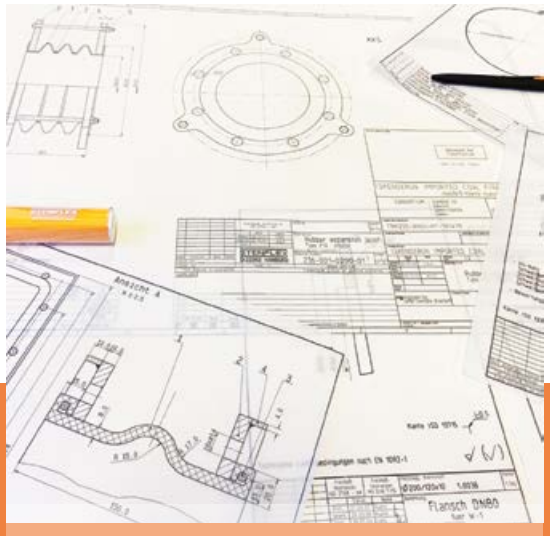
STENFLEX®

TECHNICAL ANNEX
PROGRAMME OVERVIEW

WHETHER YOU ARE LOOKING FOR FLANGE CONNECTION DIMENSIONS, MATERIAL COMPARISONS, INFORMATION ON THE LAYOUT OF FIXED POINTS FOR PIPELINES OR CONVERSION TABLES – **ALL THE TECHNICAL DATA YOU NEED** AS WELL AS HELPFUL INFORMATION REGARDING FLEXIBLE PIPE CONNECTIONS.



QUALITY.

TECHNICAL ANNEX

MOVEMENT AND FORCE AT EXPANSION JOINTS

MOVEMENT

Before opting for a expansion joint type, it is important to decide on how a change in length of a pipe system is to be compensated.

The choice of the expansion joint type depends essentially on the securing expansion, on the routing of the piping system and on the space available.

Pipe expansion can be absorbed by shift and deflection of a certain type of expansion joint.

When choosing an expansion joint the following types of movement must be considered:

- axial movement
- lateral movement
- angular movement

RUBBER EXPANSION JOINTS

If both axial and lateral (superimposed) movement are simultaneously introduced into a rubber expansion joint, its maximum extension in the axial direction and its ability to absorb the highest rated movement are reduced (see diagram ❶).

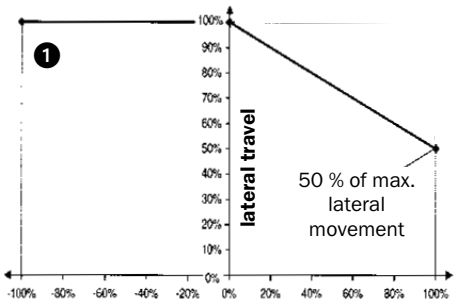
The interrelation of superimposed angular and axial movement is shown in diagram ❷.

STEEL EXPANSION JOINTS

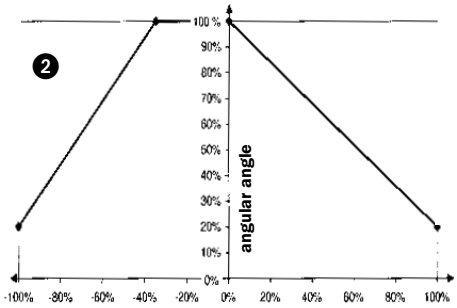
If axial and lateral movement are simultaneously introduced into a steel expansion joint (superimposed movement), the lateral share is converted by an equation into an equivalent axial path and must not exceed 100 % when added. Please contact our Technical Consultation Service.

RUBBER EXPANSION JOINTS: INFLUENCE OF TEMPERATURE ON THE PERMISSIBLE INNER PRESSURE

The maximum permissible operating pressure of rubber expansion joints stated in the data sheets refers to a temperature of 20 °C. The pressure must be reduced with rising temperature as the strength of bellows materials decreases with rising temperature (see table).



Restriction of the lateral movement with simultaneous axial movement (universal expansion joints)



Restriction of the angular deflection with simultaneous axial movement (universal expansion joints)

MAX. PERMISSIBLE OPERATING PRESSURE (BAR)

Temperature °C	Type series A. AG. B. R bar	AS. RS bar	AR bar	GR-SAE bar	E. G bar		C bar			W bar
20	16	16	25	16	10	16	4	10	16	2.5
30	16	16	25	16	10	16	4	10	16	2.5
40	16	16	25	16	10	16	4	10	16	2.5
50	16	16	25	16	10	16	4	10	16	2.5
60	16	16	25	16	10	16	4	10	16	2.5
70	14	15	22	15	9	14	3.5	9	14	2
80	11	14	20	14	7	11	2.8	7	11	1.7
90	6	12	16	12	4	6	1.5	4	6	1
100	6*	10	11	10	4*	6*	1.5*	4*	6*	1*
110		6	6	6						
120		6*	6*	6*						
130		6*	6*	6*						

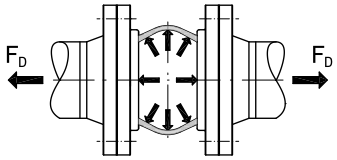
*for brief periods (max. 100 hours)

FORCE OF AXIAL EXPANSION JOINTS

Axiale compression force F_D referred to structural length (reaction force)

Axial compression force is the longitudinal force resulting from internal pressure.

F_D = axial compression force (N)
A = effective bellows cross sectional area (cm2) (see data sheet tables)
p = internal pressure (bar)



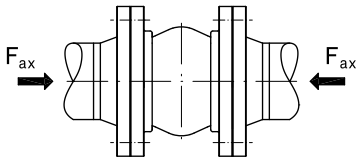
$$F_D = A \cdot p \cdot 10$$

Axial bellows moving force F_{ax}

The axial bellows moving force is the force required for the axial movement of the bellows.

It results from the stiffness of the bellows together with the movement.

c_{ax} = axial bellows moving rate (N/mm)
Δ_{ax} = axial travel (mm)
\+ = sign for compression
\- = sign for extension



$$F_{ax} = c_{ax} \cdot \Delta_{ax}$$

Axial bellows total force F_{axB}

Addition of axial compression force and axial bellows moving force

F_{axB} = total axial force of the bellows (N)
\+ = compression force on pipe
\- = tensile force on pipe

$$F_{axB} = F_D + F_{ax}$$

FORCE OF LATERAL EXPANSION JOINTS

Lateral bellows moving force F_{latB}

The lateral bellows moving force is the force required for the lateral movement of the bellows. It results from the stiffness of the bellows together with the movement.

F_{latB} = lateral bellows moving force (N)
c_{lat} = lateral bellows spring rate (N/mm)
Δ_{lat} = lateral travel (mm)

$$F_{latB} = c_{lat} \cdot \Delta_{lat}$$

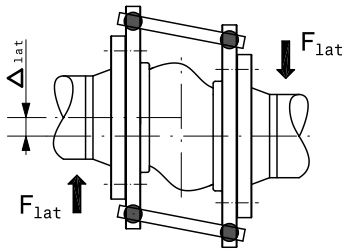
Total lateral moving force F_{lat}

STENFLEX® ateral expansion joints are equipped with tie rod restraints. The tie rods absorb axial compression force described for axial expansion joints. But this compression force generates friction force at the tie rod hinges which must be overcome with the lateral movement.

The moving force of lateral expansion joints is calculated as follows:

F_{lat} = total lateral moving force (N)
F_{fric} = friction force from tie rod hinges (N)

The moving force, introduced into the lateral expansion joints, is not as high as in unrestrained axial or universal expansion joints, but is still transferred to the pipe and needs to be accounted for when rating the fixed points.



$$F_{lat} = F_{latB} + F_{fric}$$

MOMENT OF ANGULAR EXPANSION JOINTS

Angular bellows moving moment M_{angB}

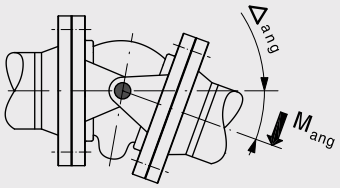
The angular bellows moving moment is the period required for the angular movement of the bellows. It results from the stiffness of the bellows together with the angular movement.

$$M_{angB} = c_{ang} \cdot \Delta_{ang}$$

M_{angB} = angular bellows moving moment (Nm)
c_{ang} = angular bellows moving rate (Nm/degrees)
Δ_{ang} = angular moving angle (degrees)

Total angular moving moment M_{ang}

STENFLEX® angular expansion joints are equipped with angular hinges. The hinge restraints absorb axial compression force described for axial expansion joints. But this compression force generates friction force at the angular hinges which must be overcome with the angular movement.



$$M_{ang} = M_{angB} + M_{fric}$$

The moving moment of restrained angular expansion joints is calculated as follows:

M_{ang} = total angular moving moment (Nm)
M_{fric} = friction moment in the hinges (Nm)

Effective bellows cross sectional areas, moving rates and friction force or moments are specific to the type or manufacture, and depend on operating conditions. Please inquire for further details.

ATTENTION!

Lateral expansion joints with tie rod restraints are not designed for axial adjusting movements. However, if axial adjusting movements are initiated, the tie rod restraints cannot compensate the compressive force and will be transferred to the fixed points of the piping instead.

TECHNICAL ANNEX

PIPE FIXED POINTS FOR EXPANSION JOINTS AND PIPE CONNECTORS

As a flexible pipe element, an expansion joint or pipe connector separates the rigid system and destabilizes the pipe if there are no fixed points. Positive internal pressure induces force into the pipe. Direction and degree of the force depend on the nominal diameter, pipe internal pressure, movement being absorbed and the pipe routing. A lack of fixed points (see fig. 1) will cause the pipe to shift. The flexible element would be stretched to its load limits and, eventually this would cause the elastic connection to break.

When rating fixed points, the following force must be taken into account:

F_D = axial compression force (from positive inner pressure in the pipe)
F_{axB} = total axial force of the expansion joint
F_{lat} = total lateral moving force of the expansion joint
M_{ang} = total angular moving moment of the expansion joint
F_{fricFL} = friction force at the guide bearings
F_{cent} = centrifugal force from pipe diversions (at high flow speeds)

In addition to the fixed points (see fig. 3), functionally safe operation of expansion joints and pipe connections also requires flawless pipe routing.

Guide bearings (see fig. 2) prevent the pipe from buckling.

We differentiate between the following fixed points and guides:

HFP = main fixed point
ZFP = intermediate fixed point
KFP = knee fixed point
FL = guide bearing (plain bearing)

Pipes with unrestrained expansion joints or pipe connectors must be equipped with robust fixed points and guides. The main fixed points must absorb F_{axB} and F_{fricFL} force.

Special care must be given to correct rating and design of the fixed points. They must be robust enough to withstand negative effect on supports (e.g., on building wall, ceiling or steel structure), when pipe force is introduced.

Fixed points are also necessary for unpressurized operation where vibration must be compensated to relieve the pipe, or if several expansion joints or pipe connectors are fitted in a pipeline system.

In an unstable pipe system (see fig. 4), an expansion joint or pipe connector cannot perform its function; pipe force cannot be absorbed.

