HYDRA
Quality by Witzenmann

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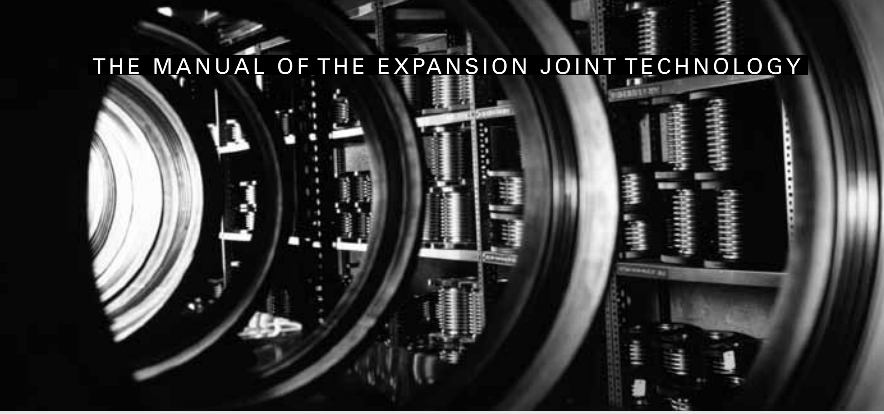
EXPANSION JOINTS

WITZENMANN

WITZENMANN
managing flexibility

EXPANSION JOINT MANUAL

THE MANUAL OF THE EXPANSION JOINT TECHNOLOGY



Updated edition of the Manual of Expansion Joint Technology to meet the requirements of the new works standard and the Pressure Equipment Directive.

Position as of: November 2012

We reserve the right to make changes to the technical specifications.

Technical information can also be downloaded from the Internet in the form of PDF documents;
go to www.flexperte.de

Please ask for a copy of our Flexperte analysis and design software, which will provide you with all the basic technical information you need to design expansion joints, metal hoses, metal bellows and clamped pipe supports.
e-mail: flexperte@witzenmann.com

THE MANUAL OF THE EXPANSION JOINT TECHNOLOGY
Content

Skilled solutions
Wherever pipes expand due to frequent changes of temperature or pressure, wherever vibrations occur in pipework, wherever heavy loads have to be carried, wherever pressure-tight transport of media is essential, wherever a high vacuum must be maintained – these are all situations where flexible metal elements are called for.

Those elements include the actual expansion joints and metal bellows. But also metal hoses, special pipes and the appropriate hangers and supports.

Witzenmann is your first port of call in all these instances. Witzenmann, the inventor of the metal hose and the founder of the metal hoses and expansion joints industry. It all goes back to the year 1885 and the first patented metal hose. The metal expansion joint patent followed in 1920.

Worldwide presence
The Witzenmann company today stands for innovation and high quality. An international group of companies with a total of 3,000 employees in more than 23 companies.
Witzenmann can offer the broadest range of products in this branch of industry. Solutions for decoupling vibrations, accommodating expansion in pipes, flexible mountings and conveying media. Witzenmann is a development partner for industrial customers, the building services sector, the automotive industry and numerous other markets. With in-house machine design, toolmaking and prototyping plus comprehensive testing and inspection systems.

Crucial to the cooperation with customers are the consultancy services provided by the competence centre at the Witzenmann headquarters in Pforzheim, southern Germany. Teams of highly qualified engineers working side by side with the customer on product developments and new expansion joint applications. Specialists complementing the customer's skills. From the preliminary drawings to large-scale production.

Technically Competent
This concentration of knowledge forms a foundation for the synergy is evident in every product, every solution. Our Products have an almost unlimited and diverse range of application but all have one thing in common – maximum safety even in the most extreme applications. This is true of all Witzenmann solutions whether a highly flexible hose or an expansion joint is specified.

Quality

Before a new flexible element is released for large-scale production, it undergoes the most rigorous testing in our modern development centre. Equipped with the very latest in electrodynamic vibration test rigs. Hot gas and service life testing systems. Corrosion resistance apparatus. Portable testing units.
These tests enable Witzenmann to guarantee the optimum configuration for an expansion joint. And also that the expansion joint can withstand all conceivable loads over a long period. Our large-scale production is also carried out with the same degree of care and attention. Our in-house machine design and toolmaking departments work closely with the production department to guarantee stable production processes and products with the best possible quality. Witzenmann has been working to these high standards faithfully for a long time. Back in 1994 Witzenmann was the first company in this sector to gain accreditation to DIN ISO 9001. Such accreditation forms the basis for our leading position in the marketplace.

General approvals

Quality management system to DIN ISO 9001/EN 29001

TÜV Industrie Service GmbH TÜV Süd Gruppe, inspection and confirmation as a manufacturer to AD data sheet HP0, W0 and to TRD 100

Specific approvals

DVGW – German Gas and Water Association

ÖVGW – Austrian Gas and Water Association

GL – Germanischer Lloyd

ABS – American Bureau of Shipping, USA

BV – Bureau Veritas, Belgium

DNV – DET NORSKE VERITAS, Norway

LRS – Lloyd's Register of Shipping, UK

RINA – Registro Italiano Navale, Italy

BAM – German Institute for Materials Research and Testing

VDE – German Association of Electrical Engineers (testing and certification)

VdS – German Association of Property Insurers

FM – FM Global, USA

LPCB – Loss Prevention Certification Board, UK

2 | QUALITY MANAGEMENT

Tight Organization of Quality Responsibility
Our quality assurance is organized on two levels. The central quality assurance department is in charge of superior organizational and technological quality assurance measures. The quality departments of our product divisions deal with quality planning, quality management and documentation within the scope of the execution of orders.
In respect to its organization, the quality assurance department is independent of the production department. It has the competence of giving orders to all employees in charge of tasks which have an influence on quality.

Calculation, Construction
The Product Development and Production Processes provides basic information for the construction and calculation of our products. Comprehensive theoretical investigations and tests are the basis of our activities. The individual divisions will finally apply the construction requirements in practice, taking specific product features and customers' requirements into particular consideration.

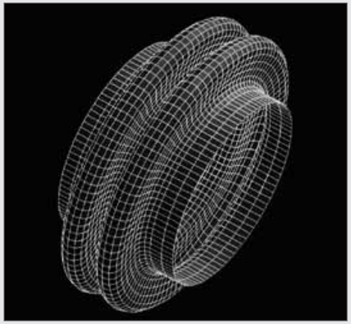


Fig. 2.1 FEM Structure of a Corrugated Part

Meticulous Supplier Audits
We only cooperate with qualified suppliers who can give proof of an efficient quality assurance. For semi-finished products belts, metal plates, pipes, wires, we demand inspection certificates according to the application of the parts. We make sure that the supplied products meet our order and acceptance provisions by means of inspections in our receiving department and our material laboratory.

Complete Production Supervision
The supervision department of our company is responsible for inspection and maintenance of production equipment and correct execution of production procedures in the production process according to provisions of the production documents provided.

Proper Execution of Welding Processes
Welding processes are carried out according to written instructions. The qualification of the welders is guaranteed by means of examinations according to EN 287-1 (EN ISO 9601-1)/EN ISO 9606-4. The most important and frequently applied welding techniques are certified by means of process inspections. The welding supervision meets the respective requirements according to AD Sheet HP3.

Supervision of Measuring and Inspection Equipment
All testing and inspection equipment has been documented They are inspected for precision and reliability at regular intervals. The date of calibration can be taken from control marks.

Supervision of the Quality Assurance System
The quality assurance measures set forth in the QA System are inspected for compliance by all departments dealing with such measures and checked for effectiveness by means of internal audits carried out at regular intervals.

Quality put to the Test

Product Audit
Comprehensive systematic audits carried out in the last few years have enabled us to take the step from empiric knowledge based on routine to the development of systematic knowledge.

2 | QUALITY MANAGEMENT

On one hand, this systematic knowledge is the precondition for product development and optimizing. On the other hand, it is necessary to meet the increasing demand of the market for information about all product properties, especially, e.g., in case of applications for the purpose of safety in air and space travel and in automotive industry.

Material Audit

The demand for economic production requires the selection of appropriate materials. A thorough knowledge of material properties is the precondition for both this selection processes and the demand for an increase in quality and safety.
Semi-finished parts for our products are mostly thin high grade strips, wires, metal plates or thin-ply pipes. The high qualitiy demands made on our semi-finished parts are documented in our order and purchasing conditions. Besides the provisions of national and international standards and regulations, the quality requirements also include specific internal requirements concerning production and documentation. In continuous incoming inspections, the parts ar inspected for compliance with geometrical, mechanical, technological and chemical properties required in our order provisions.
Another task of the material inspection department is the execution of mechanical, technological and metallographical audits in the course of process and acceptance audits of welding operations.

Audits of Welding Staff and Welding Procedures

The welding procedures applied in the production are documented in procedure audits. Continuous actualization of procedure audits is one of the tasks of the welding supervision. Furthermore, this department is responsible for regular qualification audits of the welding staff (welding staff audits according to DIN EN 287-1 [EN ISO 9606-1], DIN EN 287-1 and EN ISO 9606-4).

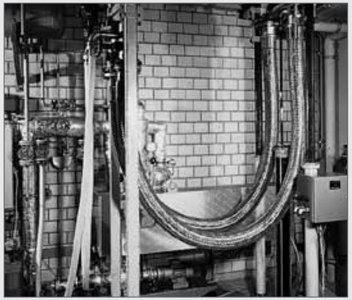


Fig. 2.2 Testing device for load application to hose lines of high nominal widths installed at U-bends and subject to interior pressure and fluid temperatures of up to 300 °C

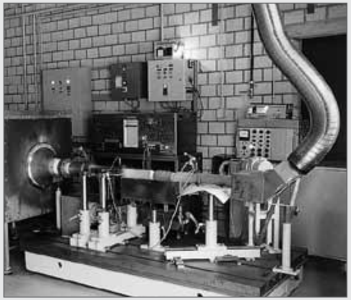


Fig. 2.3 Testing device for load application to flexible parts in exhaust systems with exhaust gas temperatures of up to 1100 °C

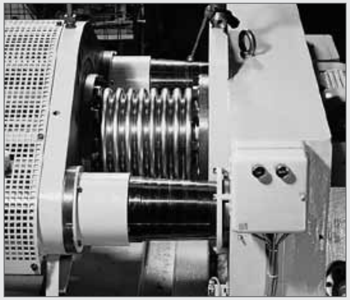


Fig. 2.4 Testing device for load application with an expansion joint DN 200

Fig. 2.5 Vibration test stand for simulation of complex application conditions

2 | QUALITY MANAGEMENT

For non-destructive testing of construction parts and welding seams, we use X-ray and ultrasonic testing devices.

Our material laboratory has been certified by the inspection and clasification institutions that are competent in these fields to be an inspection department for destructive and non-destructive material testing independent of the production departments. It is therefore authorized to issue inspection certificates.

Damage Analysis

Another task of the material inspection department is the damage analysis of products after failure during testing or service. As a rule, metallographical inspections are carried out and the type of damage is documented by means of photographes.

For inspections that go further into detail, the laboratory is equipped with testing devices for material analysis methods as well as for electronic raster scanning microscopy.

Fig. 2.6 Alternating bending apparatus for determination of the fatigue behaviour (service life provisions) of thin strips and metal sheets

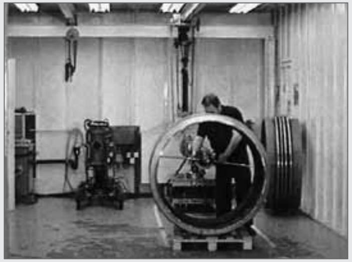


Fig. 2.7 Non-destructive testing by means of an X-ray testing device

Expansion joint quality

In the interest of our customers, we make stringent demands on our expansion joints with regard to performance, quality and reliability.

The quality-assurance process therefore also monitors the incoming materials used for manufacturing, continuously supervises production and subjects the finished products to meaningful final inspections before they leave our plant.

In conjunction with this, samples are taken from production and subjected to functional and destructive tests to verify the quality of their design and manufacture.

The use of high-quality materials, optimized manufacturing procedures which are gentle on metarials, modern automatic facilities and equipment and – last but not least – responsible, qualified personnel are however the most important guarantees of quality for our products.

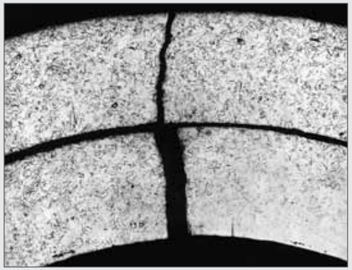


Fig. 2.8 Micrograph of fatigue fracture in a thin bellows ply

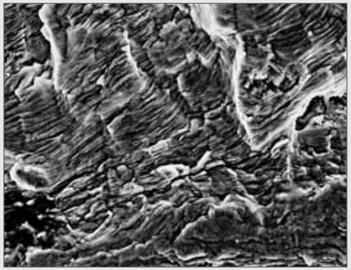


Fig. 2.9 Fatigue fracture under a scanning electron microscope

2 | QUALITY MANAGEMENT

Within the bounds of quality assurance, we have defined the minimum requirements on materials in ordering and acceptance instructions for the most popular types.

Certificates can on request be supplied for the materials used against reimbursement of the costs; if the material is strip material that is normally kept in stock, it can be confirmed with certificate 3.1 to DIN EN 10204, but also according to 3.2.

Possible certificates of performed tests are stated in DIN EN 10204 (see table).

We would like to point out that the scope of the required material tests can have a significant impact on product and testing costs as well as delivery times; disproportionately stringent requirements should therefore be avoided.

Designation of standard	Certificate	Type of test	Content of certificate	Delivery conditions	Confirmation of certificate by
2.1	Declaration of compliance with the order	Non-specific	Confirmation of agreement with the order	According to the delivery conditions of the order or, if requested, according to the official regulations and associated technical rules	The manufacturer
2.2	Test report		Confirmation of agreement with the order stating results of non-specific test		
3.1	Inspection certificate 3.1	Specific	Confirmation of agreement with the order stating results of specific test	According to the delivery conditions of the order or, if requested, according to the official regulations and associated technical rules	The acceptance officer of the manufacturer who is independent of the production department
3.2	Inspection certificate 3.2			According to official regulations and associated technical rules	The acceptance officer of the manufacturer who is independent of the production department as well as the acceptance officer authorised by the orderer or the acceptance officer stated in the official regulations

Design and operation

The various types of expansion joint serve to compensate movements I pipes, machines and apparatus. The movement, which is always a relative movement between two sections of a plant, is caused by thermal expansion, forming by pressure, inertial forces, misalignment or foundation settlement. (Figs. 3.1 – 3.2).

Connections

The expansion joints are connected either by welding them to the pipes or container walls or by flanging them on, e.g. to machine sockets. The standard types of connection part are weld ends and flanges; in special cases screwed nipples are used. (Figs. 3.3 – 3.5).

Fig 3.1 Axial expansion joints

Fig. 3.2 Universal expansion joints

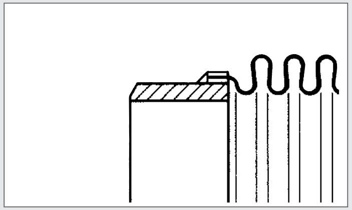


Fig. 3.3 Weld end

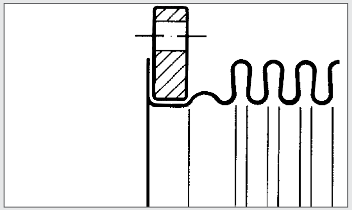


Fig. 3.4 Lap-joint flange

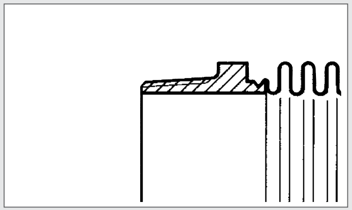


Fig. 3.5 Screwed nipple

The bellows and its principle of operation

The basic flexible element of the expansion joint is the metal bellows, which is flexible on all planes on account of its toroidal corrugations; this flexibility is utilized in the expansion joint in different ways according to the construction type (Fig. 3.6). The flexibility of the bellows is derived from the flexibility of the radial corrugation flanks (Fig. 3.7)

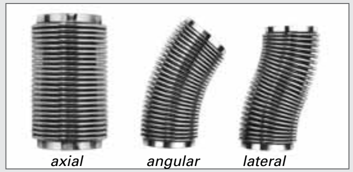


Fig. 3.6 Types of bellows movement

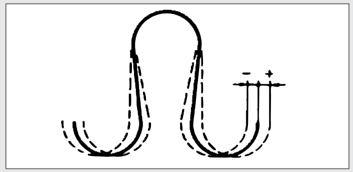


Fig. 3.7 Principle of operation of a bellows corrugation

3 | THE EXPANSION JOINT

In addition to flexibility, the metal bellows must have a certain pressure reliability. Flexibility and pressure reliability are contrary requirements, which in extreme cases result in different corrugation shapes. The lyre-shaped corrugation is a good compromise, which combines considerable flexibility and an adequate pressure reliability (Figs. 3.8 – 3.10).

The lyre-shaped corrugation, to which the description below is restricted, can be adapted to specific requirements to a greater or lesser extend by altering its geometry. It is also possible to increase the number of plies; this is the basis of the best technical solution, namely the multi-ply bellows (see also Chapter 10, “The multi-ply principle“). Figs. 3.11 – 3.13. are diagrams of the various possible types of bellows.

