E.g. for bellows with thermo-plastic inner layer min. annually, steam expansion joints biannually. An increased strain requires shorter inspection intervals, e.g. in case of increased mechanical, dynamical, or chemical strain.
- After each maintenance
- For pipelines in pre-insulated pipelines, expansion joint inspections cannot be carried out during operation. There is a moisture sensor in the insulation that signals a leak.

Scope of inspection
The type and scope of the inspection (e.g. pressure test, visual examination inside and outside, testing of electrical conductivity etc.) are to be set by "qualified personnel" acc. to the internal work safety regulation of the operator.

Repairs
Any repairs on expansion joints have to be carried out by a "qualified person" acc. to the internal work safety regulation of the operator with subsequent inspection, marking, and documentation.

Special features are valid for the following expansion joint types:

- Expansion joints for steam applications. In case of expansion joints without outer thermal insulation, there is an increased risk of burning due to the high thermal conductivity.
- Metal bellows are sufficiently conductive without any additional measures.
- Pay special attention to any kind of damages and deformations of the bellows, e.g. buckling, kinking, deformation of convolutions, mechanical damage.
- Avoid any contact with chlorides, bromides, iodides, or rust during storage.

Pipe anchor load
The forces (F) acting on the anchor points at the ends of a pipe run (L) whose expansion/contraction is to be absorbed, result from:

Thrust force (Fa), Inherent resistance (Fc), Pipe friction (Fr)

The thrust force (Fa) of the expansion joint, which stresses the pipe anchor at both sides, is calculated from the product of the effective thrust area (AB) multiplied by the maximum working or test pressure.

$$F_A = P_S * A_B \quad [N;Mpa,mm^2]$$

The deflection force (Fc) of the expansion joint is the force which the bellows opposes during a movement, and which is shown in the specification sheets as the stiffness for ± 1 mm movement absorption, is calculated as:

$$F_c = C_a * (\Delta l) \qquad [N;N/mm,mm]$$

The pipe friction forces depend on the pipe friction coefficient, the pipe support, the arrangement as well as the weight of the pipe run (G) and are calculated as

$$F_R = \mu * G * L*9.81 \qquad [N; - , kg/m,m,-]$$

μ = coefficient of friction, G specific mass including the medium and insulation kg/m

Load on the main anchor point:

$$F_H = F_A + F_C + F_R \qquad [N;N,N,N]$$

Load on the intermediate anchor point:

$$F_Z = F_C + F_R \qquad [N;N,N]$$

Presetting and fitted length
The presetting or correct fitted length of an axial expansion joint, which depends on the installation temperature (T_E) – pipe wall temperature –is calculated as:

Temperature difference

$$\Delta T = T_{max} - T_{min} \qquad [°C;°C,°C]$$

Temperature difference between installation and min. temperature

$$\Delta T_1 = T_E - T_{min} \qquad [°C;°C,°C]$$

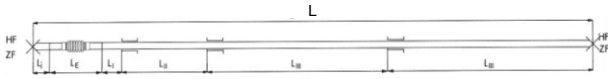
Prestressing (ΔR = pipe expansion in mm) $V = \Delta R \left(0.5 * \frac{\Delta T_1}{\Delta T}\right)$ [mm;mm,°C,°C]

Installed length L_E = Overall length +/- presetting [mm;mm,mm]

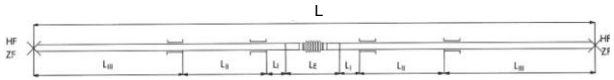
Distances between pipe supports

Pipe guide distance: L_I = max. 4.DN
(ΔR = dilatace) L_{II} = 0.6 * pipe support span
L_{III} = pipe support span

Expansion joint directly adjacent to the pipe anchor point



Expansion joint in the middle of a pipe run



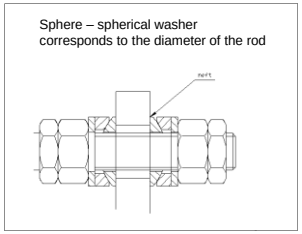
Tightening torques of screws of flange connections for mater. 8.8, 4.6, A2, A4
(following table is based on ČSN EN 1591-1:2015, Annex B, article B.4)

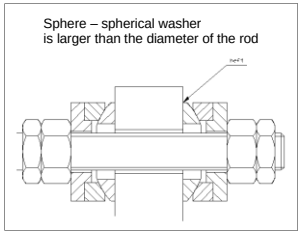
$M_{t,nom}$ = nominal torque acting when tightening the screw
F_{B0nom} = nominal force in one screw in assembly condition after tightening $M_{t,nom}$

Screw [mm]	p_t [mm] thread pitch	Mat. 8.8		Mat. 4.6		Mat. A2		Mat. A4	
		$M_{t,nom}$ [Nm]	F_{B0nom} [N]	$M_{t,nom}$ [Nm]	F_{B0nom} [N]	$M_{t,nom}$ [Nm]	F_{B0nom} [N]	$M_{t,nom}$ [Nm]	F_{B0nom} [N]
M10	1,5	27,3	8958	16,4	5375	17,1	5599	23,9	7838
M12	1,75	46,3	12975	27,8	7785	28,9	8110	40,5	11353
M16	2	112,7	23764	67,6	14258	70,4	14852	98,6	20793
M20	2,5	220,1	37130	132,0	22278	137,5	23206	192,5	32488
M24	3	380,3	53466	228,2	32079	237,7	33416	332,7	46782
M27	3	553,5	69003	332,1	41402	345,9	43127	484,3	60378
M30	3,5	751,3	84532	450,8	50719	469,5	52833	657,4	73966
M33	3,5	1020,4	103815	612,2	62289	637,7	64884	892,9	90838
M36	4	1310,8	122677	786,5	73606	819,2	76673	1146,9	107342
M39	4	1689,1	145703	1013,5	87422	1055,7	91064	1478,0	127490
M42	4,5	2092,0	167904	1255,2	100742	1307,5	104940	1830,5	146916
M45	4,5	2601,8	194674	1561,1	116804	1626,1	121671	2276,6	170340
M48	5	3135,5	220213	1881,3	132128	1959,7	137633	2743,6	192686
M52	5	4048,8	261338	2429,3	156803	2530,5	163336	3542,7	228671

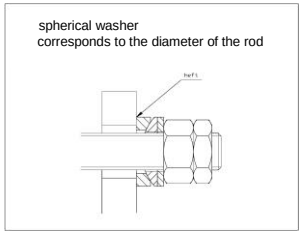
Additional note for the lateral expansion joint with tie rods and spherical washers

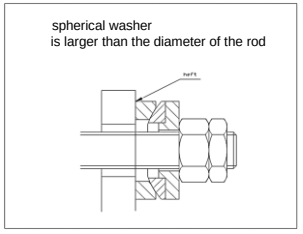
Sphere – spherical washer type 1K and 2K





Spherical washer type 3M and 4M





The nuts are set correctly at the factory, according to the construction length of the expansion joints. It is not intended to change the length of the expansion joint during installation (it would affect correct function of expansion joint). If it is necessary to remove the nuts, for some reason, then it is necessary to set the expansion joint on original construction length again, by nuts. For spheres – spherical washers (type 1K and 2K) the nut on one side is tightened and secured with a lock nut, and the gap 0,5 mm have to be set on second side and also secured with a lock nut.

Issued: 5.6.2024