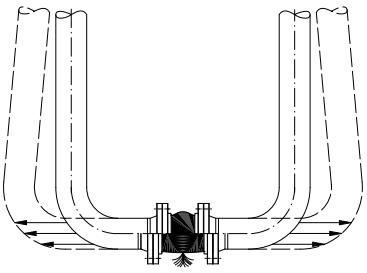


Fig. 1: Lack of fixed points

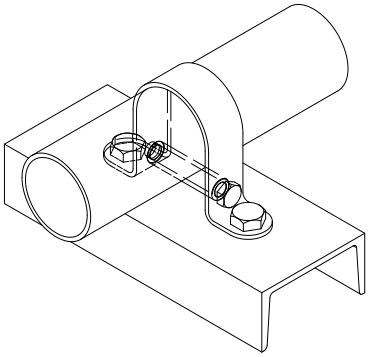


Fig. 2: Pipe guide bearing with rollers

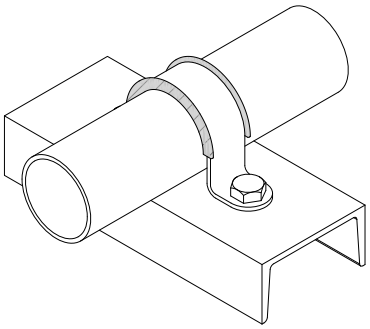


Fig. 3: Fixed point design

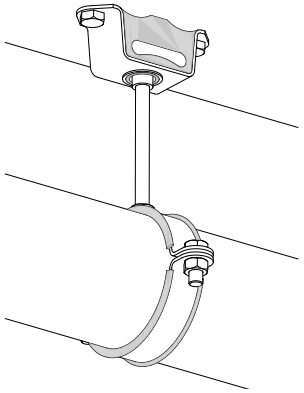
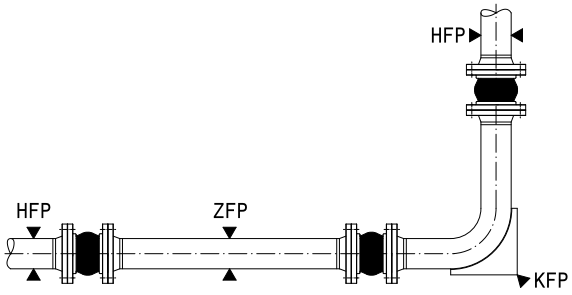
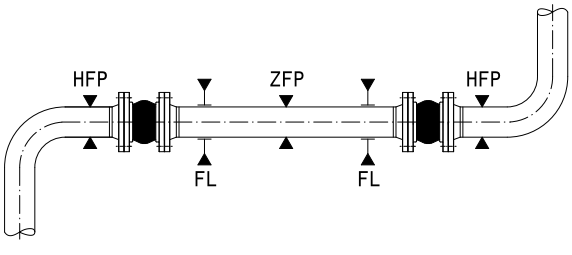


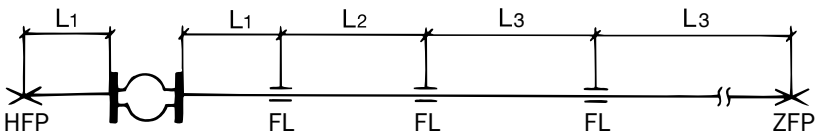
Fig. 4: Pendulum-type pipe suspensions are not fixed points



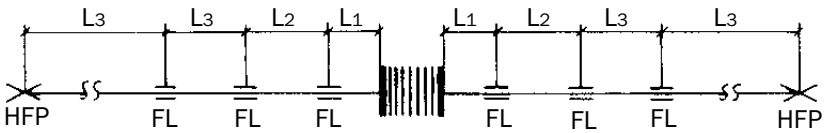


At pipe deflection points the main fixed points (HFP) and knee fixed points (KFP) absorb the full reaction force. The intermediate fixed points (ZFP) are practically relieved of pressure.

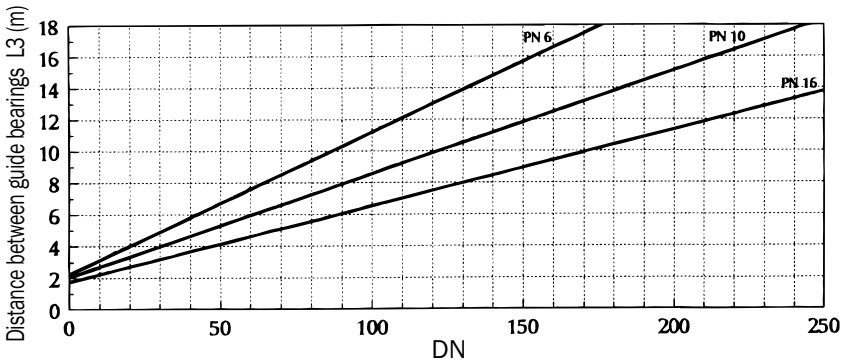
ARRANGEMENT OF FIXED POINTS AND GUIDE BEARINGS FOR AXIAL EXPANSION JOINTS AND PIPE CONNECTORS



Arrangement of an expansion joint beside a main fixed point



Arrangement of an expansion joint between two guide bearings



Distance between guide bearings

L_1 = distance between expansion joint/ pipe connector and fixed point or distance between expansion joint/ pipe connector and 1st guide bearing ($L_1 \leq 3 \times DN$)

L_2 = distance between 1st guide bearing and 2nd guide bearing ($L_2 = 0{,}5 \times L3$)

L_3 = normal distance between 2 guide bearings

L_3 must be seen in the context of the weight and nominal diameter of the pipe together with the positive inner pressure (for indicative values see diagram).

The pipe must be guided exactly through the bearing. Guide bearings must be placed on both sides of the expansion joint. A fixed point replaces a guide bearing. Internal guide sleeves are unsuitable as pipe guides.

ARRANGEMENT OF FIXED POINTS FOR LATERAL AND ANGULAR EXPANSION JOINTS

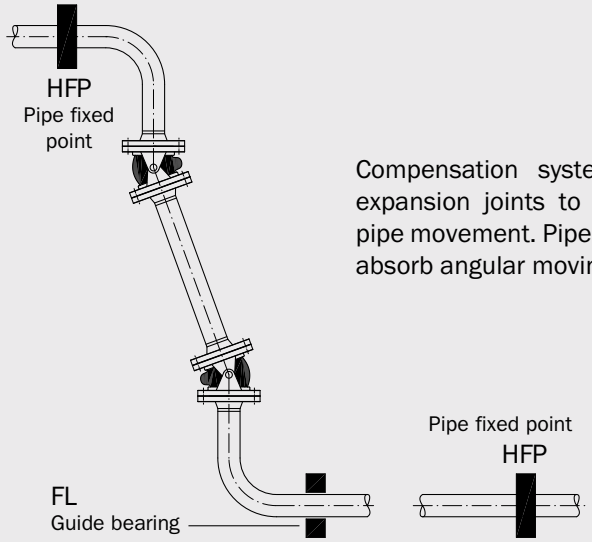
Pipes with lateral and angular expansion joints must also be equipped with fixed points, even though axial compression force F_D is absorbed by the restraint.

Here only lateral moving force F_{lat} resp. angular moving moment M_{ang} needs to be absorbed.

As a rule only one compensation system may be placed between two fixed points. When several compensation systems are fitted into the pipe system, fixed points must be provided between them.

Hinged expansion joints have a given rotation axis around which they can revolve.

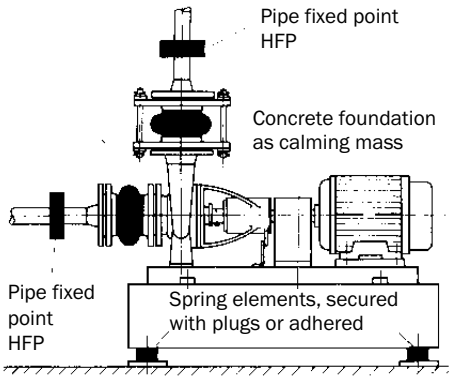
When arranging a expansion joint system, the correct position of the rotation axes must be considered.



Compensation system with two angular expansion joints to compensate for large pipe movement. Pipeline with fixed points to absorb angular moving moment.

ARRANGEMENT OF FIXED POINTS AT PUMPS

Appliances such as pumps are de-coupled from the pipe system by expansion joints or pipe connectors. The pump housing is relieved of pressure and tension. The force is absorbed by correctly positioned pipe fixed points.



Pump appliance in elastic mount, silenced pipe connection with rubber expansion joints.

TECHNICAL ANNEX

REDUCING THE SOUND LEVEL BY RUBBER EXPANSION JOINTS

REDUCING THE SOUND LEVEL, EXAMPLE EXPANSION JOINT TYPE AS

Diagram 1

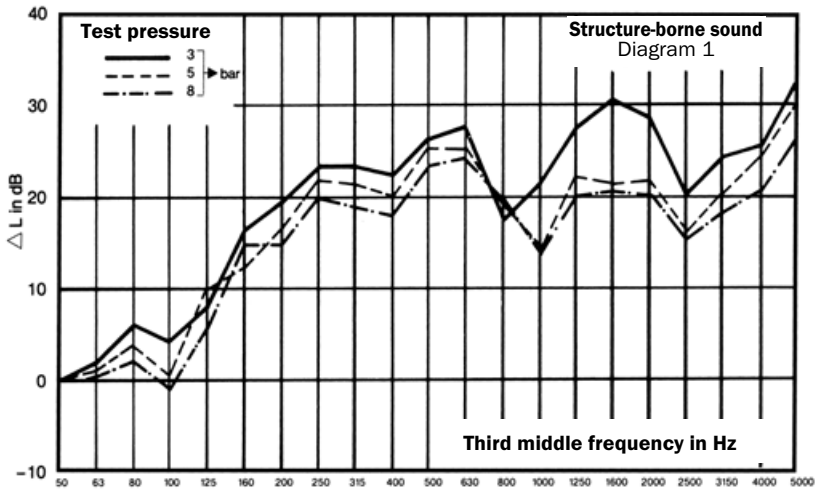


Diagram 2

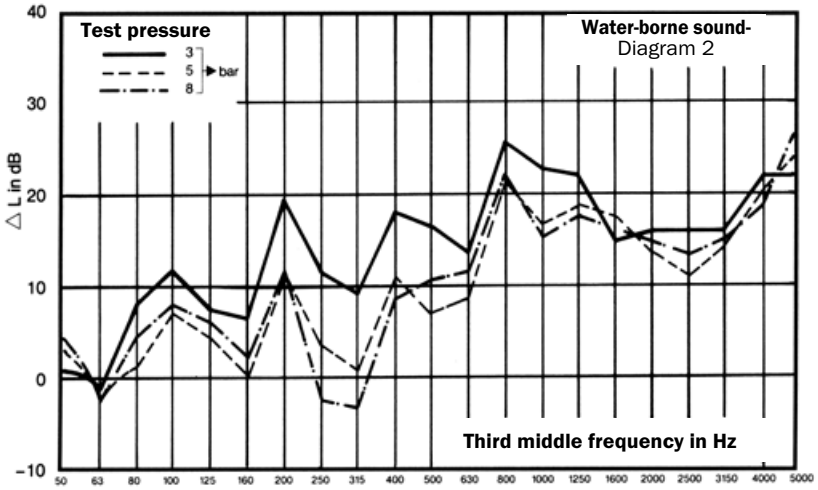


Diagram 3

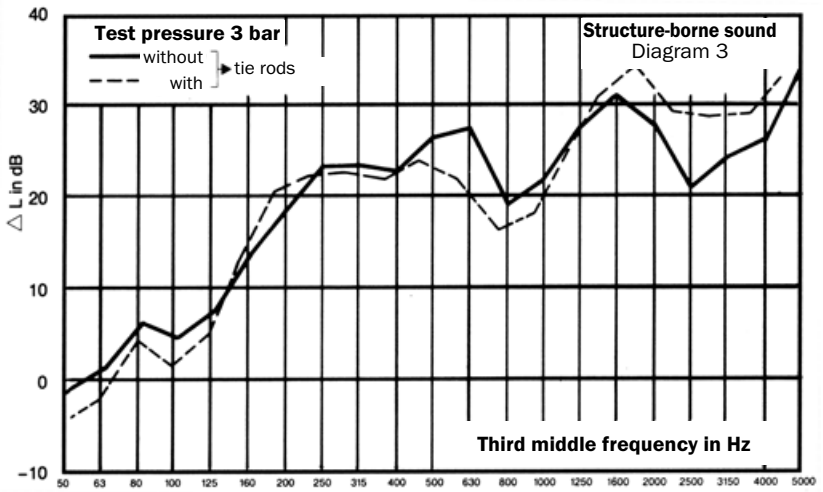


Diagram 1 and 2

Both diagrams show the degree of structure-borne and water-borne sound absorption, depending on operating pressure when using rubber expansion joints type AS.