Although the multi-ply bellows is relatively complicated with regard to its design and manufacturing process, it is used as the basic elastic element in our expansion joints on account of its

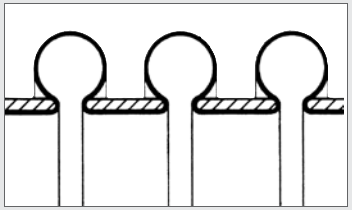


Fig. 3.8 Toroidal shape, extremely pressure resistant

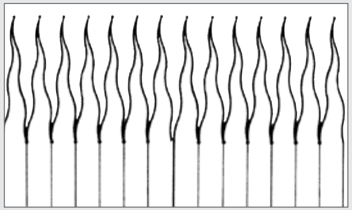


Fig. 3.9 Diaphragms extremely flexible

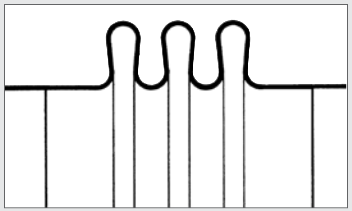


Fig. 3.10 Lyre shape, pressure resistant and flexible

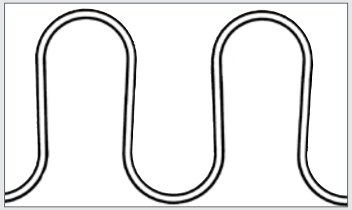


Fig. 3.11. Single-ply bellows

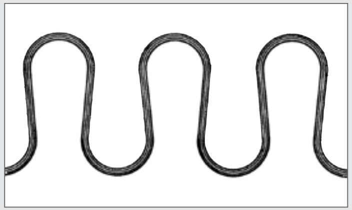


Fig. 3.12. Double-ply bellows

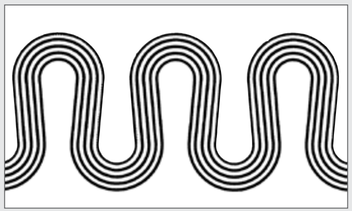


Fig. 3.13 Multi-ply bellows

good characteristics, and has proven to be successful over many years, especially in constructions which are subject to pressure loads.

Anchoring

The various types of hinged expansion joint are fitted with different types of anchors according to their specific functions; the tasks of these anchors are to absorb the axial reaction force and to permit angular or lateral flexibility. The most important types of anchors are shown in Figs. 3.14 – 3.17. The details of the anchoring designs may differ; they are shown in the diagrams for the individual type series.

Fig. 3.14 Angular expansion joint "WRN”

3 | THE EXPANSION JOINT

Fig. 3.15 Gimbal higed expansion joint "WRK"

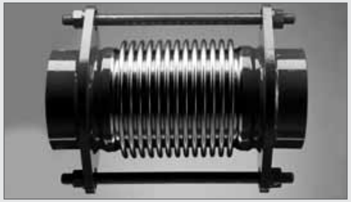


Fig. 3.16 Lateral expansion joint with tie rods in spherical washers "LRR"

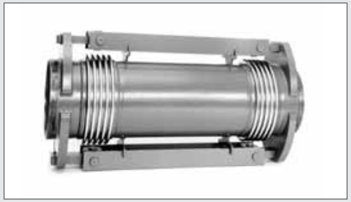


Fig. 3.17 Lateral expansion joint with gimbal hinges "LRK"

Assembly parts
These are a numer of additional assembly parts which may be required; the most frequently encountered of these are described below.

- **Inner sleeve**
  Internal pipe, usually made of stainless steel, which protects the bellows from direct contact with the flowing medium and reduces the flow resistance.
- **Guide sleeve**
  Pipe either inside or outside the bellow, which guides it at defined points or over the entire length to prevent buckling.
- **Protective sleeve**
  Pipe on the outside of the expansion joint, which protects the bellows from mechanical damage and from dirt in the lower bends of the corrugation, and which acts as a carrier for thermal insulation.
- **Reinforcing rings**
  Rings in the lower bends of the bellow corrugations, to reinforce the bellows against internal pressure.

Technical characteristics
HYDRA expansion joints are in line with the latest state of the art (technology and manufacturing processes), and are fully-developed, flexible metal elements which are suitable for universal use in modern pipe construction and plant engineering/construction.

Their outstanding characteristics are based on an ideal combination of design details resulting from intensive development work and several decades of practical experience.

The multi-ply bellows
The multi-ply bellows described above provides HYDRA expansion joints of all types with a series of technical and economic advantages, which are described in detail in the Chapter 10, "The multi-ply principle"; they are listed in brief here:

- Suitable for high pressure
- Good movement
- Compact size
- Low adjusting forces
- Optimum compensation in small spaces
- Early indication of leakages (if damage is likely to occur) through check hole
- Absolute safety against bursting
- Permanent leakage monitoring possible with critical media
- Economic use of high-quality, corrosion-resistant materials, such as Inconel, Incoloy, Hastelloy, titanium and tantalum
- Isolation against impact noise up to 20 dB

Fig. 3.18 Multi-ply bellows (section)

3 | THE EXPANSION JOINT

The weld connection

The connection seam between the multi-ply bellows made of austenitic, stainless steel with a ferritic weld end (or flange) necessitates special welding measures; still more stringent demands are made on the design of the welded area and on the welding process when special alloys must be welded. Even though a mechanical load is only placed on the seam by a part of the axial reaction force, namely that acting in the toroidal chamber of the corrugations, and by the slight adjusting forces of the bellows in relation to tension and shear ($\sigma < 50$ N/mm^2), it must nevertheless remain absolutely tight throughout the entire operating period and is consequently crucial to the quality of the expansion joint.

Special measures must therefore be taken to ensure a low stress level. The bending moment produced by the movement of the bellows in the corrugation flanks is reduced before it reaches the weld connection:

- The raised bellows rim generates a countertorque which relieves the load
- Press-fitted rings reinforce the rim and reduce the stress level
- The cylindrical rim reduces any residual bending stresses

The rim weld seam which is sometimes used for expansion joints with smaller bellows dimensions is located roughly at the mid-diameter, where the bending moment of the corrugation flank tends to zero, and is consequently practically free from moment. It has been proved that the standard seam shown in Fig. 3.19 can be examined non-destructively, due to the low stress level however, the costly examinations necessary to assure the quality of other types of seam can be despensed with, and it is sufficient to perform the standard leakage test.

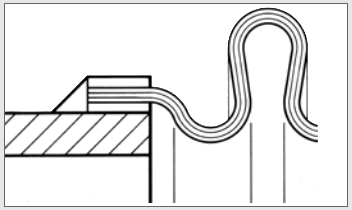


Fig. 3.19 Conection seam of bellows/weld end

The lap-joint flange

Like fixed flanges, lap-joint flanges offer the familiar advantages of flange connections, such as rapid assembly, interchangeability of valves, etc.

Since lap-joint flanges are moreover not welded to the bellows, but form-fitted and assembled on it so that they are rotatable (Fig. 3.20), they have a number of additional advantages:

- The fact that they can be rotated simplifies assembly allowing positive alignment of the flange holes.
- The flanges are not in contact with the media, which may be aggressive, and can be made either of normal steel or of special materials, such as aluminium and plastic.
- The flanges can be protected against corrosion at relatively little costs by means of suitable coating or by galvanization.
- Special materials, which cannot be welded neither to other bellows ply members or to the flange can be used.

Expansion joints with small nominal diameters are fitted for production-related reasons with floating flages with flange rings offering largely the same advantages.

The spacer corrugation shown in Fig. 3.20 is a simple means of keeping space clear for bolting, and prevents the corrugations at either end to move freely.

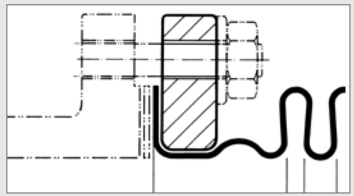


Fig. 3.20 Form-fitted connection between bellows and lap-joint-flange

3 | THE EXPANSION JOINT

The inner sleeve
Inner sleeves are used whenever expansion joints must be protected from:

- Abrasion caused by solid particles in the flowing medium
- Deposits of solid components in the corrugations
- Vibrations generated by high flow velocities

Inner sleeves theoretically also reduce the pressure losses in the flow through the expansion joint; in practice however these pressure losses are so slight – roughly twice as those in a pipe of identical length – that the expenditure is rarely worthwhile.

Our expansion joints with lap-joint flanges are provided with press-fitted, form-fitted inner sleeves (Fig. 3.21), they can also withstand vibration loads.

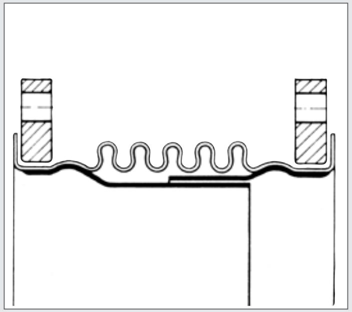


Fig. 3.21 Form-fitted inner sleeves

Patented anchoring
Hammer-shaped anchors inserted in plates (Fig. 3.22) combined with multi-ply bellows permit extremely short total lengths to be used for the HYDRA hinged expansion joints. The full benefit of this advantage is particularly apparent in hinge systems with angular expansion joints, since it also results in small overall dimensions for the hinge system and any other construction which are necessary.

The hammer-shaped anchors are form-fitted to the plates and the plates are welded around the pipe so that the forces/stresses are evenly distributed. The effects of unintentional overloading of the anchoring, e.g. as a result of impulse pressure, are consequently less drastic; the plate yields and is formed without generating excessive stresses in the pipe. Together with the effective safety against bursting of the multi-ply bellows, this acts an efficient safety reserve.

Fig. 3.22 Hammer-shaped tie rod

3 | THE EXPANSION JOINT

General instructions of choice of materials
The wide variety of applications for which our bellows are used necessitates an appropriate choice of materials.

In the appendix A material tables we have listed the common materials we use and the more frequently used special materials with all necessary data in order to simplify selection of suitable materials in each case.

The most important requirements on the material are in general:
- Corrosion resistance
- Temperature resistance
- Strength
- Welding properties
- Forming properties

Bellows materials

Materials for general applications
Standard materials from the group of stainless, austenitic steels are 1.4301, 1.4541, 1.4571 and 1.4404. These materials are especially able to satisfy the requirements over a wide range of applications. In respect of quick availability and optimised stock holding, for general applications Witzenmann manufactures bellows from 1.4541.

Material 1.4541 – standard for bellows manufacture
1.4541 is used in the chemical industry, food industry, in exhaust systems, in district heating and compressor pipe systems and in cryoengineering. Since titanium is used for alloying in 1.4541, unlike 1.4301, this material has better resistance to intercrystalline corrosion up to 400°C.

Material 1.4571
As with 1.4541, 1.4571 is used in the chemical industry, food industry, in exhaust systems, in district heating and compressor pipe systems and in cryoengineering. 1.4571 has proven itself, above all, for decoupling elements in exhaust systems of motor vehicles and when used in drinking water piping. As with 1.4541, 1.4571 is stabilised with titanium, which increases its resistance to intercrystalline corrosion. In addition, molybdenum is added in 1.4571, so that it is more resistant to pitting corrosion than 1.4541, which can occur in the presence of chlorides.

Material 1.4301
For strip-wound hoses, which are used in, for example, exhaust systems of trucks, the high-alloy steel 1.4301 exhibits adequate corrosion resistance. The corrosion resistance is attributable to the elements chromium and nickel.

Material 1.4404
1.4404 is used for components in vacuum equipment; it has also proven itself as hose material. In principle, it can be used in the same ways as 1.4571. The chemical composition largely matches that of 1.4571. In comparison to 1.4571, 1.4404 is not stabilised with titanium. Through a reduced carbon content of less than 0.03%, however, it exhibits a similar resistance to intercrystalline corrosion. Owing to the reduced carbon content, the strength characteristics are somewhat lower than those of 1.4571.

Materials for high temperatures
For higher temperatures (>550 °C), where high scaling resistance is required, high-temperature or heat-resisting steels are taken into consideration if they have adequate forming properties (e.g. 1.4828, 1.4876 or 2.4856).

3 | THE EXPANSION JOINT

Material 1.4828
The material 1.4828 has proven itself as strip-wound hose liner in decoupling elements, as expansion elements in manifolds of engines. Owing to its high silicon content, 1.4828 has good scaling resistance.

Material 1.4876 (Incoloy 800 H)
The material 1.4876 is used where compressive stresses occur in addition to high temperatures, e.g. in the inlet and outlet pipes of engine turboch argers. 1.4876, in which aluminium is added, has even better scaling resistance than 1.4828; the chromium and nickel content is also significantly higher, but this makes it more expensive and reduces its suitability for forming. 1.4876 exhibits excellent long-time rupture strength characteristics and is approved for components under compressive stresses at temperatures above 550°C.

Material 2.4856 (Inconel 625)
Use of the nickel-based alloy 2.4856 is recommended where high temperatures occur as well as corrosive stress, e.g. with chlorides.

Materials for corrosive media
Especially corrosive conditions require the use of special materials that should at least have the corrosion resistance of the connected pipe or fittings. If in doubt, a higher-grade material should be chosen. In many cases, nickel-based alloys are suitable for this, a fact that is substantiated by good experiences. In special cases, titanium or tantalum is the only alternative.
For expansion joint bellows, the materials 2.4856 (Inconel 625), 2.4610 (Hastelloy C-4) are preferred, and for bellows of smaller size (diameter < 100 mm), the material 2.4819 (Hastelloy C-276).

Material 2.4856 (Inconel 625)
Expansion joint bellows that are exposed to seawater are preferably made of Inconel 625. The molybdenum-containing material 2.4856 has excellent resistance to pitting, crevice and stress crack corrosion.

Material 2.4610 (Hastelloy C4 / - C276)
Bellows of these two materials are used in chemical and other process engineering plants. They are exceptionally resistant to hot acids, chloride-containing solutions or even chlorine gas up to temperatures of 400°C.

Expansion joints for corrosive operating fluids

Suitability of metal expansion joints
Expansion joints with corrugated metal bellows are basically suitable for the transport of critical fluids under pressure and temperature.

The flexibility of the corrugated bellows of expansion joints generally requires their wall thickness to be considerably smaller than all other parts of the system in which they are installed. As increasing the bellows wall thickness to prevent damages caused by corrosion is not reasonable, it becomes essential to select a suitable material for the bellows element, which is sufficiently resistant against all aggressive media that may occur during the entire lifetime. In many cases the bellows has to be manufactured of a material with even higher corrosion resistance than those of the system parts it is connected to.

In addition, possible corrosive environmental effects must be considered.

The material selection must take into account all possible kinds of corrosion, especially pitting corrosion, intercrystalline corrosion, creve corrosion cracking (SCC).

Selection of a suitable material
The material for the bellows layers is to be selected according to the specific aggressiveness of the operating fluid or for the surrounding atmosphere. References for material resistance can be found under appendix B – Resistance tables.

Responsibility of the manufacture for the suitability of expansion joints
The expansion joints manufacturer is responsible for the design of the expansion joint according to the given pressure, temperatures and movements, and for the material concerning its formability and weldability. Witzenmann contributes his wide scope of experience when assisting the user in selecting a suitable material.

With regard to the influences of the operating situation given in the plant only the operator can take full responsibility. The advice of the expansion joint manufacturer can only be given without obligation, i. e. without any liability for the material to be selected for the special application.

Fittings, flange materials and materials for anchors
When choosing materials for connection fittings, strength and welding properties are particularly important. For flanges and fittings, unalloyed steel and general constructional steel is normally used. Where there are higher operating temperatures, high-temperature steels are used. Under higher stresses or lower temperatures, fine-grained constructional steels and low-temperature steels are used.

Under corrosion-critical conditions, fittings of compound steel, stainless, ferritic or austenitic steels and nickel-based alloys are used.

Safety and economy with expansion joints

Expansion joints are required in almost all technically oriented branches of industry where plants must be operated reliably. They must perform a variety of tasks, such as:
- Compensation of thermal expansion in pipes
- Decoupling of equipment vibrations from connected systems (e.g. compressors etc.)
- Compensation of relative movements between plant sections
- Isolation of structure-borne noise
- Reduction of forces and moments at connections.

It is not merely essential to employ flexible, metal expansion joints in modern plant and apparatus engineering and construction for technical reasons; it is equally important to meet the requirement of all branches of industry for:
- Improved economic efficiency
- Reduced plant size
- Ease of assembly
- Trouble-free operation
- Safety in the event of system mal function.

HYDRA expansion joints meet all these requirements, and if chosen carefully and installed correctly are:
- Pressure proof
- Vacuum-tight
- Temperature-resistant
- Corrosion-proof
- Durable
- Reliable
- Maintenance-free

A comprehensive range of standard expansion joints are available; our experienced engineers are always ready to examine the eventuality of delivering special designs for special applications. Their experience is based on decades of company experience in almost all branches of industry.

Engineering for special situations
We are always willing to support you in optimizing your compensation problems, insofar as a feasible solution can be found. We also offer a special engineering service for solving specific problems:

- Optimization of compensation systems using modern methods of pipe calculation
- Optimization of the design of bellows and connection parts for special applications, supported by FE methods
- Development of special designs, including the necessary manufacturing processes (forming, welding, etc.)
- Performing of series of tests with special products or for special applications
- Support in solving corrosion problems, including material recommendations and corrosion tests.

4 | COMPENSATION TYPES

Compensation types and selected criteria

There are three basic types of compensation, namely:

- Compensation by elastic bending of pipe legs (“natural compensation”)
- Axial expansion joints
- Anchored expansion joints (hinged expansion joints)

The relevant characteristics are as follows:

- Magnitude and type of movement which must be compensated
- Pipeline routing
- Forces and moments acting on anchors and connections
- Installation space required for expansion joints
- Overall cost of compensation
- Assembly work

The above overview of characteristics permits a qualitative comparison of the compensation types – either compensation with axial expansion joints or compensation with hinged expansion joints – and is an important decision-making aid.

Compensation by pipe bending

The question as to whether compensation, for example of thermal expansion, is possible by means of the intrinsic elasticity of the pipe system is generally superfluous due to the fact that with large diameters pipe legs which are sufficiently long are not available (Fig. 4.1). Extending the pipes artificially or laying them with bends is however usually not feasible for economic reasons, as has been demonstrated by numerous examinations. (High-pressure steam pipes in power stations are one example of an exception made for technical reasons).

The examination can generally be restricted to pipe diameters less than DN 100, and is only advisable if, in addition to the stresses from the internal pressure, the pipes can also absorb significant, alternating stresses from the movement cycles without fatiguing prematurely.

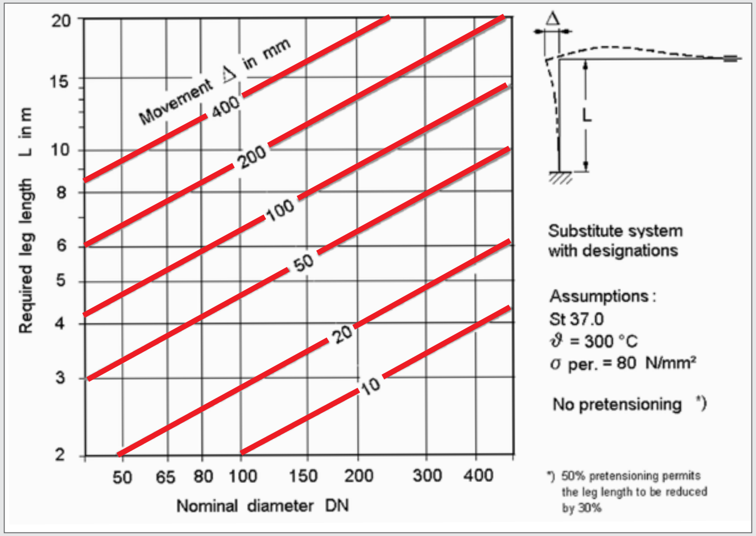


Fig. 4.1 Compensation by bending pipe legs (“natural compensation”)

4 | COMPENSATION TYPES
Comparison of compansation types

Axial expansion joints

Movement
- Small to medium axial movement up to approx. 200 mm
- Additional lateral and angular movement also possible
- Several axial expansion joints must be distributed over the length of the pipe section for large movements caused by long sections

Pipeline routing
- No change in direction of flow

Anchors and guides
- Higher pressures and nominal diameters result in high anchor forces (Fig. 4.2)
- Anchors must be positioned at the corners of offset systems
- Long pipe sections with several axial expansion joints require intermediate anchors
- Additional guides must be incorporated directly at the axial expansion joint

Installation space
- Low space requirement, outside diameters only slightly larger than the pipe itself

Costs
- Low price per unit (several expansion joints required for long pipe sections)
- Possily high costs for anchors and guides

Assembly
- Simple assembly and pretensioning of expansion joints
- Pipe sections must be guided exactly to give proper alignment
- Pressure test only possible when fully secured at anchors

Hinged expansion joints

Movement
- Medium to large perpendicular to the expansion joint axis, on one plane or on all planes (lateral expansion joints often only compensate main elongations, whilst small residual elongations must be absorbed by the pipe)

Pipeline routing
- Pipeline necessary rerouted
- Compensation with hinged expansion joints advisable if the pipe run already contains offsetts

Anchors and guides
- Relatively small load on anchors, even in pipes with high pressure, since the axial reaction force is absorbed by the expansion joints hinges
- Only the adjusting forces of the expansion joints and the frictional forces of the supports are active. The frictional forces may cause problems in long pipes with regard to the design of the anchors!
- Normal guides sufficient for the pipe

Installation space
- More installation space required than with axial compensation, especially if the pipeline must also be rerouted

Costs
- Price per unit higher than for axial expansion joints
- Angular expansion joints must be installed in pairs as a minimum
- In relation to movement, costs comparable with those of axial expansion joints, if long pipe runs are compensated
- Anchors more economical

Assembly
- Assembly of hinged joint is more complex
- Position of pivots and tie rods very important
- Normal amount of work for pipe routing
- Pressure test can be performed without anchors

4 | COMPENSATION TYPES

Operating limits of axial expansion joints

Fig. 4.2 provides a rough overview of the potential applications of axial expansion joints in pipes; please note the assumptions which have been made.

A more detailed examination of the technical boundary conditions and a cost comparison are generally advisable before a final decision can be taken. The most important criterion is the anchor force.

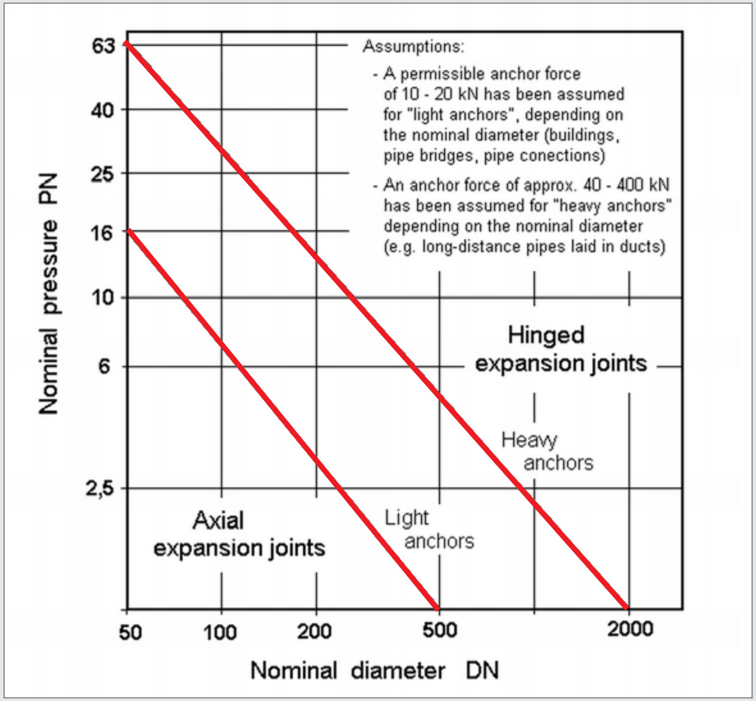


Fig. 4.2 Operating limits of axial expansion joints

4 | COMPENSATION TYPES

Anchor force
When axial joints are used, the anchor force is made up of the axial reaction force F_P, the axial adjusting force F_δ and the friction coefficients of the supports F_R; these are calculated as follows:

Axial reaction force in kN
(see also Fig. 4.3)

(4.1) $$F_p = 0.01\ A \cdot p$$

Effective cross-section A in cm^2
(taken from dimension tables for axial expansion joints)
Pressure *p* in bar (maximum pressure, e.g. test pressure, should be used)

Axial adjusting force in kN

(4.2) $$F_\delta = 0.001\ c_\delta \cdot \delta$$

Axial spring rate c_δ in N/mm (taken from dimension tables for axial expansion joints)
Half overall movements δ in mm (with 50% pretensioning)

Friction coefficients of supports in kN

(4.3) $$F_R = \sum F_L \cdot K_L$$

Support load F_L in kN
Resistance coefficient of supports K_L

Empirical values for K_L:

Steel/steel:	0.2 – 0.5
Steel/PTFE:	0.1 – 0.2
Roller supports:	0.05 –0.1[1])

The crucial share of the anchor force when axial expansion joints are used is contributed by the axial reaction force; the adjusting force is relatively insignificant in the multi-ply bellows we use.

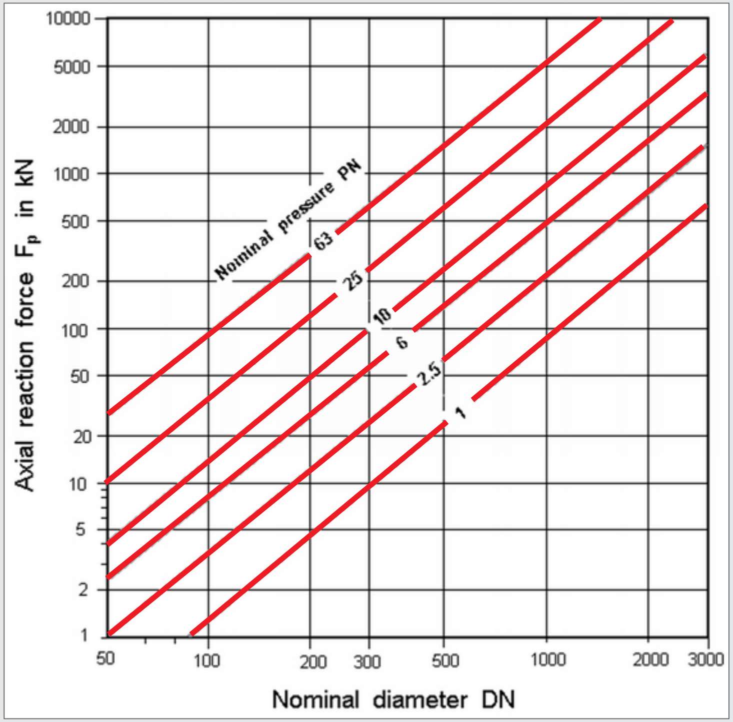


Fig. 4.3 Axial reaction force

4 | COMPENSATION TYPES

Adjusting forces and moments
Adjusting forces and adjusting moments for expansion joints should be calculated using the adjusting force and adjusting moment rates given in the tables. The values given in the tables are valid for the cold state (room temperature) only; smaller values must be expected in the operating condition. The deviations are practically negligible for temperatures up to 300°C. At higher temperatures the reduction factors in the table below enable the adjusting rate to be estimated when using standard materials (1.4541 or 1.4876).

Reduction factors for adjusting rates

Operating temperature ϑ in °C	200	300	400	500	600	700	800	900
Correction factor K_c	0,93	0,9	0,86	0,83	0,80	0,75	0,71	0,67

Adjusting rate for temperature

$$c_{i\vartheta} = K_c \cdot c_i$$

General adjusting rate, c_i
(taken from tables)

Hinged expansion joints
If hinged expansion joints are used, no load is placed on the pipe anchors by the axial reaction force; the load is carried instead by the hinge parts. The only loads placed on the anchors are the adjusting forces of the expansion joints and the friction coefficients of the supports, as well as any forces and moments resulting from movements of the pipe legs if residual elongations are transferred to the pipes in conjunction with lateral expansion joints. The friction coefficients of the supports may become significant in this case, since the movement in long pipe sections can be transferred to a single compensation system, thereby moving several different supports.

Compensation with lateral expansion joints
Hinged expansion joints have been considered so far as a single group, i.e. no distinction has been made as yet between angular and lateral expansion joints.

The basic question involved is whether or not a double-hinge system is sufficient for compensation or whether full compensation with three hinges is necessary.

Two hinges (angular expansion joints) – or alternatively one lateral expansion joint – can be used if the residual elongation from the pipe offset and the axial offset of the double hinge resulting from the movement ("height of arch") can be absorbed by the downstream pipe legs by means of bending (see also Fig. 4.1), and if the forces and moments which are generated as a result can be supported by the system. The question as to whether it is better to use two hinges or one lateral expansion joint is generally related primarily to costs.

4 | COMPENSATION TYPES

Compensation with pressure balanced designs
In some cases pressure balanced expansion joints or straight section tie rods are the best alternative technically speaking, though they may be more expensive. The basic alternatives which are available are described in Chapter 12, "Axial reaction force and pressure balanced designs".

The criteria for selecting the right type of compensation system which are discussed in this chapter should be sufficient in most practical situations to permit a decision to be taken as to which types of expansion joint should be used.

The final decision may however depend on other data, for example on the total length of the expansion joints, which is not determined until later on; this frequently makes it necessary to revise the overall system.

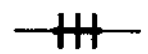
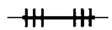
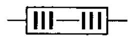
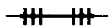
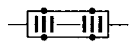
Drawing up a cost comparison is the only means of choosing the most economical of all the technically feasible systems. An economic consideration should not merely take into account the cost of the expansion joints; it should also include all miscellaneous costs related to the selected compensation type, namely:

- Anchors
- Guides and other supports
- Constructions/shafts
- Assembly work
- Miscellaneous

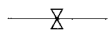
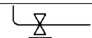
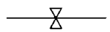
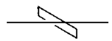
In case of doubt or complex applications, please consult our specialists.

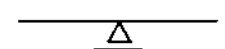
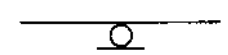
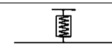
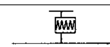
Symbols used to represent systems

Expansion joint symbols Fig. 4.4

Designation	Plane representation according to direction of movement Elevation view	Plan view	Isometric representation
Axial expansion joint			
Angular expansion joint, single hinge			
Angular expansion joint, gimbal hinged expansion joint			
Lateral expansion joint, movable on one plane			
Lateral expansion joint, flexible on all planes (in circular plane)			

Support symbols Fig. 4.5

Designation	Representation
Anchor FP Intermediate anchor ZFP	
Sliding anchor GFP	
Guide bearing FL	
Two-way Glide guide KGL	

Designation	Representation
Support AL	
Roller support RL	
Spring hanger FH	
Constant hanger KH	

Overview of the main compensation types

Principal characteristics

Axial compensation Fig. 4.6
- Simple design
- Small to medium movements
- Flexibility on all planes possible
- Pipeline reroutimg not necessary
- High axial forces in conjunction with high pressure
- Strong anchors and good guides necessary

Angular compensation Fig. 4.7
- Complex design
- Medium to large movement possible
- Axial movement not possible
- Pipeline rerouting necessary
- Relatively small load on anchors
- Normal guides adequate.

Lateral compensation Fig. 4.8
- Relatively simple design
- Small to medium movements
- Axial movement not possible
- Pipeline rerouting necessary
- Relatively small load on anchors
- Additional load from residual elongations
- Normal guides adequate (sometimes with clearance).

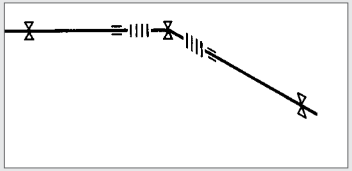


Fig. 4.6

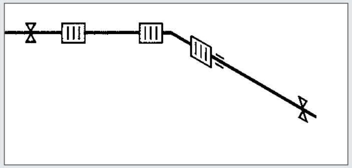


Fig. 4.7

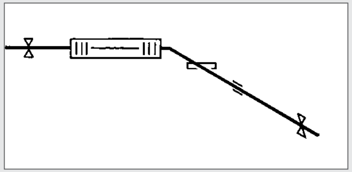


Fig. 4.8

Selecting an expansion joint

Introduction
The basis for selecting the right expansion joint is our comprehensive standard range. Individual series designed and arranged according to nominal diameter, nominal pressure and nominal travel. That makes selection quick and dependable. Guarantees cost-effective, fully designed installations. Achieves short and reliable delivery times.

Wherever an expansion joint has to be designed for a very particular application, our engineers optimise the joint to meet the customer's engineering and economic specifications. Even the initial quotation includes exact computer-assisted data.

Design codes
The manufacturer is responsible for providing a properly designed expansion joint. "State-of-the-art" design is indispensable, complying with national and international standards. As many pressurised lines fall under the remit of the EU's Pressure Equipment Directive, the associated expansion joints, too, are classed as pressurised components in the meaning of this directive. CE marking is a must.

The Pressure Equipment Directive
The Directive applies to all expansion joints with a maximum permissible pressure PS > 0.5 bar, provided the specific application does not explicitly exclude this.

Therefore, even our standard expansion joints fulfil the additional requirements of the Pressure Equipment Directive.

Our expansion joints can be employed in a vast range of applications. Therefore, we have designed them for use in all categories up to category IV.

Witzenmann has implemented, operates and maintains a quality assurance system as described in the pressure equipment directive (97/23/EC) Annex III, Module H/H1 for the scope of design, manufacturing and distribution of expansion joints and metal bellows. This also applies to all other conditions. Certification of the raw materials, methods and manufacture and personnel. That means customers can rely on design and selection of expansion joints in compliance with the Pressure Equipment Directive. Work in accordance with the Pressure Equipment Directive takes place in defined modules. These depend on the category selected. Therefore, the extent of testing and documentation is defined accordingly.

Witzenmann – a Member of EJMA
Witzenmann is a member of the Expansion Joints Manufactures Association (EJMA). Every expansion joint pruduced by Witzenmann can be designed and manufactured in strict accordance with EJMA standards.

Detailed calculations to validate design in accordance with latest edition of the EJMA standards are available to every Witzenmann customer.

5 | SELECTING AN EXPANSION JOINT

FLEXPERTE

Knowledge by Witzenmann

Flexperte is a design tool for flexible metal elements. It was specially conceived according to the latest design codes and selects the products from the standard range to suit the particular application. This program enables the user to select the right expansion joint. And also metal bellows, metal hoses and pipe supports.

The user simply enters the operating conditions. Flexperte then selects the most suitable products and outputs all the necessary information and sketches. The user can use this information for further design work, or as the basis of an inquiry or an order.

We shall be happy to send you a copy of the program on request. All the functions can also be used directly online. Simply go to www.flexperte.de.

List of symbols used in formulae

â	Amplitude in mm
c	Adjusting-force/adjusting moment rate
c_δ	Axial adjusting-force rate in N/mm
c_α	Angular adjusting-moments rate in Nm/deg
c_λ	Lateral adjusting-force rate in N/mm
$c_{t,\vartheta}$	Adjusting rates at various temperatures
A, B, C	Pipe sections in hinge system in m
D	Bellows external diameter in m
DN	Nominal diameter
K_1, K_2, K_3	Expansion joints in hinge system
K_p	Reduction factor for pressure
K_Δ	Reduction factor for movement
K_c	Reduction factor for adjusting rate
l	Corrugated length of bellows in mm
l*	Hinge distance / bellows centre distance in mm
l_z	Intermediate pipe length in mm
L	Length of the pipe section in m
PN	Nominal pressure
P_A	Working pressure in ba
P_P	Test pressure in bar
P_{RT}	Cold pressure in bar
$R_{m/100000}$	Endurance tensile strength (100000h to rupture) in N/mm^2
$R_{P\,0.2}$	Yield point with 0.2% residual elongation in N/mm^2
R_{PRT}	Yield point at room temperature in N/mm^2
$R_{p\vartheta}$	Yield point in temperature in N/mm^2
α	Angular movement in one direction in deg
α	Mean thermal expansion coefficient in mm/mK
α_o	Pressure-less bending angle in one direction
α1, α2, α3	Bending angles of expansion joints K_1, K_2, K_3 in deg

δ	Axial movement on one plane (elongation or compression) in mm
δ_{RT}	Cold value of axial move ment on one plane in mm
Δ	Movement, general in mm
Δ_P	Pressure stretch in mm
Δ_ϑ	Thermal expansion in mm
$\Delta\vartheta$	Temperature difference in °C
λ	Lateral movement on one plane in mm
λ_o	Pressure-less lateral move-ment on one plane in mm
ϑ	Temperature in °C
ϑ_o	Assembly temperature in °C
ϑ_A	Working temperature in °C

Indices:

o	Pressure-less, assembled condition
c	For adjusting rate
A	Working ..., referred to pipe section A
B	Referred to pipe section B
L	Dependent on number of stress cycles
N	Nominal ...
i	ith value in set of values, substitute pointer for index for movement type
P	Pressure-related
RT	At room temperature
z	Intermediate pipe
zul.	Permissible
α	Dependent on angular movement
δ	Dependent on axial movement
λ	Dependent on lateral movement
ϑ	Temperature-related
Δ	Movement-related

5 | SELECTING AN EXPANSION JOINT

Pipe Sections
A pipe system must generally be sub-divided into a number of suitable sec-tions to ensure optimum compensa-tion, these sections being separated by means of anchors; the type of compen-sation must be taken into account. Machines and containers must be con-sidered to be anchors if they are not flexibly supported.