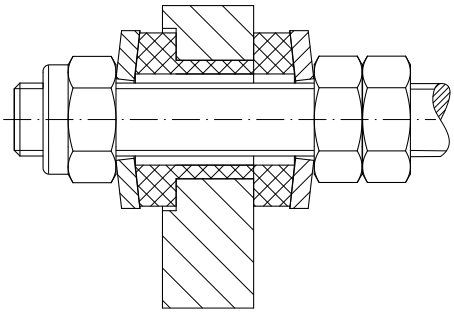
The insulation values of this expansion joint differ scarcely from those with synthetic fibre reinforcement (e.g., type A).

Please note: The attained value 20 dBA corresponds to a damping efficiency of approx. 90 %.

Diagram 3

Thanks to the special structure of the tie rod restraint (types AS-2, and AS-4), the sound absorption is almost the same as in unrestrained expansion joints.

Tie rod restraints are carried in rubber sockets for sound absorption up to DN 150 as a standard feature



- outside in type AS-2
- outside and inside in type AS-4.

The structure-borne sound which is carried through the tie rods is ideally interrupted by the rubber sockets.

Our studies are based on sound absorption requirements in accordance with DIN 4109.

TECHNICAL ANNEX

ABSORBING EXPANSION BY STEEL EXPANSION JOINTS

THERMAL EXPANSION OF PIPES

Pipe movement to be absorbed is calculated primarily from the thermal expansion caused by changes in temperature, with the change in length of the pipe being the dominant factor.

The change in length, calculated this way, can be compensated for by axial, lateral and also angular means. The suitable expansion joint is selected from the data sheets on the basis of the calculated change in length.

Movement is calculated according to the following equation:

$$\Delta L = L \cdot \alpha \cdot \Delta T$$

ΔL = change in length of the pipe (mm)
L = length of the pipe (mm)
α = length expansion coefficient $\left(\frac{1}{K}\right)$
ΔT = change in temperature (K)

Pipe material	Length expansion coefficient α at +20 °C (K)
1.0038 (S235JR)	$11{,}1 \cdot 10^{-6}$
1.0345 (P235GH)	$11{,}9 \cdot 10^{-6}$
1.4541	$16{,}0 \cdot 10^{-6}$
1.4404	$16{,}5 \cdot 10^{-6}$
Copper	$16{,}8 \cdot 10^{-6}$
Aluminium	$23{,}8 \cdot 10^{-6}$
Polypropylene	$110{,}0 \cdot 10^{-6}$

ABSORPTION OF EXPANSION BY NOT PRE-TENSIONED EXPANSION JOINTS

Standard STENFLEX® expansion joints are supplied in a neutral setting, i.e. the expansion joints can be moved in all directions (± axial, lateral and angular). The tolerable movement is stated in the corresponding data sheets for each nominal diameter. When using angular expansion joints, in double or triple joint systems, the overall system movement depends not only on the angular movement values of the expansion joint but also on the length of pipe section between the expansion joints.

ABSORPTION OF EXPANSION BY PRE-TENSIONED EXPANSION JOINTS

A expansion joint can be pre-tensioned for change in length of the pipe in just one direction. This achieves effective utilisation of the total movement as stated in the data sheets.

The installation length of a pre-tensioned steel expansion joint is calculated according to equation:

$$EBL_t = BL + \frac{\Delta L}{2} - \Delta L \cdot \frac{t_e - t_{min}}{t_{max} - t_{min}}$$

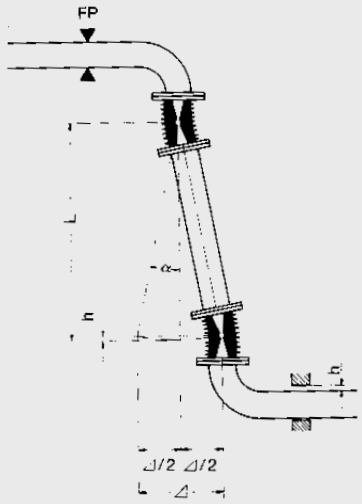
The expansion joints should, where possible, be mounted in a neutral setting and then pre-tensioned by moving the pipe section or by removing the length needed to install the expansion joint.

The absorption of expansion (Δ) of two-joint systems depends on the center distance (L) of the expansion joints and the maximum tolerable angle of deflection (α). It is calculated according to equation:

$$L = \frac{\Delta/2}{\sin \alpha} \qquad \Delta/2 = L \cdot \sin \alpha$$

The expanding pipe must have play corresponding to the radian measure in the guide bearing. This measure is calculated as follows:

$$h = L\,(1 - \cos \alpha)$$



Installation at 50 % pre-tension

EBL_t = temperature depending on installation length of the pre-tensioned expansion joint (mm)
BL = installation length of the steel expansion joint (mm)
ΔL = change in length of the pipe (mm)
t_e = temperature during installation (°C)
t_{min} = minimum temperature occurring in the pipe (°C)
t_{max} = maximum temperature occurring in the pipe (°C)

TECHNICAL ANNEX

ABSORBING EXPANSION BY STEEL EXPANSION JOINTS

ABSORBING EXPANSION

Operation conditioned diminution factors for steel expansion joints

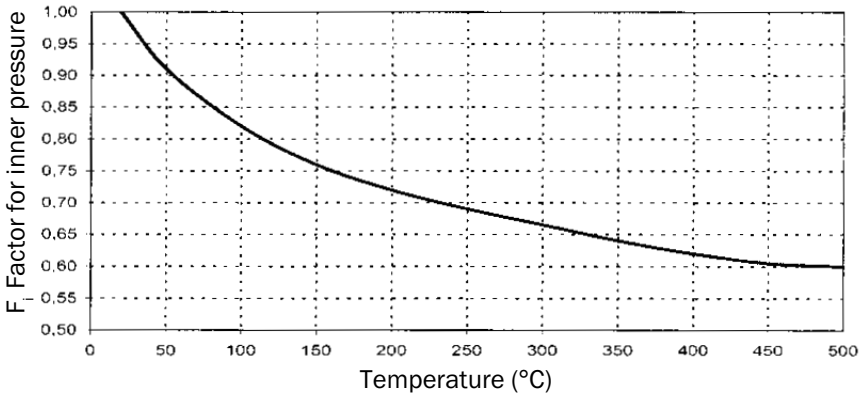
The table values stated in the data sheets refer to 1.4541 as bellows material at a temperature of +20 °C and 1000 load cycles.

Temperature, inner pressure, movement and load cycle of an expansion joint are all directly related. If operating conditions deviate from the above stated values, the diminution coefficients stated in the following diagrams can be used as indicative values.

The strength of the bellows materials decreases with increasing temperature, so that pressure and tolerable movement as stated in the data sheets must be reduced as temperature increases.

Exact rating is only possible with corresponding calculating programs.

Diagram 1 - Decrease in pressure from the influence of temperature



INFLUENCE OF TEMPERATURE ON TOLERABLE INNER PRESSURE

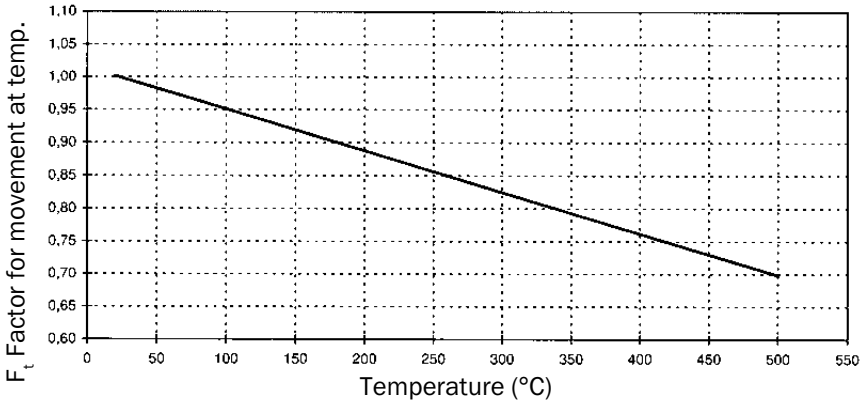
$$P_{tol} = PN \cdot F_i$$

P_{tol} = max. tolerable pressure at stated temperature

PN = nominal pressure

F_i = factor for inner pressure (from diagram 1)

Diagram 2 - Reduction in movement from the influence of temperature



INFLUENCE OF TEMPERATURE ON TOLERABLE MOVEMENT

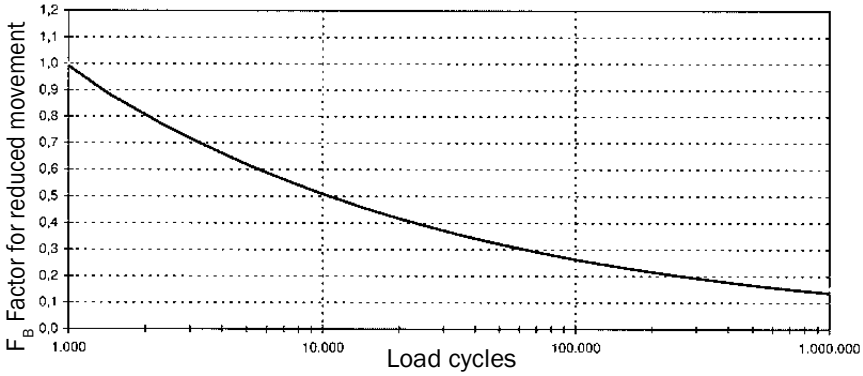
$$\Delta B_{tol} = \Delta B_{tab} \cdot F_t$$

ΔB_{tol} = max. tolerable movement of the expansion joint

ΔB_{tab} = movement absorption according to data sheets

F_t = factor for movement at stated temperature (diagram 2)

Diagram 3 - Influence of movement on the number of load cycles



INFLUENCE OF MOVEMENT ON TOLERABLE NUMBER OF LOAD CYCLES

$$F_B = \frac{\Delta B_{act}}{\Delta B_{tab}}$$

F_B = factor for reduced movement

ΔB_{act} = actual movement

ΔB_{tab} = tolerable movement from data sheets (see Diagram 3)

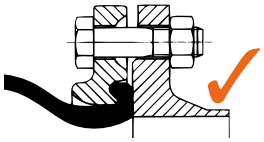
F_B can be used to calculate the tolerable number of load cycles. If the actual movement of the expansion joint is smaller than the tolerable movement, then the number of load cycles of the expansion joint increases.