Axial compensation
Only straight pipe sections without off-sets are permissible. Long, straight sections must be split up by means of intermediate anchors if several axial expansion joints are required to com-pensate the complete pipe section. Only one expansion joint must be installed between each pair of anchors (or intermediate anchors).

Anchors must be installed at the corner points at which pipelines are rerouted. A sliding anchor may be installed instead if the axial expansion joint (or a universal expansion joint) can be sub-jected to a lateral stress (Figs. 5.1 and 5.2)

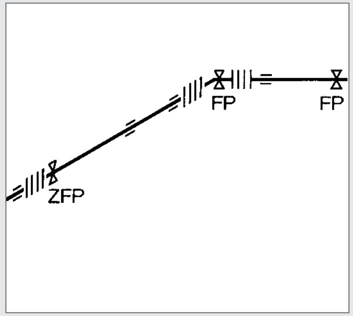


Fig. 5.1 Arrangement of axial expansion joints

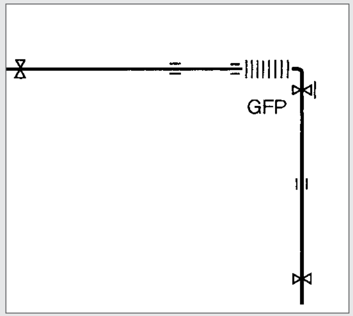


Fig. 5.2 Arrangement of a universal expansion joint

Compensation with hinge systems
When a complex pipe system is subdivided into sections, the aim should be to achieve the basic subsystems shown in Figs. 5.3 to 5.5, namely a U-system, an L-system or a Z-system. A straight pipe section is not suitable for compensation by means of hinged expansion joints; the pipeline is therefore usually rerouted “artificially” by creating a U-system.

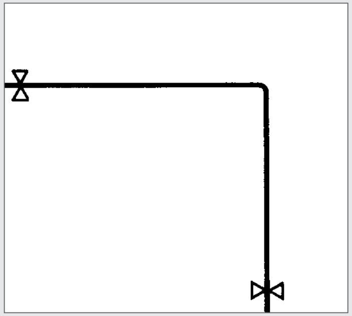


Fig. 5.3 L - system

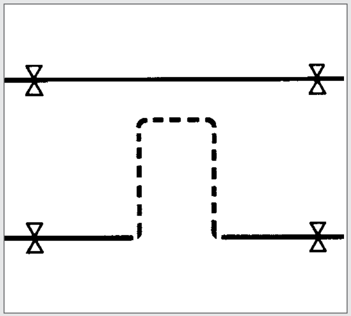


Fig. 5.4 Straight pipe section, U-system

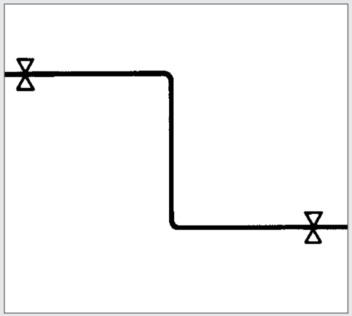


Fig. 5.5 Z-system

Determining movement values

The following types of relative movement must be absorbed by the expansion joint (examples):
- Thermal expansion
- Pressure stretch
- Vibrations
- Compensation of misalignement
- Foundation settlement
- Assembly movement.

The highest movement values are generally caused by thermal expansion; this is discussed separately and in detail below.

Pressure stretch
Pressure stretch occurs at containers and in pipes as a result of a pressure load; it is however only significant in conjunction with large dimensions, which may have an important effect on compensation. When its magnitude is estimated, it must be remembered that in a long, closed cylinder the longitudinal stresses caused by pressure are half the magnitude of the circumferential stresses. If a full pressure utilisation coefficient is assumed, the values for normal steel are as follows: $R_{p\,0.2}$ = 210 N/mm², E = 21 · 10⁴ N/mm² and S = 1.5 (safety factor for pressure tanks), taking into account the transversal contraction:

(5.1) $$\Delta_p \approx 0.1 \text{ mm/m}$$

This value is generally negligible, except, for example, in extremely high columns or containers, such as blast furnace, whose axial pressure stretch may result in lateral stresses in expansion joints with large diameters in connecting pipes.

There is no pressure stretch in pipes with axial expansion joints due to the lack of a longitudinal force.

5 | SELECTING AN EXPANSION JOINT

Vibrations
Vibrations occur in machines where masses are moved (e.g. in turbo-engines, piston engines and centrifuges), and are defined in terms of their frequency and amplitude. The frequencies are primarily dependent on the speed; in this type of aggregate, it is moreover possible to establish harmonic vibrations with a multiple of the speed but only a low amplitude.
The amplitudes of sustained vibrations in well-balanced machines are normally less than 1 mm, and are only higher temporarily during the start up phase and when traversing critical speeds (see also Chapter 13, "Vibrations and noise"). Centrifuges are an exception, in that considerably high vibration amplitudes can occur in them.

Compensation of misalignment
Expansion joints can be used to compensate assembly inaccuracies, providing this is taken into account when these are chosen. Since only a one-off movement must be compensated, it can be theoretically be borne by the expansion joint without any impairment to its service life; in practise, however, the corrugations can very soon become either fully or partially blocked, which means tat normal movement will be impeded and the expansion joint will fail at a relatively early stage. This risk is especially high if a relatively short axial expansion joint is used to compensate lateral misalignments.

Foundation settlement
Foundation or groud settlements are likewise normally one-off movements, and may thus be greater for an expansion joint than the values specified for 1000 stress cycles. If a one-off foundation settlement is the only movement which is expected, even excessive forming of the corrugations may be acceptable, and the expansion joint will remain tight. Settlement which occues when containers are filled and which disappears again when they are drained must be dealt with according to the stress cycles in the same way as other compensation movements.

Assembly movement
If space must be created for assembling or dismantling valves, a suitable type of expansion joint can be used, namely so-called demounting parts (see Chapter 9, "Special designs", Fig. 8.16). The assembly procedures are generally so infrequent that the expansion joint can withstand large movements (before the corrugations are blocked).

Thermal expansion
The linear thermal expansion of metal components, referred to a temperature difference, can be determined by means of the material-related elogation coeficient.
Thermal expansion Δ_ϑ in mm

(5.2) $$\Delta_\vartheta = L \cdot \overline{\alpha} \cdot \Delta\vartheta$$

Component length L in m
(e.g.pipe section between two anchors)
Mean thermal expansion coefficient $\overline{\alpha}$ in mm/mK (see Fig. 5.7)
Temperature difference $\Delta\vartheta$ in K
(Difference between operating temp. and assembly temp.)

Mean thermal expansion coefficient
$\overline{\alpha}$ in mm/mK

Material	Temperature range from 20°C to				
	100°C	200°C	300°C	400°C	500°C
Ferritic steel (DIN 17 155)	0.0125	0.013	0.0136	0.0141	0.0145
Austenitic steels (1.4541) DIN 17 440	0.016	0.0165	0.017	0.0175	0.018
Copper	0.0155	0.016	0.0165	0.017	0.0175
Aluminium alloy (AlMg3)	0.0237	0.0245	0.0253	0.0263	0.0272

Fig. 5.6

5 | SELECTING AN EXPANSION JOINT

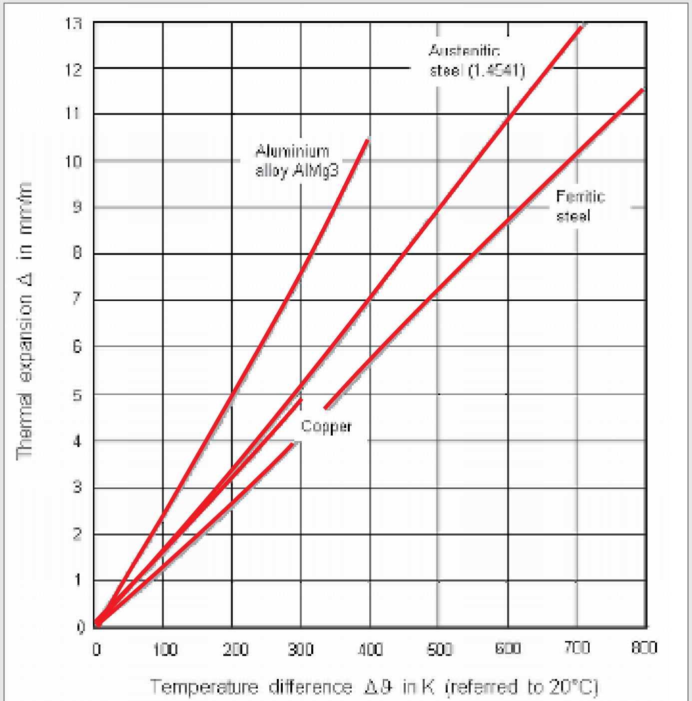


Fig. 5.7 Thermal expansion of metals

Assembly temperature
The assemly temperature can normally be taken to be ϑ_o = 15 to 20 °C, when determining the temperature difference $\Delta\vartheta$ which must be taken into account in the movement calculation; at low operating temperatures of around 100 °C, it is necessary to proceed somewhat more precisely and to take a mean temperature at standstill. A check must also be made to determine whether the pipe can still contract sufficiently at the lowest possible standstill temperature without the expansion joints being overstretched or the hinge system being geometrically overloaded. Particular attention must be paid to the possile extreme positions of the expansion joint or of the compensation system at the maximum and minimum outside temperatures, as well as to correct pretensioning at the prevailing assembly temperature in pipes which are really cold and which only stretch or contract as a result of the prevailing outside temperature.

5 | SELECTING AN EXPANSION JOINT

Real movement values
The real movement of the individual expansion joints can be determined from the previously established relative movements – usually thermal expansion – in the various pipe sections.

Axial and lateral expansion joints
If axial or lateral expansion joints are used, the movement values which are determined correspond to the real expansion joint movements.

Hinge systems
The movement values Δ established in hinge systems must be converted to angular movements. A good approximation can be achieved with the aid of the graph below (Fig. 5.9).

The conversion is exact if the system is a simple double-hinge system with hinges arranged perpendicularly above one another; in other systems the angles are determined approximately, whereby the diffenrence in relation to the exact angles is small and dependent on the arangement of the hinges and on the magnitude of the movement which must be absorbed.

The relevant movement value Δ must first be determined for the particular hinge system in accordance with Fig. 5.8a, 5.8b. The expansion joint angle α must then be read from the graph (Fig. 5.9), together with the hinge distances A and B.

The hinge distances A and B.which are selected should be as large as permitted by the overall construction, and should be such as to ensure small expansion joint bending angles and – above all – the smallest possible forces and moments in the pipe system. The smallest possible distance should be selected for C.

The bending angles which are determined are real angles of the system at operating temperature, and are also valid when the cold system is pretensioned.

If the system is to be operated without pretension, the angles obtained will be roughly twice as large, and correspondingly larger expansion joints will be necessary. The real bending angles must be converted into nominal angles in order to select the best expansion joints, whereby the potential effects of the operating temperature, the pressure utilisation coefficient and the number of stress cycles must be taken into account.
Since this applies generally to all types of movement, the section below refers to all types of expansion joint.

Definitions for Figs. 5.8a, 5.8b and 5.9
“Calculation of the bending angles of hinge systems”

Distances
A Main distance
U and Z-systems: Distance between the hinges in or at the pipe offset
L-systems: Distance between the hinges in the same pipe run
B Secondary Distance (three-hinge systems only)
All systems: Distance from balancing element
U-system: Distance between basic swivel hinge and crown hinge
C Corner distance (three-hinge systems only)
All systems: Diagonal distance between hinges
U-systems: Distance designated “B”

Hinges
K_1 Outer hinge in pipe section A
K_2 Second hinge in pipe section A (U-systems: second basic swivel hinge)
K_3 Second outer hinge/balancing element (U-systems: crown hinge)
Only exists in three-hinge systems!

Movements in pipe runs
Δ_1 First main movement
Movement in first main run; assigned to K1
Δ_2 Second main movement
Movement in second main run
Δ_3 Secondary movement
Movement in pipe offset (Z-systems only)

5 | SELECTING AN EXPANSION JOINT

Calculation of the bending angles in hinge systems

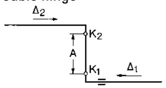
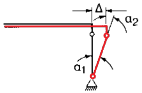
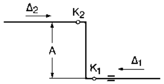
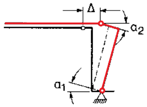
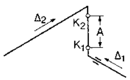
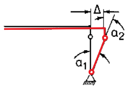
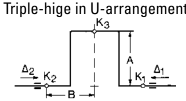
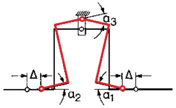
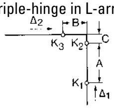
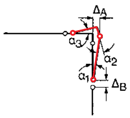
No.	Hinge system	Substitute system	Bending angle in degrees with 50% pretension
1	Double hinge 		$\Delta = \frac{1}{2}(\Delta_1 + \Delta_2)$ $\alpha_1 = (\Delta, A)$ cf. Fig. 7.9 $\alpha_2 = \alpha_1$
2	Double hinge in Z-arrangement 		$\Delta = \frac{1}{2}(\Delta_1 + \Delta_2)$ $\alpha_1 = (\Delta, A)$ cf. Fig. 7.9 $\alpha_2 = \alpha_1$
3	Double-hinge, 3-dimensional 		$\Delta = \frac{1}{2}\sqrt{\Delta_1^2 + \Delta_2^2}$ $\alpha_1 = (\Delta, A)$ cf. Fig. 7.9 $\alpha_2 = \alpha_1$
4	Triple-hige in U-arrangement 		$\Delta = \frac{1}{4}(\Delta_1 + \Delta_2)$ $\alpha_1 = (\Delta, A)$ cf. Fig. 7.9 $\alpha_2 = \alpha_1$ $\alpha_3 = 2 \cdot \alpha_1$
5	Triple-hinge in L-arrangement 		$\Delta_A = \frac{1}{2}(\Delta_2 + \Delta_1 \frac{C}{B})$ $\Delta_B = \frac{1}{2}\Delta_1$ $\alpha_1 = (\Delta_A, A)$ cf. Fig. 7.9 $\alpha_3 = (\Delta_B, B)$ cf. Fig. 7.9 $\alpha_2 = \alpha_1 + \alpha_3$

Fig. 5.8a

Calculation of the bending angles in hinge systems

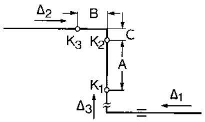
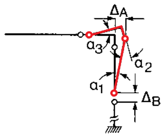
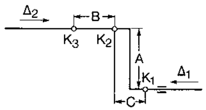
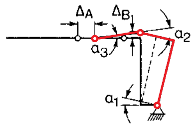
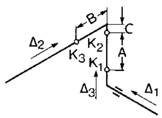
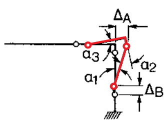
No.	Hinge system	Substitute system	Bending angle in degrees with 50% pretension
6	Triple-hinge in Z1-arrangement 		$\Delta_A = \frac{1}{2}(\Delta_1 + \Delta_2 + \Delta_3 \frac{C}{B})$ $\Delta_B = \frac{1}{2}\Delta_3$ $\alpha_1 = (\Delta_A, A)$ cf. Fig. 7.9 $\alpha_3 = (\Delta_B, B)$ cf. Fig. 7.9 $\alpha_2 = \alpha_1 + \alpha_3$
7	Triple-hinge in Z2-arrangement 		$\Delta_A = \frac{1}{2}(\Delta_1 + \Delta_2)$ $\Delta_B = \Delta_a \frac{C}{A}$ $\alpha_1 = (\Delta_A, A)$ cf. Fig. 7.9 $\alpha_3 = (\Delta_B, B)$ cf. Fig. 7.9 $\alpha_2 = \alpha_1 + \alpha_3$
8	Triple-hinge, 3-dimensional 		$\Delta_A = \frac{1}{2}(\sqrt{\Delta_1^2 + \Delta_2^2} + \Delta_3 \frac{C}{B})$ $\Delta_B = \frac{1}{2}\Delta_3$ $\alpha_1 = (\Delta_A, A)$ cf. Fig. 7.9 $\alpha_3 = (\Delta_B, B)$ cf. Fig. 7.9 $\alpha_2 = \alpha_1 + \alpha_3$

Fig. 5.8b

5 | SELECTING AN EXPANSION JOINT

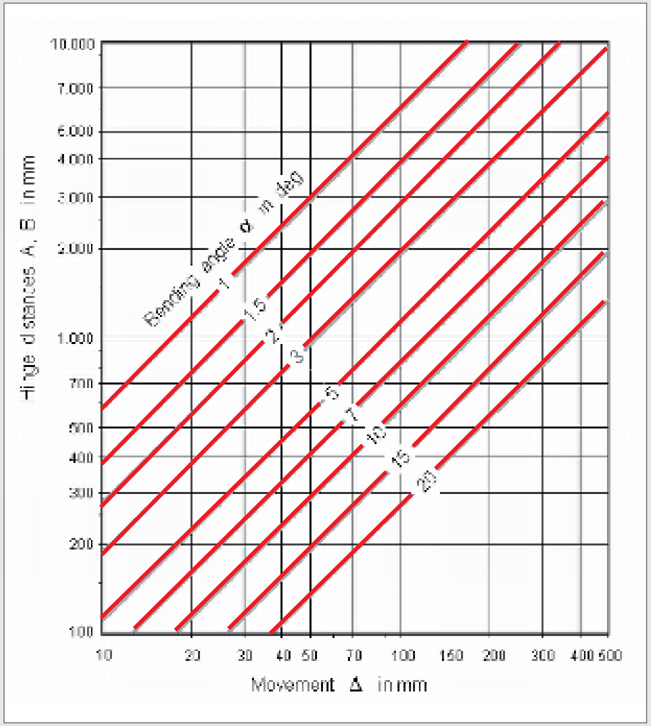


Fig. 5.9 Bending angles in hinge systems

Universal expansion joints
We have developed a standard range for this type of expansion joint, which comprises of two bellows connected via an intermediate pipe and which can cope with all types of movement – axial, lateral and angular; this range is designed for the more common types of application (type series UBN, URN). The values for the movement specified in the dimension tables (axial, lateral) are alternatives, i.e. the percentage values must not exceed 100% when added together.
If any additional requirements must be met, universal expansion joints can be designed on the basis of the axial expansion joints in the standard range. Axial expansion joints with only one bellows for absorbing "universal" movements must also be discussed in this context.
The calculation formulae for possible angular or lateral movements, equivalent to the nominal axial movement $2\delta_N$, are specified, together with equations for determining the adjusting-force rates for these types of movement (extremely good approximations).

It is important to remember that the pressures valid for axial expansion joints are hardly ever permitted for universal expansion joints.

The necessary presure relevant reduction factors are shown in the graphs below (Fig. 5.11 and 5.14).

Bending angle of a single bellows

(5.3) $$2\,\alpha_O = 2\delta_N \frac{115}{D}$$

Bending angle, **pressure-less** $2\,\alpha_O$ in deg
Overall, nominal axial movement $2\delta_N$ in mm
Bellows outside diameter D in mm

The permissible cold pressure for an angular movement is dependent on the maximum, effective bending angle α, and can be read from the graph opposite (Fig. 5.11) in relation to the nominal pressure PN.

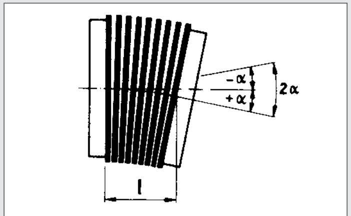


Fig. 5.10 Single bellows, angular

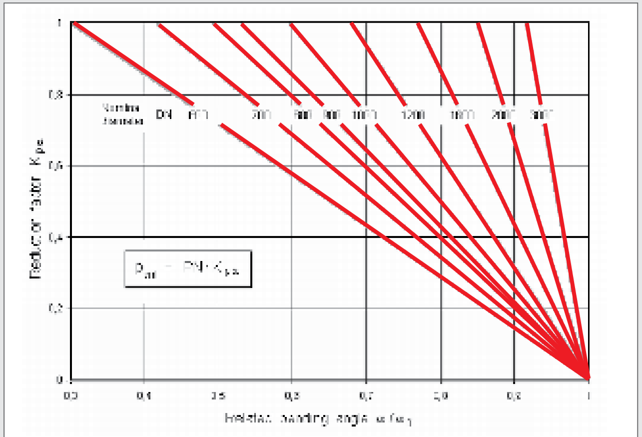


Fig. 5.11 Pressure relevant reduction factor in a single bellows at angular movement

5 | SELECTING AN EXPANSION JOINT

Adjusting-moment rate
of a single bellows $c\alpha$ in Nm/deg

(5.4.) $$C_\alpha = C_\delta \cdot 2.2 \cdot 10^{-6} \cdot D^2$$

Axial adjusting rate c_δ in N/mm
Bellows outside diameter D in mm

Lateral movement
Single bellows
(without pressure relevant reduction factor)

(5.5) $$2\lambda_N = 2\delta_N \frac{l}{3D}$$

Twin bellows
(Note pressure relevant reduction factor shown in Fig. 7.14!)

(5.6) $$2\lambda_O = 2\delta_N \cdot \frac{2}{3D} \cdot \frac{l^2 + 3l^{*2}}{l + l^*}$$

Overall lateral movement $2\lambda_N$ or $2\lambda_O$ in mm
Axial movement of single bellows $2\delta_N$ in mm
Corrugated length of single bellows l in mm

“Hinge” distance l* in mm
($l^* = l + l_Z$, with intermediate pipe length l_Z)

Adjusting-force rate C_λ in N/mm
Single bellows

(5.7) $$C_\lambda = C_\delta \cdot \frac{3}{2} \left(\frac{D}{l}\right)^2$$

Twin bellows

(5.8) $$C_\lambda = C_\delta \cdot \frac{3}{4} \cdot \frac{D^2}{l^2 + 3l^{*2}}$$

Adjusting-force rate of single bellows C_δ in N/mm
(other values as specified above)

The permissible cold pressure for a lateral movement is dependent on the maximum effective, lateral movement λ, and can be read from the graph opposite (Fig. 5.14).

5 | SELECTING AN EXPANSION JOINT

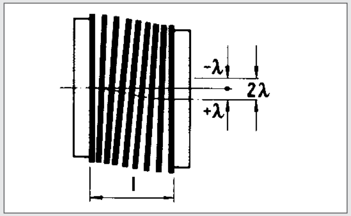


Fig. 5.12 Single bellows, lateral deflected

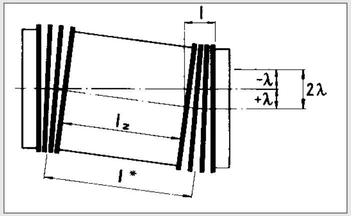


Fig. 5.13 Twin bellows, lateral deflected

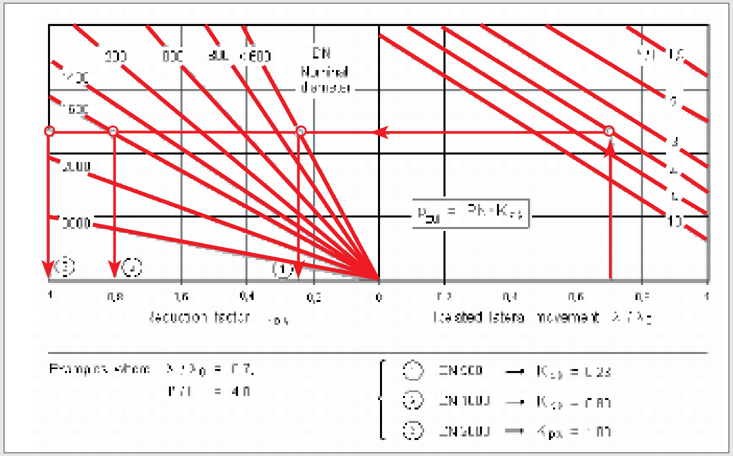


Fig. 5.14 Pressure relevant reduction factor for universal expansion joint with two bellows at lateral movement

Nominal diameter DN
The nominal diameter of an expansion joint depends on the dimensions of the pipe or the flange connections. Select an expansion joint to suit these criteria.

The standard wall thicknesses of **weld ends** are given in the tables. These thicknesses meet the requirements of the nominal pressure rating. If possible, standard wall thicknesses of welded pipes to DIN EN 10220 have been chosen.

Flanges with dimensions to DIN EN 1092 part 1 are preferred. The flange thicknesses of lap-joint flanges have in each case been adapted to suit the stresses prevailing in the expansion joint and in some cases are different to those of standard welding neck flanges. Flanges with other dimensions are possible, e.g. to the US standard (ANSI). Also non-standard flanges for special machine connections. Flanges with pitch circle diameters smaller than those given in DIN EN 1092 part 1 must be checked to ensure that the screwed fixing is compatible with the bellows side.

Nominal pressure PN
The standard expansion joints are designed for a nominal pressure (PN) and arranged in PN ratings in the tables. (The nominal pressure parameter corresponds to the permissible operating pressure at room temperature, rounded off to a PN nominal pressure rating to DIN EN 1333.) It is known that at higher temperatures the permissible pressure is lower than the nominal pressure because the characteristic strengths of the materials used are correspondingly lower at higher temperatures. The permissible nominal pressure must be reduced accordingly.

The **reduction factor** is defined as: (5.9)

$$K_{p\vartheta} = \frac{R_{p/t}}{R_{p/RT}}$$

Characteristic strength:

$R_{p/t}$ – proof stress in N/mm² at design temperature

$R_{p/RT}$ – proof stress in N/mm² at room temperature

The proof stress Rp is valid for the characteristic strength over a wide temperature range. At higher temperatures the creep and stress rupture properties play a role.

Our expansion joints are designed in such a way that the reduction can be based on the material of the bellows.

The choice of a suitable nominal pressure is based on the **cold pressure** P_{RT}. This may not be greater than the nominal pressure:

(5.10) $$PN \geq P_{RT} = PS/K_{p\vartheta}$$

PS – maximum permissible operating pressure in bar

$K_{p\vartheta}$ – pressure reduction factor based on operating temperature

The **test pressure** PT must be at least equal to the larger of the two values given by the equations below:

for a water pressure test

(5.11) $$P_T = \max \begin{cases} 1{,}25 \cdot PS \cdot \frac{f_0}{f} \\ 1{,}43 \cdot PS \end{cases}$$

for a gas pressure test

(5.12) $$P_T = PS \cdot \frac{f_0}{f}$$

f_0 – permissible stress in N/mm² for design conditions at test temperature

f – permissible stress in N/mm² for design conditions at design temperature

The expansion joints are designed to withstand a test pressure of 1.43 times their nominal pressure. If a higher test pressure is required, this must be taken into account when determining the PN rating.

5 | SELECTING AN EXPANSION JOINT

Pressure reduction factor (temperature-related)

Temperature in °C	Reduction factor $K_{p\vartheta}$	Standard material combinations			
		bellows	weld end	flange	tie rod
20	1,00	1.4541	1.0305	1.0038	1.0425
100	0,83		(P235G1TH)	(S235JRG2)	(P265GH)
150	0,78		seamless		
200	0,74				
250	0,71		1.0425		
300	0,67		(P265GH)		
350	0,64		welded		
400	0,62			1.5415	
450	0,61		1.5415	(16Mo3)	1.5415
500	0,60		(16Mo3)		(16Mo3)
550	0,59		1.4541	1.4541	1.4541
600	0,46				
650	0,32				
700	0,19				
750	0,14	1.4876	1.4876	1.4876	1.4876
800	0,08				
850	0,06				
900	0,03				

Fig. 5.15

Basis:
R_p 1,0 – values for 1.4541 (cold-rolled strip) to DIN EN 10028 part 7
R_m 100.000 – values for 1.4876 to DIN EN 10095

Low temperatures
The standard versions can be used in temperatures down to $\vartheta = -10$ °C without having to apply a reduction factor.

At lower temperatures low-temperature steels should be chosen for the ferritic parts. The table below specifies suitable materials approved to the AD 2000 standard that enable the expansion joint to be loaded to maximum. At very low temperatures down to $\vartheta = -270$ °C it is possible to use a version made completely from the austenitic material 1.4541.

Materials for low-temperature applications (AD 2000-W10)

Temperature in C°	Bellows	Pipe	Tie rod
– 10		P235TR1	P265GH
– 20		P355N	P355N
– 60	1.4541	P355NL1	P355NL1
– 70		P275NL2	P275NL2
– 270		1.4541	1.4541

Fig. 5.16

5 | SELECTING AN EXPANSION JOINT

Nominal travel and nominal angle
The nominal travel should be calculated from the true movement values determined beforehand so that it is possible to choose a suitable expansion joint from the tables. The nominal travel is based on a service life of at least 1000 full load cycles at room temperature and maximum pressure, and are valid for the standard bellows material 1.4541.

A load cycle here means the total movement of the expansion joint from some starting position to an extreme position on one other side, then returning via the starting point to an extreme position on the other side and then back to the starting position.

The service life is influenced by
- pressure utilization
- movement
- pressure pulsation

plus other factors whose effects cannot be calculated or are unacceptable, such as

- thermal shock
- corrosion
- damage (improper installation, damaged corrugations, etc.)
- resonance (e.g. flow-induced).

Up to 500°C the temperature has no influence on the amount of movement. Please consult us for higher temperatures.

The correction factors given below are valid for the standard materials 1.4541 (≤ 550°C) and 1.4876 (> 550°C). Other materials with comparable characteristic strengths behave very similarly and can be handled in a similar way. However, materials whose characteristic strengths deviate considerably from the values given here cannot be dealt with in this way, or not accurately enough. That frequently calls for a different approach. Please consult us if you wish to use special materials.

5 | SELECTING AN EXPANSION JOINT

Effect of pressure on amount of movement

Pressure ratio p_{RT} / PN	1	0,8	0,6	0,4	0,2	0
Correction factor $K_{\Delta p}$	1,00	1,03	1,07	1,10	1,13	1,15

Fig. 5.17

Effect of load cycles on amount of movement

Load cycles	Correction factor $K_{\Delta L}$	Load cycles	Correction factor $K_{\Delta L}$	Load cycles	Correction factor $K_{\Delta L}$
500	1,15	10000	0,53	$5 \cdot 10^5$	0,20
1000	1,00	20000	0,44	$1 \cdot 10^6$	0,17
2000	0,82	$5 \cdot 10^4$	0,34	$2 \cdot 10^6$	0,14
4000	0,68	$1 \cdot 10^5$	0,29	$5 \cdot 10^6$	0,12
7000	0,58	$2 \cdot 10^5$	0,24	$1 \cdot 10^7$	0,11

Fig. 5.18

General correction factor

(5.13) $K_\Delta = K_{\Delta p} \cdot K_{\Delta L}$ The total correction factor K_Δ may not exceed 1.15.

Movement absorption, cold

(5.14) axial: $2\delta_{RT} = 2\delta / K_\Delta \leq 2\delta_N$

(5.15) lateral: $2\lambda_{RT} = 2\lambda / K_\Delta \leq 2\lambda_N$

(5.16) angular: $2\alpha_{RT} = 2\alpha / K_\Delta \leq 2\alpha_N$

Cumulative movement

If an expansion joint is to accommodate movements with different numbers of load cycles, the respective cold values (related to 1000 load cycles) are determined first. Afterwards, the theoretical total travel of the cumulative movement can be calculated reasonably accurately using the following equation:

(5.17) $2\delta_{RTges.} = [\, \sum(2\delta_{RT,i})^4 \,]^{1/4}$

The cold travel and nominal pressure calculated as described above can now be used to select the necessary expansion joints from the standard range.

Pressure pulsation

The pressure pulsations or dynamic operating pressures superimposed on the static pressure have an influence on the service life. Their effect, which can be calculated and allowed for, depends on the magnitude of the pressure fluctuations in relation to the nominal pressure, and their frequency. Generally, pressure fluctuations are negligible. However, if the magnitude and frequency of pressure surges are expected to have a detrimental effect on the service life, please consult us.

When designing expansion joints it is usual to check the utilisation condition (related to load cycles):
$D = \sum (Ni,reqd/Ni,calc) \leq 1$.

5 | SELECTING AN EXPANSION JOINT

Materials
We have selected material combinations for standard expansion joints that are adequate for the majority of applications. The most important aspects when choosing the material of the bellows are generally:

- formability
- weldability
- thermal stability
- strength
- corrosion resistance

Our standard material, 1.4541, a non-corroding austenitic steel, satisfies these requirements admirably for a wide range of requirements.

Provided they possess adequate deformability, high-temperature or heat-resistant steels (e.g. 1.4876, 1.4828) can be used for higher temperatures (ϑ > 550°C)

In particularly aggressive conditions special materials with a corrosion resistance at least equivalent to that of the adjoining pipe must be used. This is because the relatively thin walls of the bellows and their function – to remain highly flexible expansion-contraction elements – does not permit any corrosion allowance. If in doubt it is best to choose a higher-quality material for the bellows, at least for the inner ply. In many cases nickel-based alloys, with which we have had good experience, are suitable.

The choice of a suitable corrosion-resistant material should be based on the experience of the user, who is familiar with the particular features of his system and his operating medium. The resistance tables can prove helpful when making a choice. Please note that special materials with – in comparison to 1.4541 – completely different physical parameters (e.g. aluminium) will inevitably lead to different dimensions and performance data for the bellows.

Inner sleeve
An inner sleeve is used to protect the bellows when deposits or abrasion are anticipated. Also if high flow velocities could excite the corrugations of the bellows and cause them to vibrate.

The diagram on the right shows maximum values for flow velocities permissible without an inner sleeve. These figures are based on an unfavourable flow towards the corrugations.

The inner sleeve can also act as an internal guide sleeve (in special versions) and is indispensable in such cases. In addition, it can also act as a mounting for an internal brick lining, but in this case calls for a special design. If an inner sleeve is necessary but must not hinder lateral or angular movement, tapering or stepped sleeves can be incorporated.

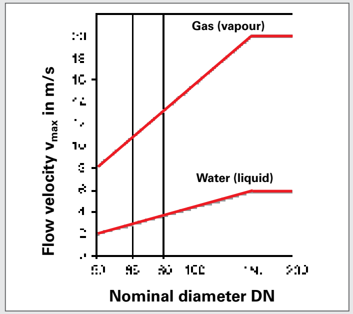


Fig. 5.19 Maximum values for use of inner sleeve

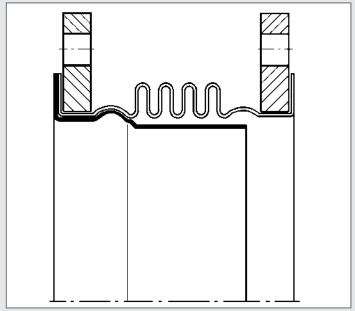


Fig. 5.20 Axial expansion joint with stepped inner sleeve to allow lateral movement

Economic
and safe

General
This manual deals with the expansions joints used for pipeline construction and for plant and apparatus engineering. The expansion joints are designed for 1000 stress cycles in line with the standard mode of operation of thermal plants, which corresponds to 20 years operation if the plant is started up and shut down once a week. Other designs are also possible.

The HYDRA expansion joints described here – which from part of our wide manufacturing range of flexible metal elements – cover all the most important needs of industrial applications:

Nominal diameters DN 15 - 3000
Nominal pressures PN 1 – 63

Larger expansion joints up to 12 m in diameter, and designed for higher pressures, can be supplied on request.

The standard expansion joints are of different construction types, such as axial, angular and lateral expansion joints, and are listed separately according to type series; in addition to the construction type, the type series also specifies such features as the connection type and any particularities of the design.

The individual type series are classified according to the nominal pressure rating, the nominal diameter and the movement value.

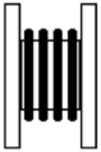
The design of the standard expansion joints, of which variant can be supplied on request is defined initially in relation to the connections and materials:

Connections:
Weld ends according to ISO
Flanges according to DIN 2501

Materials:
According to the table below, temperature-related.

6 | STANDARD RANGES
Overview

①



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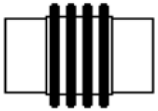

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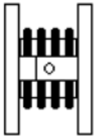

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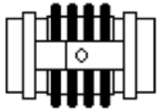
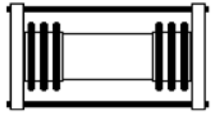


⑥

⑤ + ⑦



① **Axial/Universal expansion joints for low pressure (exhaust gas)**
- with flanges
- with weld ends

Series:
ABG/AFG
UBG/UFG
ARG/URN
Nominal diameters:
DN50 – DN3000
Pressure rating:
PN1
Special features, main applications:
Non-anchored expansion joints as inexpensive solutions for exhaust-gas lines, with small adjusting force rates and large movement absorption.