TECHNICAL ANNEX

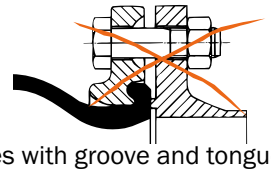
INSTALLATION AND OPERATING INSTRUCTIONS FOR RUBBER EXPANSION JOINTS AND PIPE CONNECTORS

STENFLEX® expansion joints and pipe connectors can only fulfil their function when installed and fitted correctly. The service life is affected not only by the operating conditions but above all by correct installation. Expansion joints and pipe connectors are not simple pipe elements but moving parts which require regular inspection.

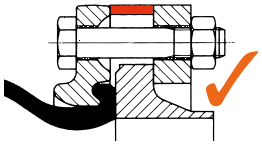
Expansion joints and pipe connectors are individual components of a pipeline system manufactured by STENFLEX®. STENFLEX® assumes no guarantee for imitation products or modifications to original products.



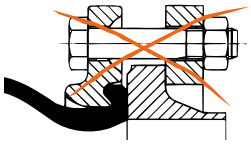
The sealing faces of the counter flange must be smooth and clean.



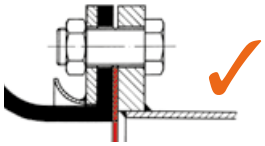
Flanges with groove and tongue are not allowed.



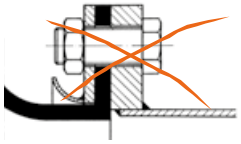
Spacer pieces or rotating flanges with welding stub must be used to level gaps.



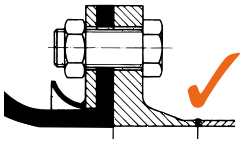
Rotable flanges with short stub end are unsuitable: no uniform full-circumference surface pressure.



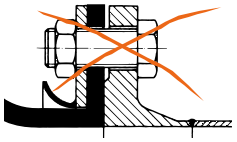
Additional flat seals (65+5 Shore A) protect the rubber sealing face from sharp-edged pipe ends.



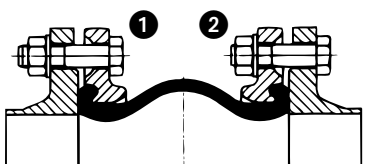
Sharp-edged pipe ends cut into the rubber sealing face.

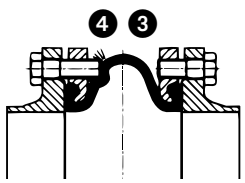


For full-faced rubber flanges, uniform full-circumference surface pressure is only possible with smooth mating flanges.



Mating flanges with raised shoulder will squash the rubber flange, the press-on retaining flange warps – insufficient surface pressure.





INSTALLATION

- The expansion joint or pipe connector must be kept clean and dry. When stored out in the open, it must be protected from intense sunshine and weather.
- Prior to installation, check the packaging and expansion joint or pipe connector for signs of damage. If any sign of damage whatsoever is detected the product must not be installed.
- Keep the expansion joint or pipe connector clear of any foreign matter e.g., dirt, insulation etc. on the inside and outside, and check again accordingly before and after installation.
- Do not remove transport safeguards and protective caps until immediately before installation.
- Expansion joints and pipe connectors must only be installed by authorized qualified personnel. Appropriate accident prevention regulations must be observed.
- Do not throw, or jolt, the expansion joint or pipe connector; protect from falling objects. Do not attach chains or cables directly to the bellows.
- Special seals are not required because the expansion joints and pipe connectors are self-sealing. The sealing faces of the flanges must be smooth and clean. Additional seals are not required; a seal only needs to be inserted when fitting internal guide sleeves.
- Insert rubber expansion joints with vacuum supporting rings for negative pressure operations.
- The length of the installation gap shall be equal to the installation length of the expansion joint.
- The expansion joint shall preferably be stressed by compression.
- Expansion joints are to be mounted according to (1) i.e. the screw head always shall be positioned on the bellows' and the screw nut on the piping side. If this is not possible the screw length for (2) must be selected so as not to damage the bellows. In the case of flanges with threaded holes, make sure that the screw length is flush with the flange as far as possible (3). The risk of damage from screws that are too long increases when the rubber bellows expands when operating under pressure (4).
- The inside of the pipeline as well as the flange sealing areas must be coated with an effective corrosion protection for agressive media (e.g. sea water, acids, lyes etc.)
- During installation ensure that the bores in the pipe flanges are aligned. If necessary, adjust rotable flanges at the expansion joint or pipe connector.

TECHNICAL ANNEX

INSTALLATION AND OPERATING INSTRUCTIONS FOR RUBBER EXPANSION JOINTS AND PIPE CONNECTORS

INSTALLATION

- Evenly tighten the flange screws crosswise. In order to avoid damages to the bellow caused by tools, keep the screw head with the key inside and turn the nuts outside. Retighten the screws after first commissioning.
- It is important to ensure that there is no torsion strain (twisting) on the expansion joint or pipe connector during assembly/dismantling and during operation. This applies in particular to types with threaded connection: hold these with a key at the hexagon.
- When electric welding is carried out on the pipe near the expansion joint or pipe connectors they must be bridged with earthing cables. Expansion joints and pipe connectors must always be protected from welding splashes and thermal load during welding work.
- Wherever possible install expansion joints or pipe connectors so that they can be visually checked at regular internals for possible damage.
- Cover expansion joints or pipe connectors to prevent damage of any kind.
- The installation of a guide sleeve is required for flow with abrasive media and of high velocity as well as for possibly resulting reactions or turbulences by diverting the flow direction (e.g. behind pumps, valves, T-pieces, pipe bends). The flow direction needs to be observed for installation (arrow direction = flow direction).
- Do not paint the bellows, do not apply any insulation.
- Do not remove the pre-tensioning safeguards until after installation.
- The pipes must be equipped with adequately rated fixed points and pipe guides to absorb pipe force (see chapter: ‘Movement, force, pipe fixed points.’) The operator is responsible for correct rating.
- The fixed points of the pipe system must only be fastened after the expansion joint has been mounted (after flange screws have been tightened).
- In general the manufacturer does not conduct pressure tests according to Annex 1, section 3.2.2 of the pressure equipment directive PED 2014/68/EU. This is the responsibility of the operator after installation in the pipe system (PT = 1.43 x PS).
- The operator must provide the necessary safety and monitoring devices for the pipe system (e.g., installation of temperature sensors, pressure reduction valves, measures to prevent pressure pulses and water hammers).

INITIAL COMMISSIONING

- Expansion joints and pipe connectors with restraints have been adjusted to the structural length (BL) in the factory. The tie rods must be connected to the flanges with a positive connection after installation.
- Only proceed with pressure and leak tests after the fixed points and guide bearings have been installed correctly. Otherwise the expansion joint will extend in length and become useless.
- During operation at high temperatures the operator must take safety precautions to prevent injury to persons inadvertently touching hot surfaces.
- To guarantee safe operation the expansion joints and pipe connectors must only be operated within the permitted ranges of pressure, temperature and movement.
- Consider table on page 198.
- The operator is responsible for precautions that will prevent incorrect use of expansion joints or pipe connectors by ensuring that the staff have been instructed accordingly and are supervised adequately, and by providing safety equipment and operating instructions.

USE

- Before using the expansion joints or pipe connectors check the media resistance (if in doubt, please inquire).
- Guide sleeves must be installed in the expansion joints for a flow containing aggressive media and in the event of high flow velocities or turbulent flows.
- To avoid fire damage, expansion joints and pipe connectors can be provided with additional flameproof covers.
- The operating data as stated in the data sheets, design drawings and on the nameplate are the application limits for use. STENFLEX® assumes no liability for damage caused by operation outside these limits. The operator is responsible for complying with these specifications (e.g. by using safety devices).

Detailed installation, and operating instructions which also stipulate screw torques are enclosed with every expansion joint and pipe connector.

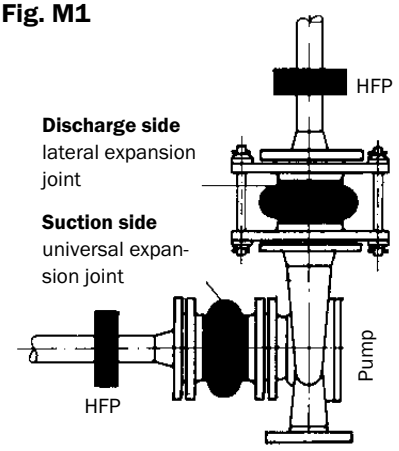
INSPECTION AND MAINTENANCE

- The operator must ensure that the expansion joints and pipe connectors are freely accessible so that visual inspections can be carried out at regular intervals.
- Check the expansion joints and pipe connectors for flawless condition in accordance with valid standards. In the case of faults such as blistering, surface cracks or irregular deformation, please contact our Technical Consultation Service. Repairs are not permitted.
- The Shore hardness of the flexible rubber elements in expansion joints and pipe connectors must be checked at regular intervals. If the hardness exceeds 83 Shore A, the element must be replaced, for safety reasons.
- Avoid using chemically aggressive media to clean the pipe system. The media and the corrosion resistance are to be observed.
- The expansion joints and pipe connectors can be cleaned with soap and warm water. Never use sharp or pointed objects such as wire brushes or sandpaper.

INSTRUCTIONS FOR RUBBER EXPANSION JOINTS AT PUMPS

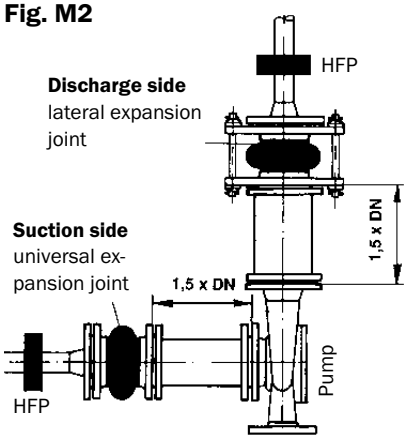
- Connect the expansion joints or pipe connectors as close to the pump flange as possible. (see Fig. M1). Exception: a spacer pipe should be used where abrasive media are concerned.
- When using centrifugal pumps to pump abrasive media, the expansion joints or pipe connectors must not be positioned directly on the pump fitting (suction/discharge side).
- Otherwise there is a risk that the expansion joints could be damaged by the high relative speeds caused by swirling and eddying at the pump connection.
- The spacing between the pump connection and the expansion joint or pipe connector must be 1 to 1.5 x DN (see Fig. M2)
- In the case of negative pressure on the suction side, use a rubber expansion joint with vacuum supporting ring.
- Avoid operating pumps against completely or partially closed gate valves. Also avoid cavitation! This can destroy the expansion joint or pipe connector in a very short time.