② **Axial/Universal expansion joints**
- with flanges
- with weld ends

Series:
ABN/AFN
UBN/UFN
ARN/URN
Nominal diameters:
DN50 – DN2000
Pressure ratings:
PN2.5 – PN40
Special features, main applications:
Non-anchored expansion joints for pipelines and plant engineering, with small adjusting force rates and large movement absorption.

③ **Angular expansion joints as single/gimbal hinge versions**
- with swivel flanges
- with plain fixed flanges

Series:
WBN/WBK
WFN/WFK
Nominal diameters:
DN50 – DN800
Pressure ratings:
PN6 – PN25
Special features, main applications:
Large bending angle, short length, for use in chemical plants.

④ **Angular expansion joints as single/gimbal hinge versions**
- with weld ends

Series:
WRN/WRK
Nominal diameters:
DN50 – DN800
Pressure ratings:
PN2.5 – PN63

Special features, main applications:
Large bending angle, short length, for use in pipelines and plant engineering.

⑤ **Lateral expansion joints for movement in all planes (circular plane)**
- with lap-joint flanges
- with plain fixed flanges

Series:
LBR
LFR
Nominal diameters:
DN50 – DN500
Pressure ratings:
PN6 – PN25
Special features, main applications:
Can move in all directions in a circular plane, for use in pipelines and plant engineering, as connection to machinery.

⑥ **Lateral expansion joints for movement in all planes**
- with weld ends

Series:
LRN
LRR/LRK
Nominal diameters:
DN50 – DN2000
Pressure ratings:
PN6 – PN63
Special features, main applications:
Compact design, small adjusting force rates, for use in pipelines and plant engineering.

⑦ **Noise-isolated expansion joints**
- with ties rods and lap-joint flanges

Series:
LBS
Nominal diameters:
DN50 – DN400
Pressure ratings:
PN6 – PN25
Special features, main applications:
Noise-isolated design for use with vibrating plant, pumps.

Type ABG
Type AFG

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Typee ABG: HYDRA exhaust-gas expansion joint with swivel flanges
Typee AFG: HYDRA exhaust-gas expansion joint with plain fixed flanges

Standard version/materials:
multi-ply bellows: 1.4541
flange: S 235 JRG2 (1.0038)
operating temperature: up to 550°C

Designation (example):

A	B	G	0	1	.	0	1	5	0	.	1	2	6	.	0

- Typee: ABG
- Nominal pressure (PN1): 01
- Nominal diameter (DN150): 0150
- Movement absorption, nominal (2δ = ±63 = 126 mm): 126
- Inner sleeve (0 = without, 1 = with): 0

Axial expansion joint
for low pressure (exhaust-gas) with flanges

Order text

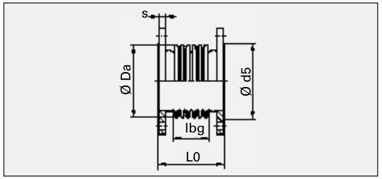
Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

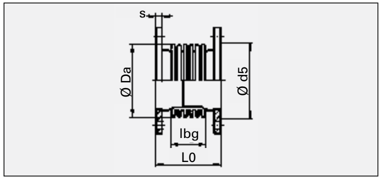
The expansion joints for low pressure (exhaust-gas) are designed for non-pressurised applications (PS < 0.5 bar gauge pressure).

The Pressure Equipment Directive 97/23/EC does not apply to this operating condition.

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.



Type ABG without inner sleeve



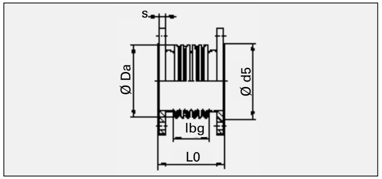
Type ABG with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type ABG 01 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange rim diameter	Flange thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
50	20	**.0050.020.0**	419285	419411	103	2	2.1	6	90	10
50	56	**.0050.056.0**	419286	419412	184	2.3	2.6	6	90	10
50	80	**.0050.080.0**	419287	419413	238	2.5	2.9	6	90	10
65	23	**.0065.023.0**	419289	419414	103	2.5	2.6	6	107	10
65	64	**.0065.064.0**	419290	419415	184	2.8	3.2	6	107	10
65	92	**.0065.092.0**	419291	419416	238	3.1	3.6	6	107	10
80	37	**.0080.037.0**	419292	419417	127	3.7	4	6	122	10
80	69	**.0080.069.0**	419293	419418	187	3.9	4.4	6	122	10
80	101	**.0080.101.0**	419294	419419	247	4.2	4.9	6	122	10
100	40	**.0100.040.0**	419295	419420	123	4.2	4.6	6	147	10
100	79	**.0100.079.0**	419296	419421	189	4.6	5.3	6	147	10
100	112	**.0100.112.0**	419297	419422	244	4.9	5.8	6	147	10
125	63	**.0125.063.0**	419298	419423	158	5.3	6	6	178	10
125	117	**.0125.117.0**	419299	419424	236	5.8	6.7	6	178	10
125	180	**.0125.180.0**	419300	419425	327	6.5	7.8	6	178	10
150	54	**.0150.054.0**	419301	419426	145	5.7	6.4	6	202	10
150	126	**.0150.126.0**	419302	419427	249	6.7	8	6	202	10
150	180	**.0150.180.0**	419303	419428	327	7.3	9	6	202	10
200	70	**.0200.070.0**	419304	419429	183	11.9	13.1	6	258	16
200	120	**.0200.120.0**	419305	419430	258	12.7	14.5	6	258	16
200	200	**.0200.200.0**	419306	419431	378	14	16.6	6	258	16

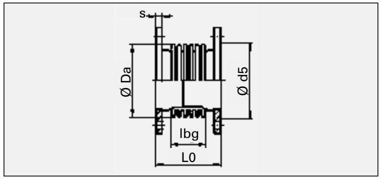
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints Type ABG 01...
for low pressure with swivel lap-joint flanges
PN 1

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] nominal for 1000 loading cycles angular[1]	Nominal movement absorption[1] lateral[1]	Vibrations in all planes	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral	Natural frequency of bellows axial	Natural frequency of bellows radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
89	45	46	30	3.9	0.3	105	1.3	451	420	1800
89	126	46	50	30.7	1	37	0.5	20	150	230
89	180	46	50	62.7	1	26	0.3	7	105	110
107	45	68.7	28	3.7	0.3	102	1.9	654	350	1840
107	126	68.7	50	28.9	1	36	0.7	30	125	235
107	180	68.7	50	59	1	25	0.5	10	90	115
121	70	89.1	39	8.1	0.5	67	1.7	233	220	840
121	130	89.1	50	28	1	36	0.9	36	165	340
121	190	89.1	50	59.9	1	25	0.6	12	80	115
148	66	137	33	6.6	0.5	73	2.8	432	210	1050
148	132	137	50	26.4	1	36	1.4	54	90	220
148	187	137	50	53	1	26	1	19	60	110
174	91	187	45	12.4	0.5	41	2.1	177	120	520
174	169	187	50	42.7	1	22	1.1	28	70	150
174	260	187	50	101	1	14	0.7	7.4	40	65
203	78	264	33	7.7	0.7	56	4.1	465	140	830
203	182	264	50	41.7	1	24	1.8	37	60	150
203	260	264	50	85	1	17	1.2	13	40	75
255	105	432	33	10.4	1	53	6.4	397	110	600
255	180	432	50	30.7	1	31	3.7	79	60	210
255	300	432	50	85.3	1	19	2.3	17	40	75



Type ABG without inner sleeve



Type ABG with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type ABG 01 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange rim diameter	Flange thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
250	72	**.0250.072.0**	419307	419432	190	14.3	16	6	312	16
250	132	**.0250.132.0**	419308	419433	275	15.4	17.7	6	312	16
250	204	**.0250.204.0**	419310	419434	377	16.8	20	6	312	16
300	56	**.0300.056.0**	419309	419435	164	18.4	20.1	6	365	16
300	140	**.0300.140.0**	419311	419436	278	20	22.8	6	365	16
300	210	**.0300.210.0**	419312	419437	373	21.4	25.1	6	365	16
350	60	**.0350.060.0**	419313	419449	168	23.4	25.2	6	410	16
350	120	**.0350.120.0**	419314	419450	248	24.7	27.3	6	410	16
350	210	**.0350.210.0**	419315	419451	368	26.6	30.6	6	410	16
400	65	**.0400.065.0**	419316	419452	203	28.5	31.2	6	465	16
400	104	**.0400.104.0**	419318	419453	266	30.5	34.1	6	465	16
400	195	**.0400.195.0**	419319	419463	413	35.3	40.8	6	465	16
450	56	**.0450.056.0**	419320	419464	186	32.4	35.2	6	520	16
450	112	**.0450.112.0**	419321	419465	274	35.7	39.8	6	520	16
450	196	**.0450.196.0**	419322	419466	406	40.7	46.7	6	520	16
500	68	**.0500.068.0**	419323	419467	190	35.3	38.3	6	570	16
500	119	**.0500.119.0**	419324	419468	259	38.2	42.3	6	570	16
500	221	**.0500.221.0**	419325	419469	397	44.2	50.4	6	570	16
600	76	**.0600.076.0**	419326	419470	210	53	57	6	670	20
600	133	**.0600.133.0**	419327	419471	288	56.8	62.3	6	670	20
600	228	**.0600.228.0**	419328	419472	418	63.1	71	6	670	20

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

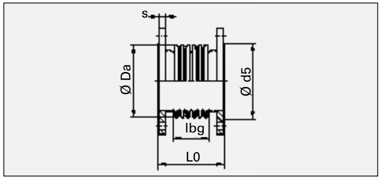
Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] nominal for 1000 loading cycles angular[1]	Nominal movement absorption[1] nominal for 1000 loading cycles lateral[1]	Vibrations in all planes	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral	Natural frequency of bellows axial	Natural frequency of bellows radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
312	102	661	28	8.4	0.7	62	11	752	110	780
312	187	661	47	28.4	1	34	6.2	123	60	230
312	289	661	50	67.8	1	22	4	33	40	100
365	76	916	18	4.2	0.4	91	23	2756	140	1610
365	190	916	43	26	1	36	9.2	174	60	260
365	285	916	50	58.4	1	24	6.1	52	40	115
400	80	1104	18	4.3	0.4	82	25	2703	120	1490
400	160	1104	34	17.1	1	41	13	338	65	375
400	280	1104	50	52.3	1	24	7.4	62	35	120
458	105	1445	17	5.3	0.5	212	85	5283	120	1260
458	168	1445	27	13.6	1	132	53	1291	80	500
458	315	1445	45	47.7	1	71	29	195	40	140
513	88	1825	13	3.4	0.3	243	123	10935	130	1850
513	176	1825	26	13.6	1	122	62	1361	70	460
513	308	1825	41	41.7	1	70	35	253	40	150
569	92	2252	14	3.9	0.3	215	135	10875	115	1690
569	161	2252	24	11.9	1	123	77	2025	70	550
569	299	2252	42	41.1	1	66	41	318	35	160
674	104	3202	14	4.1	0.3	215	191	12099	100	1570
674	182	3202	23	12.6	1	123	109	2252	60	510
674	312	3202	36	37.1	1	72	64	446	35	175

Axial expansion joints

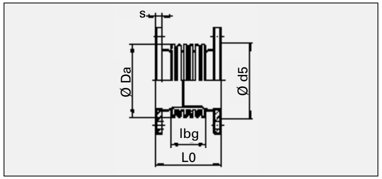
Type ABG 01...

for low pressure with swivel lap-joint flanges

PN 1



Type ABG without inner sleeve



Type ABG with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange		
		ABG 01 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
700	80	**.0700.080.0**	419329	419473	218	62.8	67.7	6	775	20
700	120	**.0700.120.0**	419330	419474	274	66	72.2	6	775	20
700	220	**.0700.220.0**	419331	419475	414	74	83.2	6	775	20
800	84	**.0800.084.0**	419332	419476	230	77.3	83.2	6	880	20
800	126	**.0800.126.0**	419333	419477	288	80.9	88.4	6	880	20
800	231	**.0800.231.0**	419334	419478	433	90.2	101.2	6	880	20
900	84	**.0900.084.0**	419335	419479	234	81.8	88.7	6	980	20
900	126	**.0900.126.0**	419336	419481	294	86.2	94.9	6	980	20
900	210	**.0900.210.0**	419337	419482	414	94.9	107.2	6	980	20
1000	72	**.1000.072.0**	419338	419483	220	86.4	93.8	6	1080	20
1000	144	**.1000.144.0**	419339	419484	316	93.7	104	6	1080	20
1000	240	**.1000.240.0**	419340	419485	444	103.4	117.6	6	1080	20
1200	72	**.1200.072.0**	419341	419486	225	107	124.6	2	1280	20
1200	120	**.1200.120.0**	419342	419487	287	113.1	135.1	2	1280	20
1200	216	**.1200.216.0**	419343	419488	411	125.2	156.4	2	1280	20
1400	48	**.1400.048.0**	419344	419490	136	124.9	137.4	2	1466	20
1400	108	**.1400.108.0**	419345	419491	266	136.9	163.3	2	1466	20
1400	180	**.1400.180.0**	419346	419492	422	151.4	191.7	2	1466	20
1600	48	**.1600.048.0**	419347	419493	136	155	169.3	2	1666	20
1600	108	**.1600.108.0**	419385	419494	266	168.8	198.9	2	1666	20
1600	180	**.1600.180.0**	419386	419495	422	185.3	231.4	2	1666	20

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints Type ABG 01...
for low pressure with swivel lap-joint flanges
PN 1

Bellows			Nominal movement absorption[1] nominal for 1000 loading cycles		Vibrations in all planes	Adjusting force rate			Natural frequency of bellows	
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]		axial	angular	lateral	axial	radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
780	112	4324	12	4	0.3	203	244	13365	90	1480
780	168	4324	18	9.1	0.8	135	162	3950	60	660
780	308	4324	30	30.4	1	74	89	644	30	195
882	116	5588	11	3.9	0.3	220	341	17449	85	1570
882	174	5588	16	8.7	0.8	147	228	5182	60	700
882	319	5588	28	29.1	1	80	124	839	30	210
992	120	7133	9.9	3.5	0.2	238	472	22421	80	1650
992	180	7133	15	7.9	0.7	158	313	6643	60	730
992	300	7133	23	22	1	95	188	1438	30	260
1095	96	8750	7.7	2.2	0.2	335	814	60745	105	2940
1095	192	8750	15	8.7	0.7	168	408	7570	50	740
1095	320	8750	23	24.3	1	101	245	1632	30	265
1295	93	12331	6.5	1.8	0.1	331	1134	89855	95	3210
1295	155	12331	11	4.9	0.4	198	678	19409	60	1160
1295	279	12331	18	16	1	110	377	3328	30	360
1456	104	16016	3.8	1.2	0.1	922	4053	257632	150	5320
1456	234	16016	8.4	5.9	0.5	410	1802	22624	70	1050
1456	390	16016	13	16.4	1	246	1081	4887	40	380
1656	104	20816	3.4	1	0.1	1046	5990	380429	150	6040
1656	234	20816	7.4	5.2	0.5	465	2660	33398	70	1200
1656	390	20816	12	14.4	1	279	1596	7214	40	430

Axial expansion joints — Type ABG 01...

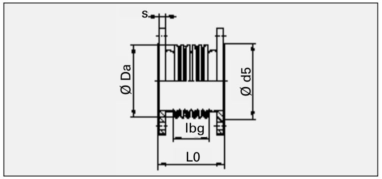
for low pressure with swivel lap-joint flanges

PN 1

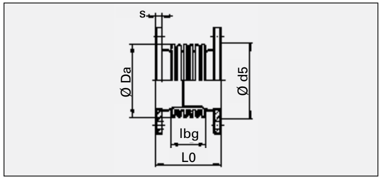
Axial expansion joints — Type ABG 01...

for low pressure with swivel lap-joint flanges

PN 1



Type ABG without inner sleeve



Type ABG with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange		
		ABG 01 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	rim diameter	thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
1800	48	**.1800.048.0**	419387	419496	136	173.5	189.6	2	1866	20
1800	108	**.1800.108.0**	419388	419498	266	189	222.9	2	1866	20
1800	180	**.1800.180.0**	419389	419499	422	207.6	259.4	2	1866	20
2000	48	**.2000.048.0**	419390	419500	136	192	209.8	2	2066	20
2000	108	**.2000.108.0**	419391	419501	266	209.2	246.9	2	2066	20
2000	180	**.2000.180.0**	419392	419502	422	229.9	287.4	2	2066	20
2200	48	**.2200.048.0**	419393	419503	136	225.7	245.3	2	2266	20
2200	108	**.2200.108.0**	419394	419505	266	244.7	286.2	2	2266	20
2200	180	**.2200.180.0**	419396	419506	422	267.4	332.9	2	2266	20
2400	48	**.2400.048.0**	419397	419507	136	245.7	267.1	2	2466	20
2400	108	**.2400.108.0**	419398	419508	266	266.3	311.6	2	2466	20
2400	180	**.2400.180.0**	419399	419509	422	291.1	362.6	2	2466	20
2600	48	**.2600.048.0**	419400	419510	136	265.4	288.6	2	2666	20
2600	108	**.2600.108.0**	419401	419511	266	287.8	336.8	2	2666	20
2600	180	**.2600.180.0**	419402	419513	422	314.7	392.1	2	2666	20
2800	48	**.2800.048.0**	419403	419514	136	319.1	344.1	2	2866	20
2800	108	**.2800.108.0**	419404	419516	266	343.2	396	2	2866	20
2800	180	**.2800.180.0**	419405	419518	422	372.2	455.5	2	2866	20
3000	48	**.3000.048.0**	419406	419519	136	341.2	368	2	3066	20
3000	108	**.3000.108.0**	419407	419520	266	367.1	423.6	2	3066	20
3000	180	**.3000.180.0**	419408	419521	422	398.1	487.4	2	3066	20

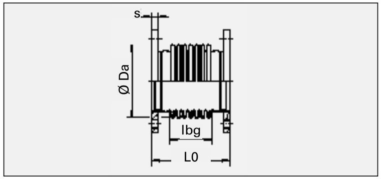
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1)] nominal for 1000 loading cycles		Vibrations in all planes	Adjusting force rate			Natural frequency of bellows	
outside diameter	corrugated length	effective cross-section	angular[1)]	lateral[1)]		axial	angular	lateral	axial	radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
1856	104	26245	3	0.9	0	1170	8449	536643	150	6760
1856	234	26245	6.6	4.6	0.4	520	3754	47143	70	1340
1856	390	26245	11	12.8	1	312	2253	10183	40	480
2056	104	32302	2.7	0.8	0	1292	11503	730650	150	7480
2056	234	32302	6	4.2	0.4	574	5114	64107	70	1480
2056	390	32302	9.6	11.5	1	345	3069	13872	40	530
2256	104	38987	2.5	0.7	0	1414	15205	965857	150	8200
2256	234	38987	5.4	3.8	0.3	628	6758	84718	70	1620
2256	390	38987	8.8	10.5	1	377	4050	18309	40	580
2456	104	46301	2.3	0.7	0	1536	19613	1245968	150	8900
2456	234	46301	5	3.5	0.3	683	8720	109332	70	1760
2456	390	46301	8.1	9.6	1	410	5235	23604	40	630
2656	104	54243	2.1	0.6	0	1657	24816	1576541	150	9620
2656	234	54243	4.6	3.2	0.3	737	11029	138302	70	1900
2656	390	54243	7.5	8.9	0.8	442	6615	29900	40	680
2856	104	62813	1.9	0.6	0	1778	30848	1959837	150	10330
2856	234	62813	4.3	3	0.2	790	13714	171984	65	2040
2856	390	62813	7	8.3	0.8	474	8218	37149	40	740
3056	104	72011	1.8	0.5	0	1900	37786	2400702	150	11050
3056	234	72011	4	2.8	0.2	844	16803	210733	65	2180
3056	390	72011	6.5	7.7	0.7	507	10082	45573	40	790

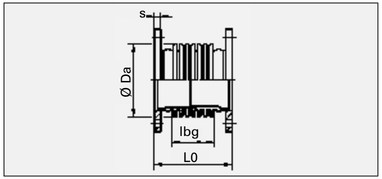
Axial expansion joints — Type AFG 01...

for low pressure with plain fixed flanges

PN 1



Type AFG without inner sleeve



Type AFG with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFG 01 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
50	20	**.0050.020.0**	420180	420272	123	2	2.1	6	10
50	56	**.0050.056.0**	420181	420273	204	2.3	2.6	6	10
50	80	**.0050.080.0**	420182	421598	258	2.4	2.8	6	10
65	23	**.0065.023.0**	420183	421599	123	2.5	2.7	6	10
65	64	**.0065.064.0**	420184	421600	204	2.8	3.2	6	10
65	92	**.0065.092.0**	420185	421601	258	3.1	3.6	6	10
80	37	**.0080.037.0**	420186	421602	148	3.6	3.8	6	10
80	69	**.0080.069.0**	420187	421603	208	3.9	4.3	6	10
80	101	**.0080.101.0**	420188	421604	268	4.2	4.8	6	10
100	40	**.0100.040.0**	420189	421605	144	4.1	4.3	6	10
100	79	**.0100.079.0**	420190	421606	210	4.5	5.1	6	10
100	112	**.0100.112.0**	420191	421607	265	4.9	5.7	6	10
125	63	**.0125.063.0**	420192	421608	179	5.2	5.6	6	10
125	117	**.0125.117.0**	420193	421609	257	5.8	6.6	6	10
125	180	**.0125.180.0**	420194	421610	348	6.4	7.6	6	10
150	54	**.0150.054.0**	420195	421611	166	5.7	6.2	6	10
150	126	**.0150.126.0**	420196	421612	270	6.6	7.6	6	10
150	180	**.0150.180.0**	420197	421613	348	7.3	8.7	6	10
200	70	**.0200.070.0**	420198	421614	199	11.8	13	6	16
200	120	**.0200.120.0**	420199	421615	274	12.6	14.2	6	16
200	200	**.0200.200.0**	420200	421617	394	13.8	16	6	16

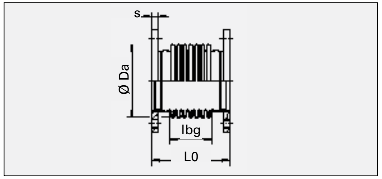
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints — Type AFG 01...

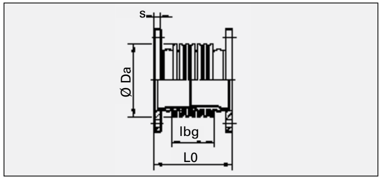
for low pressure with plain fixed flanges

PN 1

Bellows			Nominal movement absorption[1)] nominal for 1000 loading cycles		Vibrations in all planes	Adjusting force rate			Natural frequency of bellows	
outside diameter	corruga-ted length	effective cross-section	angular[1)]	lateral[1)]		axial	angular	lateral	axial	radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
89	45	46	30	3.9	0.3	105	1.3	451	420	1800
89	126	46	50	31	1	37	0.5	20	150	230
89	180	46	50	63	1	26	0.3	7	105	110
107	45	68.7	28	3.7	0.3	102	1.9	654	350	1840
107	126	68.7	50	29	1	36	0.7	30	125	235
107	180	68.7	50	59	1	25	0.5	10	90	115
121	70	89.1	39	8.1	0.5	67	1.7	233	220	840
121	130	89.1	50	28	1	36	0.9	36	165	340
121	190	89.1	50	59	1	25	0.6	12	80	115
148	66	137	33	6.5	0.5	73	2.8	432	210	1050
148	132	137	50	26	1	36	1.4	54	90	220
148	187	137	50	53	1	26	1	19	60	110
174	91	187	45	12	0.5	41	2.1	177	120	520
174	169	187	50	43	1	22	1.1	28	70	150
174	260	187	50	101	1	14	0.7	7.4	40	65
203	78	264	33	7.7	0.7	56	4.1	465	140	830
203	182	264	50	42	1	24	1.8	37	60	150
203	260	264	50	85	1	17	1.2	13	40	75
255	105	432	33	10	1	53	6.4	397	110	600
255	180	432	50	31	1	31	3.7	79	60	210
255	300	432	50	85	1	19	2.3	17	40	75



Type AFG without inner sleeve



Type AFG with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFG 01 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
250	72	**.0250.072.0**	420201	421618	206	14.1	16	6	16
250	132	**.0250.132.0**	420202	421619	291	15	18	6	16
250	204	**.0250.204.0**	420203	421620	393	17	19	6	16
300	56	**.0300.056.0**	420204	421621	180	18	20	6	16
300	140	**.0300.140.0**	420205	421622	294	20	22	6	16
300	210	**.0300.210.0**	420206	421623	389	21	25	6	16
350	60	**.0350.060.0**	420207	421624	184	23	25	6	16
350	120	**.0350.120.0**	420208	421625	264	24	27	6	16
350	210	**.0350.210.0**	420209	421626	384	26	30	6	16
400	65	**.0400.065.0**	420210	421627	219	28	30	6	16
400	104	**.0400.104.0**	420211	421628	282	30	33	6	16
400	195	**.0400.195.0**	420212	421629	429	35	40	6	16
450	56	**.0450.056.0**	420213	421630	202	32	34	6	16
450	112	**.0450.112.0**	420214	421631	290	35	39	6	16
450	196	**.0450.196.0**	420215	421632	422	40	46	6	16
500	68	**.0500.068.0**	420216	421633	206	34	37	6	16
500	119	**.0500.119.0**	420217	421634	275	37	42	6	16
500	221	**.0500.221.0**	420218	421635	413	43	52	6	16
600	76	**.0600.076.0**	420219	421636	222	52	56	6	20
600	133	**.0600.133.0**	420220	421637	300	56	62	6	20
600	228	**.0600.228.0**	420223	421638	430	62	73	6	20

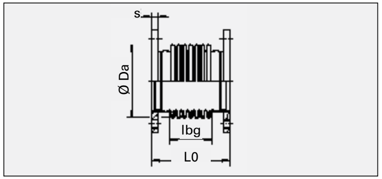
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints Type AFG 01...
for low pressure with plain fixed flanges
PN 1

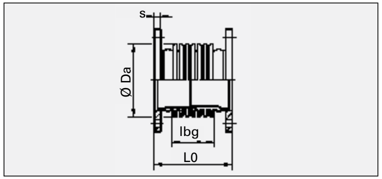
Bellows			Nominal movement absorption[1] nominal for 1000 loading cycles		Vibrations in all planes	Adjusting force rate			Natural frequency of bellows	
outside diameter	corruga-ted length	effective cross-section	angular[1]	lateral[1]		axial	angular	lateral	axial	radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
312	102	661	28	8.4	0.7	62	11	752	110	780
312	187	661	47	28	1	34	6.2	123	60	230
312	289	661	50	68	1	22	4	33	40	100
365	76	916	18	4.2	0.4	91	23	2756	140	1610
365	190	916	43	26	1	36	9.2	174	60	260
365	285	916	50	58	1	24	6.1	52	40	115
400	80	1104	18	4.3	0.4	82	25	2703	120	1490
400	160	1104	34	17	1	41	13	338	65	375
400	280	1104	50	52	1	24	7.4	62	35	120
458	105	1445	17	5.3	0.5	212	85	5283	120	1260
458	168	1445	27	14	1	132	53	1291	80	500
458	315	1445	45	48	1	71	29	195	40	140
513	88	1825	13	3.4	0.3	243	123	10935	130	1850
513	176	1825	26	14	1	122	62	1361	70	460
513	308	1825	41	42	1	70	35	253	40	150
569	92	2252	14	3.9	0.3	215	135	10875	115	1690
569	161	2252	24	12	1	123	77	2025	70	550
569	299	2252	42	41	1	66	41	318	35	160
674	104	3202	14	4.1	0.3	215	191	12099	100	1570
674	182	3202	23	13	1	123	109	2252	60	510
674	312	3202	36	37	1	72	64	446	35	175

for low pressure with plain fixed flanges

PN 1



Type AFG without inner sleeve



Type AFG with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFG 01 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
700	80	**.0700.080.0**	420225	421639	230	62	66	6	20
700	120	**.0700.120.0**	420227	421640	286	65	72	6	20
700	220	**.0700.220.0**	420228	421641	426	73	85	6	20
800	84	**.0800.084.0**	420229	421642	244	76	84	6	20
800	126	**.0800.126.0**	420230	421643	302	79	88	6	20
800	231	**.0800.231.0**	420231	421644	447	89	103	6	20
900	84	**.0900.084.0**	420232	421645	248	80	90	6	20
900	126	**.0900.126.0**	420233	421646	308	85	97	6	20
900	210	**.0900.210.0**	420234	421647	428	93	109	6	20
1000	72	**.1000.072.0**	420235	421648	234	85	92	6	20
1000	144	**.1000.144.0**	420236	421649	330	92	104	6	20
1000	240	**.1000.240.0**	420237	421650	458	102	121	6	20
1200	72	**.1200.072.0**	420238	421651	241	105	116	2	20
1200	120	**.1200.120.0**	420239	421652	303	111	128	2	20
1200	216	**.1200.216.0**	420240	421653	427	123	152	2	20
1400	48	**.1400.048.0**	420241	421654	152	122	134	2	20
1400	108	**.1400.108.0**	420243	421655	282	134	154	2	20
1400	180	**.1400.180.0**	420244	421656	438	149	179	2	20
1600	48	**.1600.048.0**	420246	421657	152	152	165	2	20
1600	108	**.1600.108.0**	420247	421658	282	166	189	2	20
1600	180	**.1600.180.0**	420248	421659	438	182	217	2	20

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints — Type AFG 01...

for low pressure with plain fixed flanges

PN 1

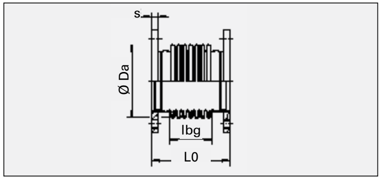
Bellows			Nominal movement absorption[1] nominal for 1000 loading cycles		Vibrations in all planes	Adjusting force rate			Natural frequency of bellows	
outside diameter	corruga-ted length	effective cross-section	angular[1]	lateral[1]		axial	angular	lateral	axial	radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
780	112	4324	12	4	0.3	203	244	13365	90	1480
780	168	4324	18	9.1	0.8	135	162	3950	60	660
780	308	4324	30	30	1	74	89	644	30	195
882	116	5588	11	3.9	0.3	220	341	17449	85	1570
882	174	5588	16	8.7	0.8	147	228	5182	60	700
882	319	5588	28	29	1	80	124	839	30	210
992	120	7133	9.9	3.5	0.2	238	472	22421	80	1650
992	180	7133	15	7.9	0.7	158	313	6643	60	730
992	300	7133	23	22	1	95	188	1438	30	260
1095	96	8750	7.7	2.2	0.2	335	814	60745	105	2940
1095	192	8750	15	8.7	0.7	168	408	7570	50	740
1095	320	8750	23	24	1	101	245	1632	30	265
1295	93	12331	6.5	1.8	0.1	331	1134	89855	95	3210
1295	155	12331	11	4.9	0.4	198	678	19409	60	1160
1295	279	12331	18	16	1	110	377	3328	30	360
1470	104	16016	3.8	1.2	0.1	922	4053	257632	150	5320
1470	234	16016	8.4	5.9	0.5	410	1802	22624	70	1050
1470	390	16016	13	16	1	246	1081	4887	40	380
1670	104	20816	3.4	1	0.1	1046	5990	380429	150	6040
1670	234	20816	7.4	5.2	0.5	465	2660	33398	70	1200
1670	390	20816	12	14	1	279	1596	7214	40	430

Axial expansion joints

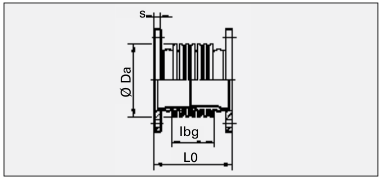
Type AFG 01...

for low pressure with plain fixed flanges

PN 1



Type AFG without inner sleeve



Type AFG with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFG 01 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
1800	48	**.1800.048.0**	420250	421660	152	170	185	2	20
1800	108	**.1800.108.0**	420251	421661	282	186	212	2	20
1800	180	**.1800.180.0**	420252	421662	438	204	243	2	20
2000	48	**.2000.048.0**	420253	421663	152	188	205	2	20
2000	108	**.2000.108.0**	420255	421664	282	205	234	2	20
2000	180	**.2000.180.0**	420256	421665	438	226	269	2	20
2200	48	**.2200.048.0**	420257	421666	152	221	242	2	20
2200	108	**.2200.108.0**	420258	421667	282	241	274	2	20
2200	180	**.2200.180.0**	420259	421668	438	263	313	2	20
2400	48	**.2400.048.0**	420260	421669	152	241	264	2	20
2400	108	**.2400.108.0**	420261	421670	282	262	299	2	20
2400	180	**.2400.180.0**	420262	421671	438	287	340	2	20
2600	48	**.2600.048.0**	420263	421672	152	260	285	2	20
2600	108	**.2600.108.0**	420264	421673	282	283	323	2	20
2600	180	**.2600.180.0**	420265	421674	438	310	368	2	20
2800	48	**.2800.048.0**	420266	421675	152	314	340	2	20
2800	108	**.2800.108.0**	420267	421676	282	338	381	2	20
2800	180	**.2800.180.0**	420268	421677	438	367	429	2	20
3000	48	**.3000.048.0**	420269	421678	152	335	364	2	20
3000	108	**.3000.108.0**	420270	421679	282	361	407	2	20
3000	180	**.3000.180.0**	420271	421680	438	392	459	2	20

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

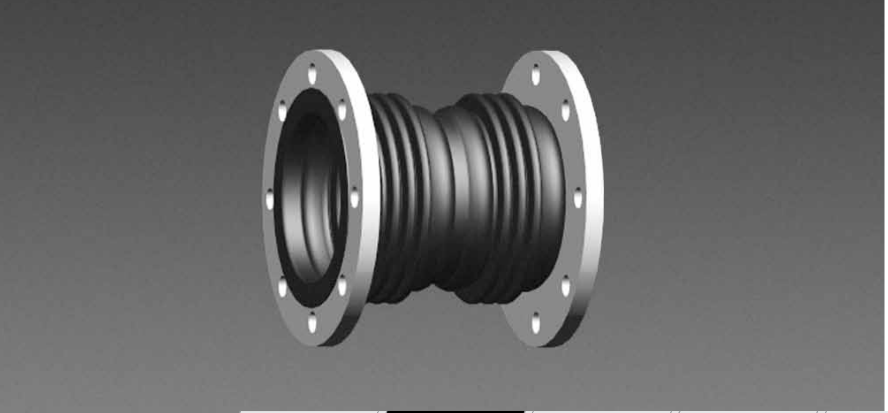
Axial expansion joints

Type AFG 01...

for low pressure with plain fixed flanges

PN 1

Bellows			Nominal movement absorption[1] nominal for 1000 loading cycles		Vibrations in all planes	Adjusting force rate			Natural frequency of bellows	
outside diameter	corruga-ted length	effective cross-section	angular[1]	lateral[1]		axial	angular	lateral	axial	radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
1870	104	26245	3	0.9	0	1170	8449	536643	150	6760
1870	234	26245	6.6	4.6	0.4	520	3754	47143	70	1340
1870	390	26245	11	13	1	312	2253	10183	40	480
2070	104	32302	2.7	0.8	0	1292	11503	730650	150	7480
2070	234	32302	6	4.2	0.4	574	5114	64107	70	1480
2070	390	32302	9.6	12	1	345	3069	13872	40	530
2270	104	38987	2.5	0.7	0	1414	15205	965857	150	8200
2270	234	38987	5.4	3.8	0.3	628	6758	84718	70	1620
2270	390	38987	8.8	11	1	377	4050	18309	40	580
2470	104	46301	2.3	0.7	0	1536	19613	1245968	150	8900
2470	234	46301	5	3.5	0.3	683	8720	109332	70	1760
2470	390	46301	8.1	9.6	1	410	5235	23604	40	630
2670	104	54243	2.1	0.6	0	1657	24816	1576541	150	9620
2670	234	54243	4.6	3.2	0.3	737	11029	138302	70	1900
2670	390	54243	7.5	8.9	0.8	442	6615	29900	40	680
2870	104	62813	1.9	0.6	0	1778	30848	1959837	150	10330
2870	234	62813	4.3	3	0.2	790	13714	171984	65	2040
2870	390	62813	7	8.3	0.8	474	8218	37149	40	740
3070	104	72011	1.8	0.5	0	1900	37786	2400702	150	11050
3070	234	72011	4	2.8	0.2	844	16803	210733	65	2180
3070	390	72011	6.5	7.7	0.7	507	10082	45573	40	790



Universal expansion joint
for low pressure (exhaust-gas) with flanges

Type UBG
Type UFG

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type UBG: HYDRA universal expansion joint with swivel flanges
Type UFG: HYDRA universal expansion joint with plain fixed flanges

Standard version/materials:
multi-ply bellows: 1.4541
flange: S 235 JRG2 (1.0038)
operating temperature: up to 550°C

Designation (example):

U	B	G	0	1	.	0	1	5	0	.	1	4	4	.	0

- U B G: Type
- 0 1: Nominal pressure (PN1)
- 0 1 5 0: Nominal diameter (DN150)
- 1 4 4: Movement absorption, nominal (2δ = ±72 = 144 mm)
- 0: Inner sleeve (0 = without)

Order text

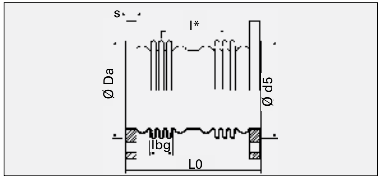
Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

The expansion joints for low pressure (exhaust-gas) are designed for non-pressurised applications (PS < 0.5 bar gauge pressure).