Fig. M1



Recommendation for arranging expansion joints at pumps (normal case)

Fig. M2



Pumping media with abrasive solid particles (special case)

SPECIAL INSTRUCTIONS FOR PIPE CONNECTORS

Rubber-metal pipe connectors are intended as decoupling elements to prevent sound transmission and to dampen vibration only. They are not to be used to absorb low frequency oscillation, expansion, tension or to compensate misalignment in the pipeline.

- During installation use only the screw lengths and washers as stated in the data sheets and attached installation instructions.
- The length of the gap in the pipe system must equal that of the pipe connector. No tensile force must be introduced into the rubber-metal pipe connector.
- Install the rubber-metal pipe connector free of tension, do not subject to tension, torsion or bending. Do not use as a expansion joint!

DECLARATION OF CONFORMITY

STENFLEX® rubber-type expansion joints of the series A, AR, AS, AG, B, C, E, G, GR-SAE, MS, R, RS and W have been subjected to the conformity assessment procedure and comply with the Pressure Equipment Directive 2014/68/EU.

Rubber expansion joints subject to the Pressure Equipment Directive are marked with the CE-sign and the tag-number of the designated location.

TECHNICAL ANNEX

INSTALLATION AND OPERATING INSTRUCTIONS FOR STEEL EXPANSION JOINTS

STENFLEX® steel expansion joints can only fulfil their proper function when installed and fitted correctly. The service life is affected not only by the operating conditions but above all by correct installation. Expansion joints are not simple pipe elements but moving parts which require regular inspection. STENFLEX® steel expansion joints are individual components of a pipe system.

STENFLEX® assumes no guarantee for imitation products or modifications to original products.

INSTALLATION

- The expansion joint must be kept clean and dry.
- Prior to installation, check the packaging and expansion joint for signs of damage. The expansion joint must not be installed if you detect any signs of damage to the steel bellows whatsoever.
- Keep the expansion joint clear of foreign matter such as dirt, insulation etc., on the inside and outside, and check again before and after installation.
- Do not remove transport safeguards and protective covers until immediately before installation.
- Expansion joints must only be fitted by authorized qualified staff. Appropriate accident prevention regulations must be observed.
- Do not throw, or jolt, the expansion joint; protect from falling objects. Do not fit chains, or cables, directly to the bellows.
- The sealing faces of the flanges must be smooth and clean.
- The length of the gap in the structure, should equal the structural length of the expansion joint.
- During installation ensure that the bores of the pipe flanges are aligned. If necessary, adjust rotable flanges at the expansion joint.
- Screw heads should always be placed on the bellows side, nuts on the piping side
- Evenly tighten the flange screws crosswise. In order to avoid damages to the bellow caused by tools, keep the screw head with the key inside and turn the nuts outside. Retighten the screws after first commissioning.
- It is important to ensure that there is no torsion strain (twisting) on the expansion joint during assembly/dismantling and during operation. This applies in particular to types with threaded connection: hold these with a key at the hexagon.
- When electric welding is carried out on a segment of pipe near the expansion joint it must be bridged with earthing cables. Expansion joints must always be protected from welding splashes and thermal load during welding work.
- When welding steel expansion joints into the pipeline, only use certified materials and welding procedures.
- No welding is allowed on the bellows (this includes ignition points).
- The installation of a guide sleeve is required for flow with abrasive media and of high velocity as well as for possibly resulting reactions or turbulences by diverting the flow direction (e.g. behind pumps, valves, T-pieces, pipe bends). The flow direction needs to be observed for installation (arrow direction = flow direction).
- DVGW-tested expansion joints must only be installed with the enclosed DVGW-tested seals.
- As far as possible, install expansion joints so that they can be visually checked at regular intervals for possible damage.
- Do not apply paint or insulation to the bellows.
- Do not remove the pre-tension safeguards until installation has been completed.
- The pipes must be provided with adequately rated fixed points and pipe guides that absorb pipe force. The operator is responsible for correct rating.
- The fixed points of the pipe system must only be fastened after the expansion joint has been mounted (after flange screws have been tightened).
- The operator must provide the necessary safety and monitoring devices for the pipe system (e.g., temperature sensors, pressure control valves, measures to avoid pressure pulses and water hammers, etc.).

INITIAL COMMISSIONING

- Expansion joints with restraints (lateral and angular expansion joints) have been adjusted to the structural length (BL) at the factory. The tie rods must be connected to the flanges with a positive connection after installation.
- Only proceed with pressure and leak tests after the fixed points and guide bearings have been installed correctly. Otherwise the expansion joint will extend in length and become useless.
- Do not exceed the permitted test pressure.
- Do not exceed the allowable temperature Ts max
- Do not fall below the allowable temperature Ts min
- During operation at high temperatures the operator must take safety precautions to prevent injury to persons inadvertently touching hot surfaces.
- To guarantee safe operation the expansion joints must only be operated within the permitted pressure, temperature and movement limits.
- The operator is responsible for precautions that prevent incorrect use of expansion joints by ensuring that staff have been instructed accordingly and are supervised adequately, and by providing safety equipment and operating instructions.

USE

- Before using the expansion joints take note of their media resistance (If in doubt please inquire).
- The installation of a guide sleeve is required for flow with abrasive media- and of high velocity as well as for possibly resulting turbulences.
- The operating data as stated in the data sheets or design drawings and on the name plate, are the limits of application for use. STENFLEX® assumes no liability for damage caused by operation outside these limits. The operator is responsible to comply with these specifications.
- The values given in the dimension drawings are based on 20 °C, 1000 motion load cycles and max. permissible pressure pulsation of 10% of the permissible operating pressure. Each expansion joint is provided with comprehensive assembly and operating instructions.

Each expansion joint is supplied with detailed installation and operating instructions.

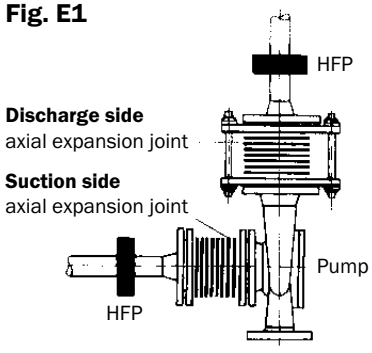
INSPECTION AND MAINTENANCE

- The operator must ensure that the expansion joints are freely accessible so that visual inspections can be carried out at regular intervals.
- Avoid using aggressive chemicals to clean the pipe system. Please observe the resistance to media.
- Check the expansion joints for flawless condition according to valid standards. In the case of damage such as scratches, surface cracks or irregular deformation, please contact our Technical Consultation Service. Repairs to the expansion joints are not permitted.

INSTRUCTIONS FOR STEEL EXPANSION JOINTS AT PUMPS

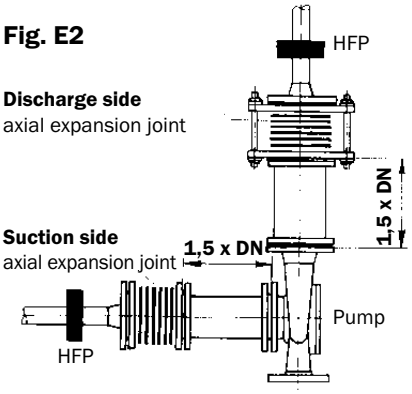
- Connect the expansion joints as close to the pump flange as possible (see Fig. E1).
- When using centrifugal pumps for pumping abrasive media, the expansion joints must not be positioned immediately on the pump fitting (suction/discharge side).
- Otherwise the expansion joints risk being damaged by the high relative speeds caused by swirling and eddying at the pump connection.
- The spacing between the pump connection and the expansion joint must be 1 to 1.5 x DN. (see Fig. E2).
- Avoid operating pumps against completely or partially closed gate valves. Also avoid cavitation as this can destroy the expansion joint in a very short time.

Fig. E1



Recommendation for arranging expansion joints at pumps (normal case)

Fig. E2



Pumping media with abrasive solid particles (special case)

DECLARATION OF CONFORMITY TO PRESSURE EQUIPMENT 2014/68/EU, ANNEX IV

We, the STENFLEX® Rudolf Stender GmbH company, declare with sole responsibility that the steel compensators to which this declaration refers conform to Directive 2014/68/EU for pressure equipment (as pressure-retaining equipment components) and meet the requirements of module H/H1 in accordance with the conformity assessment procedure.

The steel compensators that are subject to the Pressure Equipment Directive carry the CE mark and the identification number of the notified body.

TECHNICAL ANNEX

INSTALLATION AND OPERATING INSTRUCTIONS FOR RUBBER-METAL ELEMENTS

STENFLEX® rubber-metal elements can only fulfil their proper function when installed and fitted correctly. The service life is affected not only by the operating conditions but, above all by, correct installation. Rubber-metal elements are not simple pipe components but moving parts which require regular inspection.

STENFLEX® assumes no guarantee for imitation products or unauthorized modifications to original products.

INSTALLATION

- The rubber-metal elements must be kept clean and dry. When stored out in the open they must be protected from intense sunshine and weather.
- Prior to installation check the packaging and rubber metal elements for signs of damage. The product must not be installed if you detect any signs of damage whatsoever.
- Rubber-metal parts must only be fitted by authorized qualified staff. Corresponding accident prevention regulations must be observed.
- Torsional stress (twisting) to the rubber-metal elements must not occur during installation.
- Wherever possible, install rubber-metal elements so that they can be visually checked at regular intervals for possible damage.

INITIAL COMMISSIONING AND USE

- Before using the rubber-metal elements, take note of their media resistance (If in doubt please inquire).
- The operating data as stated in the data sheets or design drawings are the limits of application for use. STENFLEX® assumes no liability for damage caused by operation outside these limits. The operator is responsible for complying with these specifications.

INSPECTION AND MAINTENANCE

- The operator must ensure that the rubber metal elements are freely accessible so that visual inspections can be performed at regular intervals.
- Avoid cleaning the rubber-metal elements with aggressive chemicals. Please observe the resistance to media.
- Check the rubber-metal elements for flaws or damage at regular intervals. In the case of damage please contact our Technical Consultation Service. Repairs are not permitted.

TECHNICAL ANNEX

QUALITY MANAGEMENT

QUALITY MANAGEMENT SYSTEM

The procedures involved in development, testing, release, manufacture and final control of expansion joints are presented in our Quality Management System, in accordance with EN ISO 9001:2015.

Certified manufacturer qualifications in accordance with AD 2000-HP0 and Pressure Equipment Directive (2014/68/EU) together with welding qualifications in accordance with ISO 3834-2, guarantee on-going monitoring of our production processes.

The individual components are designed and optimized at state-of-the-art 3D-CAD workstations so that customized expansion joints can be designed and supplied in addition to our standard expansion joint range.

Expansion joints are rated to the recognized TÜV-certified calculation methods (e.g., AD 2000-B13, DIN EN 14917, EJMA, etc.)

To ensure a consistently high quality standard our expansion joints are also subject to a range of practical tests:

- visual and dimension checks
- leak and pressure tests
- bursting tests
- load cycle tests
- measurement of the reaction force

International certification agencies and independent testing institutions have confirmed that STENFLEX® expansion joints meet the most demanding quality requirements.

Special product acceptance tests can also be carried out at the request of customers, either by ourselves or by external experts. Related documentation is provided accordingly.

To guarantee high safety and reliability of your system in the long-term, we also offer on-site expansion joint servicing by our experts. This is part of the STENFLEX® Quality Concept.

TECHNICAL ANNEX

CERTIFICATES AND TYPE APPROVALS

RUBBER EXPANSION JOINTS AND PIPE CONNECTORS

Agencies / STENFLEX® Types	American Bureau of Shipping	Bureau Veritas	DNV GL® / DNV®	NKK Nippon	Lloyd's Register of Shipping	Registro Italiano Navale	TÜV Süd-deutsch-land	CCS	CR	KR Korean Register	RS Russian Maritime Register of Shipping
Type A ■ Dimensions DN 20 – DN 1000 ■ Max. operating pressure 10 bar ■ Max. operating temperature +90 °C ■ Rubber grade EPDM + NBR		✓	✓		✓		✓ T12 87 03 Rev. (Eignungs-prüfung)				✓
Type AS (flame-proof) ■ Dimensions DN 25 – DN 400 ■ Max. operating pressure 10 bar ■ Max. operating temperature +100 °C ■ Rubber grade EPDM + NBR	✓	✓	✓	✓	✓	✓	✓ T12 87 03 Rev. (Eignungs-prüfung)	✓	✓	✓	✓
Type C ■ Dimensions DN 300 – DN 800 ■ Max. operating pressure 8 bar ■ Max. operating temperature +60 °C ■ Rubber grade EPDM							✓ T12 87 03 Rev. (Eignungs-prüfung)				
Type R ■ Dimensions DN 32 – DN 300 ■ Max. operating pressure 10 bar ■ Max. operating temperature +90 °C ■ Rubber grade EPDM		✓	✓		✓		✓ T12 87 03 Rev. (Eignungs-prüfung)				
Type RS (flame-proof) ■ Dimensions DN 32 – DN 300 ■ Max. operating pressure 10 bar ■ Max. operating temperature +90 °C ■ Rubber grade EPDM	✓	✓	✓		✓	✓	✓ T12 87 03 Rev. (Eignungs-prüfung)	✓	✓		✓
Type MS (flame-proof) ■ Dimensions DN 65 – DN 250 ■ Max. operating pressure 10 bar ■ Max. operating temperature +100 °C ■ Rubber grade EPDM + NBR			✓								
Type GRV ■ Dimensions DN 20 – DN 200 ■ Max. operating pressure 10 bar ■ Max. operating temperature +100 °C ■ Rubber grade CR							✓ T12 87 03 Rev. (Eignungs-prüfung)				

STEEL EXPANSION JOINTS

Agencies / STENFLEX® Types	American Bureau of Shipping	Bureau Veritas	DNV GL® / DNV®	Registro Italiano Navale	DIN DVGW	KR Korean Register	RS Russian Maritime Register of Shipping
Types SF-10, SF-11, SA-10, SA-13 ■ Dimensions DN 32 – DN 150 pressure rate PN 16 ■ Dimensions DN 200 – DN 250 pressure rate PN 10	✓	✓	✓ without SA-10 without SA-13	✓	✓ Gas supply SF-10 without 250	✓ only SF-10	✓ only SF-10 SF-11
Types SF-23, SA-23 ■ Dimensions DN 50 – DN 250 pressure rate PN 6	✓	✓		✓	✓ Gas supply		
Types SF-20, SF-21, SA-20 ■ Dimensions DN 32 –-DN 150 pressure rate PN 16 ■ Dimensions DN 32 – DN 150 pressure rate PN 10	✓	✓	✓ only SF-20	✓	✓ Gas supply without SA-20		
Type SG-11 ■ Dimensions DN 15 – DN 50 pressure rate PN 16					✓ Gas supply		

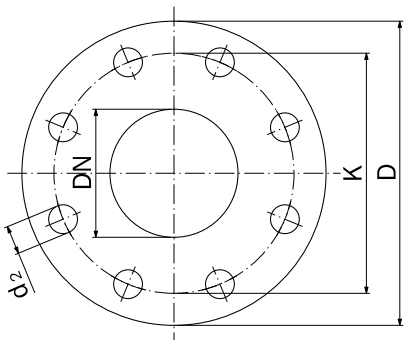
Other type approval/suitability tests on request.

TECHNICAL ANNEX

FLANGE CONNECTION DIMENSIONS
PN 6, PN 10 AND PN 16 IN ACCORDANCE WITH EN 1092

DN	PN 6				PN 10				PN 16			
	Ø D Flange outer Ø mm	Ø K Pitch circle Ø mm	No. of holes	Ø d_2 Hole Ø mm	Ø D Flange outer Ø mm	Ø K Pitch circle Ø mm	No. of holes	Ø d_2 Hole Ø mm	Ø D Flange outer Ø mm	Ø K Pitch circle Ø mm	No. of holes	Ø d_2 Hole Ø mm
15	80	55	4	11	95	65	4	14	95	65	4	14
20	90	65	4	11	105	75	4	14	105	75	4	14
25	100	75	4	11	115	85	4	14	115	85	4	14
32	120	90	4	14	140	100	4	18	140	100	4	18
40	130	100	4	14	150	110	4	18	150	110	4	18
50	140	110	4	14	165	125	4	18	165	125	4	18
65	160	130	4	14	185	145	8	18	185	145	8	18
80	190	150	4	18	200	160	8	18	200	160	8	18
100	210	170	4	18	220	180	8	18	220	180	8	18
125	240	200	8	18	250	210	8	18	250	210	8	18
150	265	225	8	18	285	240	8	22	285	240	8	22
175*	295*	255*	8*	18*	315*	270*	8*	22*	315*	270*	8*	22*
200	320	280	8	18	340	295	8	22	340	295	12	22
250	375	335	12	18	395	350	12	22	405	355	12	26
300	440	395	12	22	445	400	12	22	460	410	12	26
350	490	445	12	22	505	460	16	22	520	470	16	26
400	540	495	16	22	565	515	16	26	580	525	16	30
450	595	550	16	22	615	565	20	26	640	585	20	30
500	645	600	20	22	670	620	20	26	715	650	20	33
600	755	705	20	26	780	725	20	30	840	770	20	36
650*	800*	760*	24*	26*	840*	785*	24*	30*	880*	805*	24*	36*
700	860	810	24	26	895	840	24	30	910	840	24	36
750*	925*	870*	24*	26*	965*	900*	24*	30*	985*	900*	24*	29*
800	975	920	24	30	1015	950	24	33	1025	950	24	39
900	1075	1020	24	30	1115	1050	28	33	1125	1050	28	39
1000	1175	1120	28	30	1230	1160	28	36	1255	1170	28	42
1100*	1290*	1230*	28*	33*	1345*	1270*	32*	36*	1370*	1280*	28*	48*
1200	1405	1340	32	33	1455	1380	32	39	1485	1390	32	48
1300*	1520*	1450*	32*	36*	1565*	1485*	32*	42*	1585*	1490*	36*	48*
1400	1630	1560	36	36	1675	1590	36	42	1685	1590	36	48
1500*	1730*	1660*	36*	36*	1795*	1705*	36*	48*	1810*	1705*	36*	56*
1600	1830	1760	40	36	1915	1820	40	48	1930	1820	40	56
1700*	1940*	1865	40*	39*	2015*	1920*	44*	48*	2030*	1920*	44*	56*
1800	2045	1970	44	39	2115	2020	44	48	2130	2020	44	56
1900*	2155*	2075*	44*	42*	2220*	2125*	48*	48*	2240*	2125*	44*	62*
2000	2265	2180	48	42	2325	2230	48	48	2345	2230	48	62
2100*	2375*	2285*	48*	42*	2440*	2335*	48*	56*	–	–	–	–
2200	2475	2390	52	42	2550	2440	52	56	2555*	2440*	52*	62*
2300*	–	–	–	–	2650*	2545*	56*	56*	–	–	–	–
2400	2685	2600	56	42	2760	2650	56	56	2765*	2650*	56*	62*
2500*	2795*	2705*	56*	48*	2860*	2750*	56*	56*	2865*	2750*	60*	62*
2600	2905	2810	60	48	2960	2850	60	56	2965*	2850*	60*	62*
2800	3115	3020	64	48	3180	3070	64	56	–	–	-	–
3000	3315	3220	68	48	3405	3290	68	62	–	–	-	–
3200	3525	3430	72	48	–	–	–	–	–	–	-	–
3400	3735	3640	76	48	–	–	–	–	–	–	-	–
3600	3970	3860	80	56	–	–	–	–	–	–	-	–

*Dimensions not rated to standard



The number of screw holes for every flange is divisible by 4.

For pipes and fittings, the screw holes must be placed in such a way as to be clear of the horizontal and vertical axes.

TECHNICAL ANNEX

FLANGE CONNECTION DIMENSIONS PN 25 IN ACCORDANCE WITH EN 1092 ANSI 150 LBS AND 300 LBS • SAE 3000 PSI

DN mm	DN Zoll	ANSI 150 LBS Ø D Flange outer Ø mm	Ø K Pitch circle Ø mm	No. of holes	Ø d_2 Hole Ø mm	ANSI 300 LBS Ø D Flange outer Ø mm	Ø K Pitch circle Ø mm	No. of holes	Ø d_2 Hole Ø mm
15	0.50”	88.9	60.3	4	15.9	95.3	66.7	4	15.9
20	0.75”	98.4	69.9	4	15.9	117.5	82.6	4	19.1
25	1”	108.0	79.4	4	15.9	123.8	88.9	4	19.1
32	1.25”	117.5	88.9	4	15.9	133.4	98.4	4	19.1
40	1.50”	127.0	98.4	4	15.9	155.6	114.3	4	22.2
50	2”	152.4	120.7	4	19.1	165.1	127.0	8	19.1
65	2.50”	177.8	139.7	4	19.1	190.5	149.2	8	22.2
80	3”	190.5	152.4	4	19.1	209.5	168.3	8	22.2
100	4”	228.6	190.5	8	19.1	254.0	200.0	8	22.2
125	5”	254.0	215.9	8	22.2	279.4	235.0	8	22.2
150	6”	279.4	241.3	8	22.2	317.5	269.9	12	22.2
175	7”*	311.2*	269.9*	8*	22.2*	–	–	–	–
200	8”	342.9	298.4	8	22.2	381.0	330.2	12	25.4
250	10”	406.4	362.0	12	25.4	444.5	387.4	16	28.6
300	12”	482.6	431.8	12	25.4	520.7	450.9	16	31.8
350	14”	533.4	476.3	12	28.6	584.2	514.4	20	31.8
400	16”	596.9	539.8	16	28.6	647.7	571.5	20	34.9
450	18”	635.0	577.9	16	31.8	711.2	628.7	24	34.9
500	20”	698.5	635.0	20	31.8	774.7	685.8	24	34.9
600	24”	812.8	749.3	20	34.9	914.4	812.8	24	41.3
650	26”	870.0	806.5	24	34.9	971.6	876.3	28	44.5
700	28”	927.1	863.6	28	34.9	1035.1	939.8	28	44.5
750	30”	984.3	914.4	28	34.9	1092.2	997.0	28	47.6
800	32”	1060.5	977.9	28	41.3	1149.4	1054.1	28	50.8
850	34”	1111.3	1028.7	32	41.3	1206.5	1104.9	28	50.8
900	36”	1168.4	1085.9	32	41.3	1270.0	1168.4	32	54.0
950	38”	1238.3	1149.4	32	41.3	1168.4	1092.2	32	41.3
1000	40”	1289.1	1200.2	36	41.3	1238.3	1155.7	32	44.5
1050	42”	1346.2	1257.3	36	41.3	1289.1	1206.5	32	44.5
1100	44”	1403.4	1314.5	40	41.3	1352.6	1263.7	32	47.6
1150	46”	1454.2	1365.3	40	41.3	1416.1	1320.8	28	50.8
1200	48”	1511.3	1422.4	44	41.3	1466.9	1371.6	32	50.8
1250	50”	1568.5	1479.6	44	47.6	1530.4	1428.8	32	54.0
1300	52”	1625.6	1536.7	44	47.6	1581.2	1479.6	32	54.0
1350	54”	1682.8	1593.9	44	47.6	1657.4	1549.4	28	60.3
1400	56”	1746.3	1651.0	48	47.6	1708.2	1600.2	28	60.3
1450	58”	1803.4	1708.2	48	47.6	1759.0	1651.0	32	60.3
1500	60”	1854.2	1759.0	52	47.6	1809.8	1701.8	32	60.3
1700	66”	2032.0	1930.4	52	47.6	–	–	–	–
1800	72”	2197.1	2095.5	60	47.6	–	–	–	–
2000	78”	2362.2	2260.6	64	54.0	–	–	–	–
2100	84”	2533.7	2425.7	64	54.0	–	–	–	–
2300	90”	2705.1	2590.8	68	61.9	–	–	–	–
2400	96”	2876.6	2755.9	68	61.9	–	–	–	–

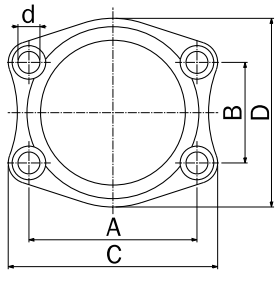
*Dimensions not rated to standard

DN mm	SAE 3000 PSI Ø d Hole Ø mm	A Hole spacing mm	B Hole spacing mm	C flange outer dimension mm	D flange outer dimension mm
40	13	70	35.7	94	75
50	13	78	43.0	102	86
65	13	89	51.0	116	98
80	17	106	62.0	134	120
100	17	130	78.0	162	146
125	17	152	92.0	190	170

DN	PN 25 Ø D Flange outer Ø mm	Ø K Pitch circle Ø mm	No. of holes	Ø d_2 Hole Ø mm
15	95	65	4	14
20	105	75	4	14
25	115	85	4	14
32	140	100	4	18
40	150	110	4	18
50	165	125	4	18
65	185	145	8	18
80	200	160	8	18
100	235	190	8	22
125	270	220	8	26
150	300	250	8	26
175*	330*	280*	12*	26*
200	360	310	12	26
250	425	370	12	30
300	485	430	16	30
350	555	490	16	33
400	620	550	16	36
450	670	600	20	36
500	730	660	20	36
600	845	770	20	39
700	960	875	24	42
800	1085	990	24	48
900	1185	1090	28	48
1000	1320	1210	28	56

*Dimensions not rated to standard

DN	PN 40 Ø D Flange outer Ø mm	Ø K Pitch circle Ø mm	No. of holes	Ø d_2 Hole Ø mm
20	105	75	4	14
25	115	85	4	14
32	140	100	4	18
40	150	110	4	18
50	165	125	4	18
65	185	145	8	18
80	200	160	8	18
100	235	190	8	22
125	270	220	8	26
150	300	250	8	26
200	375	320	12	30
250	450	385	12	33
300	515	450	12	33

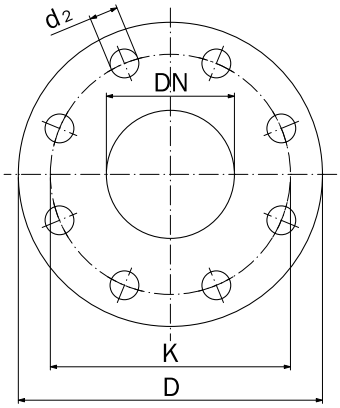


Flange to SAE standard

TECHNICAL ANNEX

FLANGE CONNECTION DIMENSIONS / ROUND FLANGES FOR EXHAUST PIPES DIN 86044

DN	DIN 86044-1			
	Ø D Flange outer Ø mm	Ø K Pitch circle Ø mm	No. of holes	Ø d_2 Hole Ø mm
80	–	–	–	–
100	–	–	–	–
125	–	–	–	–
150	–	–	–	–
160	–	–	–	–
200	320	280	8	18
250	375	335	12	18
300	440	395	12	22
(315)	–	–	–	–
350	490	445	12	22
355	–	–	–	–
400	540	495	16	22
450	595	550	16	22
500	645	600	20	22
(550)	703	650	20	22
560	–	–	–	–
600	754	700	20	22
(630)	–	–	–	–
(650)	805	750	20	22
700	856	800	24	22
710	–	–	–	–
(750)	907	850	24	22
800	958	900	24	22
(850)	1010	950	28	22
900	1060	1010	28	22
(950)	1110	1060	28	22
1000	1162	1110	32	22
1100	1266	1210	32	22
1120	–	–	–	–
1200	1366	1310	36	22
(1250)	–	–	–	–
1300	1466	1410	40	22
1400	1566	1510	40	22
1500	1666	1610	44	22
1600	1766	1710	48	22
1700	1866	1810	48	22
1800	1966	1910	52	22
1900	2066	2010	56	22
2000	2166	2110	56	22
2100	2266	2210	60	22
2200	2366	2310	64	22
2300	2466	2410	64	22
2400	2566	2510	68	22
2500	2666	2610	72	22
2600	2766	2710	72	22
2700	2866	2810	76	22
2800	2966	2910	80	22
2900	3066	3010	80	22
3000	3166	3110	84	22



For pipes and fittings the screw holes must be placed in such a way as to be clear of the horizontal and vertical axes.

TECHNICAL ANNEX

COMPARISON AND CONVERSION TABLES

COMPARISON TABLE OF INTERNATIONAL MATERIAL DESIGNATIONS

Europe		Germany		France	United Kingdom	USA	max. tol. temperature	
Designation EN	Material No. EN	Material No. DIN EN	old DIN	AFNOR	B.S.	AISI SAE ASTM	min.	max.
GJMW-400-5	JM1030	0.8040	GTW-40-05					+350 °C
				E 24-2	Fe 360 B	A 283 Gr. C		+300 °C
S 235 JR	1.0038	1.0038	RSt 37-2	E 24-2 NE	Fe 360 BFU	A 570 Gr. 36	-10 °C	+300 °C
P 235 TR 1	1.0254	1.0254	St 37.0				-10 °C	+300 °C
P 235 G1 TH	1.0305	1.0305	St 35.8I				-10 °C	+300 °C
	1.0401	1.0401	C 15	C 18	080 A 15	M 1015		+300 °C
P 235 GH	1.0345	1.0345	H I					+400 °C
P 265 GH	1.0425	1.0425	H II	AP	1501			+400 °C
P 250 GH	1.0460	1.0460	C 22.8				-10 °C	+450 °C
				E 36-3	Fe 510 D1	A 572 Gr. 50		
S 355 J2	1.0577	1.0577	St 52-3N	E 36-4	FF	1024, 1524	-10 °C	+300 °C
X 5 CrNi 18-10	1.4301	1.4301	X 5 CrNi 18-10	Z 4 CN 19-10	304 S 11	304	-196 °C	+550 °C
X 8 CrNiS 18-9	1.4305	1.4305	X 8 CrNiS 18-9	Z 8 CNF 18-09	303 S 22	303		+400 °C**
X 2 CrNiMo 17-12-2	1.4404	1.4404	X 2 CrNiMo 17-12-2	Z 2 CND 17-12	316 S 11	316 L	-196 °C	+550 °C**
X 6 CrNiTi 18-10	1.4541	1.4541	X 6 CrNiTi 18-10	Z 6 CNT 18-10	321 S 31	321	-196 °C	+550 °C*
X 6 CrNiMoTi 17-12-2	1.4571	1.4571	X 6 CrNiMoTi 17-12-2	Z 6 CNDT 17-12	320 S 18	316 Ti	-196 °C	+550 °C*
X 15 CrNiSi 20-12	1.4828	1.4828	X 15 CrNiSi 20-12	Z 9 CN 24-13	309 S 24	309	-196 °C	+550 °C*
X 12 CrNiTi 18-9	1.4878		X 12 CrNiTi 18-9	Z 6 CNT 18-10	321 S 51	321		
X 8 CrNiTi 18-10		1.4878	X 8 CrNiTi 18-10					+800 °C
X 1 NiCrMoCu 25-20-5		1.4539	X 1 NiCrMoCu 25-20-5			904 L		+550 °C
16 Mo 3	1.5415	1.5415	16 Mo 3; 15 Mo 3	15 D 3 42 CD 4	1503-243 B	4017	-10 °C	+500 °C
42CrMo 4	1.7225	1.7225	42CrMo 4	42 CrMo 4	708 A 42	4140, 4142		+450 °C
21CrMoV 5-7	1.7709	1.7709	21CrMoV 5-7					+540 °C
		2.4858	NiCr 21 Mo					+450 °C

*up to +400 °C: resistant to intercrystalline corrosion. **up to +300 °C: resistant to intercrystalline corrosion

CHANGES IN TEMPERATURE/LENGTH OF VARIOUS MATERIALS

Pipe material	Change in length ΔL at temperature change ΔT from 0 °C to ΔL					
	+100 °C	+200 °C	+300 °C	+400 °C	+500 °C	+600 °C
1.0038 (S235JR)	1.11	2.42	3.87	–	–	–
1.0305 (P235G1TH)	1.23	2.60	4.05	5.60	–	–
1.4541	1.60	3.40	5.10	7.20	9.00	11.1
1.4404	1.65	3.50	5.25	7.40	9.25	11.4
Kupfer	1.68	3.55	5.30	7.50	9.50	11.6
Aluminium	2.38	4.90	7.65	10.60	13.70	17.0
Polypropylen	11.0	–	–	–	–	–

The table indicates the mean change in length ΔL in mm for 1 m pipe length.

PRESSURE CONVERSION TABLE

Unit Abbreviation	Pa=N/m²	bar =10⁵ N/m²	at =Kp/cm²	m wc	mm HG =Torr	lbf / in² = psi	lbf / ft²
Pascal: 1 Pa=1 N/m²	1	0.00001	0.00001	0.0001	0.0075	0.00014	0.02089
bar: 1 bar=10⁵ N/m²	100 000	1	1.0197	10.197	750.062	14.504	2088.54
Technical atmosphere: 1 at=1 Kp/cm²	98066.5	0.98067	1	10	735.559	14.223	2.0482
Meter water column: 1 m wc	9806.65	0.09807	0.1	1	73.556	1.4223	204.816
Millimeter mercury column: 1 mm Hg=1 Torr	133.322	0.00133	0.00136	0.0136	1	0.0193	2.785
Pound-force per square inch: 1 lbf/in² (psi)	6894.76	0.06895	0.0703	0.7031	51.715	1	144.0
Pound-force per square foot: 1 lbf/ft²	47.880	0.00048	0.00048	0.00048	0.35913	0.0694	1

TECHNICAL ANNEX

GLOSSARY

A

Adjustment force

The force that is required to move a flexible pipe connection by a specific amount under specified conditions.

Angular movement

The terms "axial, lateral and angular" are frequently used to denote directions of movement in the context of expansion joints.

Axial compression force

The axial compression force is the longitudinal force resulting from the internal overpressure.

Axial movement

The movement of a pipeline element in the direction of the longitudinal axis of the pipe.

B

Bellows

The bellows is the flexible and pressure-tight base element of an expansion joint.

Burst pressure

The pressure at which a flexible pipe connection is no longer impermeable

C

CIIR

CIIR = chlorine-isobutene-isoprene rubber (trade name: "butyl"). Type of rubber suitable and approved for drinking water. STENFLEX colour designation: "white".

Compression

The shortening of a flexible pipe connection due to movement absorption.

Connecting parts

The parts of a flexible pipe connection with which a connection is established to the pipeline to be connected, e.g. flanges, welded ends, union nuts etc.

Corner-compensated expansion joint

An expansion joint that is installed at a 90° bend (corner) of a pipeline and that – due to its design – can absorb axial and lateral movements from both pipe legs without stressing the fixed points with reaction forces.

Corrugated hose

A metal hose with a flexible element that consists of a sequence of individual, straight shafts or a single, helically moving shaft.

CR

CR = polychloroprene (trade name: "neoprene")

D

DIN 4809 Part 1 & 2

DIN 4809: Expansion joints made from elastomer composites (rubber expansion joints) for water heating systems; for a maximum operating temperature of 100°C and a permitted positive operating pressure of 10 bar. See STENFLEX certificate.

DVGW

Deutscher Verein des Gas- und Wasserfaches (German Technical and Scientific Association for Gas and Water)

E

Effective bellows cross-section

The cross-sectional area of an expansion joint bellows that produces the hydraulic reaction force together with the internal pressure present.

EPDM

EPDM = ethylene propylene diene monomer rubber. Heat and weather-resistant material with particular resistance to highly oxidising media as well as chemicals (not oil-resistant). STENFLEX colour designation: "orange".

Expansion joint

In addition to hoses, expansion joints are the most frequently used flexible pipe connections. They are available with nominal diameters of a few millimetres up to several metres, for pressures from a vacuum up to several 100 bar and for an incredibly wide range of movements. The wide range of different designs makes expansion joints more versatile than any other flexible pipe connection. The main criterion for determining which of the different designs to use is the direction in which the expansion joint can absorb movement.

TECHNICAL ANNEX

GLOSSARY

Expansion loop; lyra-shaped design

In contrast to flexible pipe connections, pipe expansion bends do not have a flexible element; instead, they consist of a simple, rigid pipe that is sufficiently elastic to enable movements to be absorbed as a result of its curved and protruding form.

F

Fixed point

A structural device or bracket that anchors a pipeline in place at a particular point.

G

Guide bearing

A structural device or bracket that enables a pipeline to be shifted longitudinally without permitting any lateral displacement.

Guide pipe

A component that is designed to prevent an axial expansion joint from making any lateral or angular movement.

Guide sleeve

An accessory fitted inside of an expansion joint, which channels the respective medium through the expansion joint without any flow losses occurring at the bellows shafts and without the bellows shafts being initiated via damaging natural vibrations.

H

Hose

A flexible pipe connection with which a very large lateral and angular movement can be absorbed as it is available in almost any overall length.

I

Installation length

The length of a flexible pipe connection after being installed in a pipeline.

L

Lateral movement

The movement of a pipeline element transverse to the longitudinal axis of the pipe.

Load cycle / load change

A non-recurring axial, angular or torsional movement cycle from a defined starting point.

M

Movement absorption

The spatial shifting of a pipeline section that absorbs a flexible pipe connection.

N

NBR

NBR = acrylonitrile butadiene rubber

Type of rubber for media containing mineral oil. Colour designation: "red".

Number of cycles to failure

The number of cycles at which a flexible pipe connection loses its pressure tightness due to material fatigue.

O

Operating pressure

The pressure present in a pipeline system during operation.

Operating temperature

The temperature in a pipeline system during operation.

Overall length

The length of a flexible pipe connection when it is not under load or pre-tensioned.

P

Pressure Equipment Directive

Directive 2014/68/EU of the European Parliament and of the Council of 15 May 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of pressure equipment (new version) was published in the Official Journal of the European Union L 189 of 27 June 2014, page 164. It supersedes the previous Pressure Equipment Directive 97/23/EC on 19 July 2016.

Pressure stage

Standardised nominal pressure for which a flexible pipe connection has been dimensioned.

Pressure-compensated expansion joint

An untensioned expansion joint that does not develop any hydraulic reaction force in the pipeline as a result of its design and that, in contrast to a tensioned expansion joint, permits axial movement absorption.

Pretensioning

An installation condition of an expansion joint whereby the expansion joint is not installed with its untensioned overall length but rather with a pre-tensioned installation length. It is used in order to enable a bigger movement to be absorbed with an expansion joint, provided the respective movement does not take place in the opposite direction to the pretensioning direction.

PTFE

Heat and weather-resistant type of material with outstanding chemical resistance to aggressive media.

R

Reaction force, axial

A hydraulic force occurring from internal pressure and taking effect in the longitudinal direction of the pipe. It corresponds to the product of the effective cross-section of a flexible pipe connection and the internal pressure.

Reinforcing material

Rubber bellows have a three-layered wall structure:

- Inner layer (core) made from a media-resistant rubber mixtur
- Intermediate layer made from a rubber mixture with reinforcing materials
- Outer layer (top layer) made from a weather-resistant rubber mixture.

Rubber expansion joint

Expansion joint with a rubber bellows as a flexible element.

Rubber-metal pipe connector (GRV)

Vibration and noise damper

Rubber body with fully embedded metal flanges.

S

Shaft

A geometry unit of an expansion-joint bellows that gives the bellows its level of flexibility and thereby enables movement to be absorbed.

Spring rate

A variable that describes how much force must be applied in order to pre-tension a flexible pipe connection by a defined movement unit.

Steel expansion joint

Expansion joint with steel bellows as a flexible element.

T

Tension rods

Tension rods refer to the tensioning elements of lateral expansion joints with threaded rods.

Tensioning elements are used on lateral and angular expansion joints. The tensioning elements absorb the axial reaction forces caused by the internal pressure.

Tensioning unit

A functional unit of an expansion joint that generally absorbs the hydraulic reaction force of the bellows and only permits defined types of movement, such as an angular movement around an axis, in accordance with its design. When dimensioning a tensioning unit, any potential additional forces from the pipeline also need to be taken into account.

Thermal expansion

Flexible pipe connections are required for a number of reasons, including the fact that pipelines are not as rigid and static as they appear at first glance. As pipelines, like any other material, are subject to basic physical laws, they become "bigger" when the temperature increases and "smaller" when the temperature decreases. The technical expression for this is heat expansion.

Type examination

E.g. type approvals; performance tests.

V

Vacuum supporting ring

Depending on the respective requirements, type of expansion joint and nominal width, vacuum resistance can be increased for some expansion joints by using vacuum supporting rings.

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RUBBER AND PTFE EXPANSION JOINTS, PIPE CONNECTORS

Type/Designation: _____

Quantity: _____ each DN: _____ Structural length (BL): _____ mm

Flow medium: _____ Bellows material: _____

Design pressure: _____ bar (excess-pressure) Rating temperature: _____ °C

Operating pressure: _____ bar (excess-pressure) Operating temperature: _____ °C

Test pressure: _____ bar (excess-pressure) Max. temperature (briefly): _____ °C

Vacuum: _____ bar abs. Flow velocity: _____ m/s

Pressure pulses: ☐ yes ☐ no Simultaneous movement: _____

Axial extension: + _____ mm _____

Axial compression: - _____ mm _____

Lateral travel: +/- _____ mm ☐ pre-tensioned

Angular angle: +/- _____ degrees

Flange connection

Flange standard/pressure rate: _____ Corrosion protection: _____

☐ Non-standardized flange dimensions →

☐ Material: _____

☐ Connection as per enclosed specification

Outer diameter D _____ mm
Pitch circle diameter K _____ mm
No. of holes n _____ each
Hole diameter d_2 _____ mm

Threaded connection

☐ Female thread _____ ☐ Male thread _____

Restraints to absorb the reaction force

☐ External restraints with tie rods (lateral expansion joint) ☐ Hinge restraints (angular expansion joint)

☐ External and internal restraints with tie rods (lateral expansion joint)

Accessories

☐ Flame protection cover ☐ Protective hood

☐ Protective tube ☐ Vacuum supporting ring ☐ Internal guide sleeve

Tests / Certificates / Regulations

☐ Acceptance test: _____ ☐ Certificates: _____

☐ Pressure test: _____ ☐ Regulations: _____

STENFLEX®

☐ **Inquiry**
☐ **Order**

Company: _____ Phone: _____
Name/department: _____ Fax: _____
Address/P.O. Box: _____ e-mail: _____
Postcode/Town: _____ Date: _____

STEEL EXPANSION JOINTS

Type/Designation: _____

Quantity: _____ each DN: _____ Structural length (BL): _____ mm

Flow medium: _____ Bellows material: _____

Design pressure: _____ bar (excess-pressure) Rating temperature: _____ °C
Operating pressure: _____ bar (excess-pressure) Operating temperature: _____ °C
Test pressure: _____ bar (excess-pressure) Max. temperature (briefly): _____ °C
Vacuum: _____ bar abs. Flow velocity: _____ m/s
Pressure pulses: ☐ yes ☐ no Simultaneous movement: _____
Axial travel: +/- _____ mm _____
Lateral travel: +/- _____ mm _____
Angular angle: +/- _____ degrees
No. of load cycles: _____ ☐ pre-tensioned
☐ Schwingungen Amplitude: _____ mm Frequency: _____ Hz

Flange connection

Flange standard/pressure rate: _____ Corrosion protection: _____

☐ Non-standardized flange dimensions →
☐ Material: _____
☐ Connection as per enclosed specification

Outer diameter D _____ mm
Pitch circle diameter K _____ mm
No. of holes n _____ each
Hole diameter d_2 _____ mm

Pipe connection / welding end

☐ Pipe dimensions →
Material: _____

Outer diameter D _____ mm
Wall thickness s _____ mm
Corrosion protection: _____

Threaded connection

☐ Female thread _____ ☐ Male thread _____

Restraints to absorb the reaction force

☐ External restraints with tie rods (lateral expansion joint) ☐ Hinge restraints (angular expansion joint)

Accessories

☐ Protective tube ☐ nternal guide sleeve

Tests / Certificates / Regulations

☐ Acceptance test: _____ ☐ Certificates: _____
☐ Pressure test: _____ ☐ Regulations: _____

SWIVEL JOINTS

☐ **Enquiry** ☐ **Order**

Please copy, fill and fax
Fax No. +49 40 529 03 200

Application:					
Medium:					
Quantity					
Type					
Form					
Material					
FLANGE					
DN					
Flange drilling					
WELDING END					
Pipe dimension Ø x s (mm)					
THREADED CONNECTION					
Dimension: female thread					
Dimension: male thread					

working temperature °C					
working pressure bar					
test pressure bar					

Certificate 3.1 B acc. to EN 10204					
Inspection by TÜV or other					

Date of delivery:
Delivery address: (if other than purcha ser)

Enquiry Ref.:	Client's No.:
Project:	

Company:	
Name:	Dept.:
Address:	Phone/Fax:
City:	
Date:	Sign:

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