The Pressure Equipment Directive 97/23/EC does not apply to this operating condition.

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.



Type UBG

Nominal dia-meter	Nominal axial movement absorption	Type UBG 01 ...	Order No. standard version	Overall length	Weight approx.	Centre-to-centre spacing of bellows	Flange: drilling EN 1092	Flange: rim diameter	Flange: thick-ness
DN	2δ$_N$	–	–	Lo	G	l*	PN	d	s
–	mm	–	–	mm	kg	mm	–	mm	mm
50	56	**.. .0050.056.0**	425669	378	2.6	257	6	90	10
65	83	**.. .0065.083.0**	425670	418	3.3	279	6	107	10
80	95	**.. .0080.095.0**	425673	427	4.5	280	6	122	10
100	119	**.. .0100.119.0**	425674	447	5.3	291	6	147	10
125	144	**.. .0125.144.0**	425675	457	6.5	286	6	178	10
150	144	**.. .0150.144.0**	423511	470	7.4	299	6	202	10
200	160	**.. .0200.160.0**	423512	490	13.9	292	6	258	16
250	168	**.. .0250.168.0**	423513	500	16.9	293	6	312	16
300	196	**.. .0300.196.0**	423514	490	21.9	269	6	365	16
350	180	**.. .0350.180.0**	423515	510	27.1	302	6	410	16
400	156	**.. .0400.156.0**	423516	490	34.9	266	6	465	16
450	140	**.. .0450.140.0**	423517	490	39.5	282	6	520	16
500	136	**.. .0500.136.0**	423518	500	42.3	310	6	570	16

[1] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows: outside diameter	Bellows: corrugated length	Bellows: effective cross-section	Nominal movement absorption[1] for 1000 loading cycles: angular	Nominal movement absorption[1] for 1000 loading cycles: lateral	Adjusting force rate: axial	Adjusting force rate: lateral	Adjusting force rate: angular
Da	lbg	A	2α$_N$	2λ$_N$	c$_δ$	c$_λ$	c$_α$
mm	mm	cm²	degrees	mm	N/mm	N/mm	N/m degrees
89	63	45	41	154	37	1.6	1
107	81	68	49	195	28	1.6	1.1
121	90	88	49	196	26	1.9	1.3
148	99	136	50	202	24	2.5	1.9
174	104	186	51	204	18	2.6	1.9
203	104	263	43	181	21	4	3.1
255	120	430	37	149	23	7.4	5.6
312	119	658	32	127	27	13	9.7
365	133	913	31	112	26	21	13
400	120	1101	26	109	27	21	17
458	126	1439	20	71	88	114	71
513	110	1817	16	62	97	142	99
569	92	2244	14	62	107	160	135

Universal expansion joints — Type UFG 01...

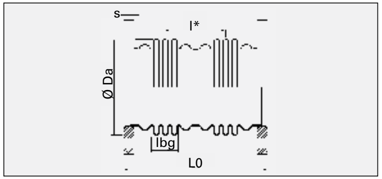
for low pressure with plain fixed flanges

PN 1

Universal expansion joints — Type UFG 01...

for low pressure with plain fixed flanges

PN 1

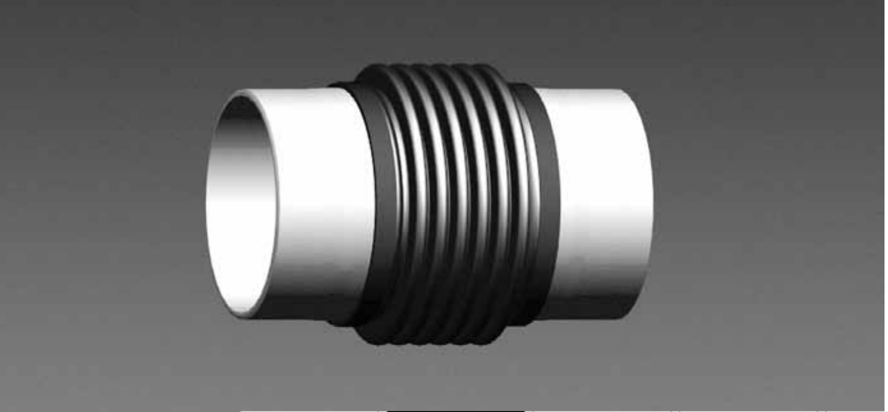


Type UFG

Nominal dia-meter	Nominal axial movement absorption	Type UFG 01 ...	Order No. standard version	Overall length	Weight approx.	Centre-to-centre spacing of bellows	Flange drilling EN 1092	Flange thick-ness
DN	$2\delta_N$	–	–	Lo	G	l*	PN	s
–	mm	–	–	mm	kg	mm	–	mm
50	56	**.. .0050.056.0**	425685	398	2.5	257	6	10
65	83	**.. .0065.083.0**	425686	438	3.2	279	6	10
80	95	**.. .0080.095.0**	425687	448	4	280	6	10
100	119	**.. .0100.119.0**	425688	468	5	291	6	10
125	144	**.. .0125.144.0**	425689	478	6	286	6	10
150	144	**.. .0150.144.0**	423527	491	7	299	6	10
200	160	**.. .0200.160.0**	423528	506	13	292	6	16
250	168	**.. .0250.168.0**	423529	516	16	293	6	16
300	196	**.. .0300.196.0**	423530	506	22	269	6	16
350	180	**.. .0350.180.0**	423531	526	26	302	6	16
400	156	**.. .0400.156.0**	423532	506	33	266	6	16
450	140	**.. .0450.140.0**	423533	506	38	282	6	16
500	136	**.. .0500.136.0**	423534	516	40	310	6	16

[1] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] for 1000 loading cycles angular	Nominal movement absorption[1] for 1000 loading cycles lateral	Adjusting force rate axial	Adjusting force rate lateral	Adjusting force rate angular
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_λ	c_α
mm	mm	cm^2	degrees	mm	N/mm	N/mm	N/m degrees
89	81	45	41	154	37	1.6	1
107	81	68	49	195	28	1.6	1.1
121	90	88	49	196	26	1.9	1.3
148	99	136	49	202	24	2.5	1.9
174	104	186	51	204	18	2.6	1.9
203	104	263	43	181	21	4	3.1
255	120	430	37	149	23	7.4	5.6
312	119	658	32	127	27	13	9.7
365	133	913	31	112	26	21	13
400	120	1101	26	109	27	21	17
458	126	1439	20	71	88	114	71
513	110	1817	16	62	97	142	99
569	92	2244	14	62	107	160	135



Type ARG

Axial expansion joint

for low pressure (exhaust-gas) with weld ends

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type ARG: HYDRA axial exhaust-gas expansion joint with weld ends

Standard version/materials:
multi-ply bellows: 1.4541
weld ends: P 235 TR1 (1.0254)
operating temperature: up to 550°C

Designation (example):

A	R	G	0	1	.	0	1	5	0	.	1	2	6	.	0

- A R G – Type
- 0 1 – Nominal pressure (PN1)
- 0 1 5 0 – Nominal diameter (DN150)
- 1 2 6 – Movement absorption, nominal ($2\alpha = \pm 63 = 126$ mm)
- 0 – Inner sleeve (0 = without, 1 = with)

Order text

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

The expansion joints for low pressure (exhaust-gas) are designed for non-pressurised applications (PS < 0.5 bar gauge pressure).

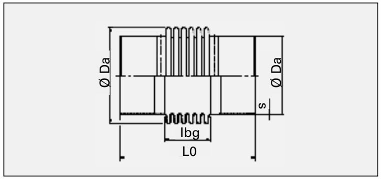
The Pressure Equipment Directive 97/23/EC does not apply to this operating condition.

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

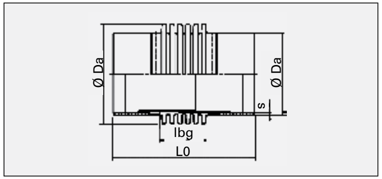
Axial expansion joints — Type ARG 01...

for low pressure with weld ends

PN 1



Type ARG without inner sleeve



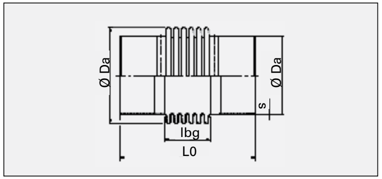
Type ARG with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type ARG 01 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Weld ends outside diameter	Weld ends wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
50	24	**.0050.024.0**	417751	417842	214	1	1.2	60.3	4
50	56	**.0050.056.0**	417753	417843	286	1.2	1.5	60.3	4
50	80	**.0050.080.0**	417754	417844	340	1.4	1.8	60.3	4
65	28	**.0065.028.0**	417755	417845	214	1.5	1.7	76.1	4
65	64	**.0065.064.0**	417756	417846	286	1.8	2.2	76.1	4
65	92	**.0065.092.0**	417757	417847	340	2	2.6	76.1	4
80	37	**.0080.037.0**	417758	417848	230	1.8	2.1	88.9	4
80	74	**.0080.074.0**	417759	417849	300	2.1	2.7	88.9	4
80	106	**.0080.106.0**	417760	417850	360	2.4	3.1	88.9	4
100	40	**.0100.040.0**	417761	417851	226	2.3	2.7	114.3	4
100	86	**.0100.086.0**	417762	417852	303	2.7	3.5	114.3	4
100	119	**.0100.119.0**	417763	417853	358	3.1	4.1	114.3	4
125	63	**.0125.063.0**	417764	417854	251	2.9	3.5	139.7	4
125	126	**.0125.126.0**	417765	417855	342	3.6	4.7	139.7	4
125	180	**.0125.180.0**	417766	417856	420	4.1	5.6	139.7	4
150	63	**.0150.063.0**	417767	417857	251	3.5	4.2	168.3	4
150	126	**.0150.126.0**	417768	417858	342	4.3	5.7	168.3	4
150	180	**.0150.180.0**	417769	417860	420	5	6.7	168.3	4
200	70	**.0200.070.0**	417770	417861	265	4.6	5.9	219.1	4
200	140	**.0200.140.0**	417771	417862	370	5.7	7.8	219.1	4
200	200	**.0200.200.0**	417772	417863	460	6.7	9.3	219.1	4

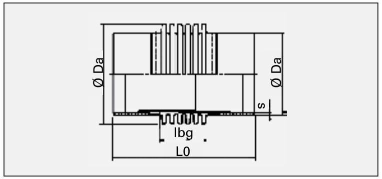
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints Type ARG 01...
for low pressure with weld ends
PN 1

Bellows outside diameter	Bellows corruga-ted length	Bellows effective cross-section	Nominal movement absorption[1] nominal for 1000 loading cycles angular[1]	Nominal movement absorption[1] nominal for 1000 loading cycles lateral[1]	Vibrations in all planes	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral	Natural frequency of bellows axial	Natural frequency of bellows radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
89	54	46	36	5.6	0.5	87	1.1	259	350	1250
89	126	46	50	31	1	37	0.5	20	150	230
89	180	46	50	63	1	26	0.3	7	105	110
107	54	68.7	33	5.2	0.5	85	1.6	378	290	1280
107	126	68.7	50	29	1	36	0.7	30	125	235
107	180	68.7	50	59	1	25	0.5	10	90	115
121	70	89.1	39	8.1	0.5	67	1.7	233	220	840
121	140	89.1	50	32	1	34	0.8	29	110	210
121	200	89.1	50	66	1	24	0.6	9.8	75	105
148	66	137	33	6.5	0.5	73	2.8	432	210	1050
148	143	137	50	31	1	34	1.3	42	100	225
148	198	137	50	59	1	24	0.9	16	70	115
174	91	187	45	12	0.5	41	2.1	177	120	520
174	182	187	50	49	1	21	1.1	23	60	130
174	260	187	50	101	1	14	0.7	7.4	40	65
203	91	264	38	10	1	48	3.5	293	120	610
203	182	264	50	42	1	24	1.8	37	60	150
203	260	264	50	85	1	17	1.2	13	40	75
255	105	432	33	10	1	53	6.4	397	110	600
255	210	432	50	42	1	27	3.2	51	55	150
255	300	432	50	85	1	19	2.3	17	40	75



Type ARG without inner sleeve



Type ARG with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type ARG 01 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Weld ends outside diameter	Weld ends wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
250	72	**.0250.072.0**	417773	417864	262	5.7	7.3	273	4
250	144	**.0250.144.0**	417774	417865	364	7	9.4	273	4
250	216	**.0250.216.0**	417775	417867	466	8.4	11.6	273	4
300	70	**.0300.070.0**	417777	417868	255	6.5	9.2	323.9	4
300	154	**.0300.154.0**	417778	417869	369	8.2	12.5	323.9	4
300	210	**.0300.210.0**	417779	417870	445	9.3	14.8	323.9	4
350	75	**.0350.075.0**	417780	417871	260	7.3	10.3	355.6	4
350	150	**.0350.150.0**	417781	417872	360	8.9	13.6	355.6	4
350	210	**.0350.210.0**	417782	417873	440	10.2	16.3	355.6	4
400	65	**.0400.065.0**	417783	417874	265	10.1	12.9	406.4	4
400	117	**.0400.117.0**	417784	417875	349	12.9	18	406.4	4
400	195	**.0400.195.0**	417785	417876	475	17.1	25	406.4	4
450	56	**.0450.056.0**	417786	417877	248	10.8	13.7	457	4
450	140	**.0450.140.0**	417787	417878	380	15.8	22	457	4
450	196	**.0450.196.0**	417789	417879	468	19.1	27	457	4
500	68	**.0500.068.0**	417790	417880	292	14.1	17.9	508	4
500	136	**.0500.136.0**	417791	417881	384	18.1	25	508	4
500	221	**.0500.221.0**	417792	417882	499	23	33	508	4
600	76	**.0600.076.0**	417793	417883	304	17.3	22	610	4
600	152	**.0600.152.0**	417794	417884	408	22	32	610	4
600	228	**.0600.228.0**	417795	417885	512	27	40	610	4

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

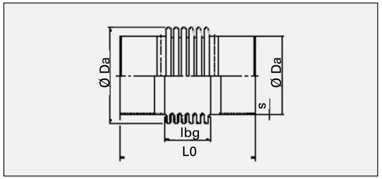
Axial expansion joints — Type ARG 01...

for low pressure with weld ends

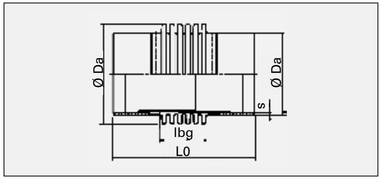
PN 1

Bellows outside diameter	Bellows corruga-ted length	Bellows effective cross-section	Nominal movement absorption 1) nominal for 1000 loading cycles angular 1)	Nominal movement absorption lateral 1)	Vibrations in all planes	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral	Natural frequency of bellows axial	Natural frequency of bellows radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
312	102	661	28	8.4	0.7	62	11	752	110	780
312	204	661	50	34	1	31	5.7	94	55	190
312	306	661	50	76	1	21	3.9	28	35	90
365	95	916	23	6.5	0.5	73	19	1415	110	1030
365	209	916	46	31	1	33	8.4	132	50	210
365	285	916	50	58	1	24	6.1	52	40	115
400	100	1104	22	6.7	0.5	66	20	1392	100	950
400	200	1104	41	27	1	33	10	174	50	240
400	280	1104	50	52	1	24	7.4	62	35	120
458	105	1445	17	5.3	0.5	212	85	5283	120	1260
458	189	1445	30	17	1	118	47	904	70	390
458	315	1445	45	48	1	71	29	195	40	140
513	88	1825	13	3.4	0.3	243	123	10935	130	1850
513	220	1825	31	21	1	97	49	698	55	300
513	308	1825	41	42	1	70	35	253	40	150
569	92	2252	14	3.9	0.3	215	135	10875	115	1690
569	184	2252	28	16	1	107	67	1359	55	420
569	299	2252	42	41	1	66	41	318	35	160
674	104	3202	14	4.1	0.3	215	191	12099	100	1570
674	208	3202	26	17	1	107	95	1512	50	390
674	312	3202	36	37	1	72	64	446	35	175

PN 1



Type ARG without inner sleeve



Type ARG with inner sleeve

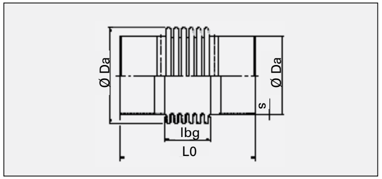
Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARG 01 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
700	80	**.0700.080.0**	417796	417886	312	21	27	711	4
700	140	**.0700.140.0**	417797	417887	396	26	36	711	4
700	220	**.0700.220.0**	417798	417888	508	32	46	711	4
800	84	**.0800.084.0**	417799	417889	316	24	33	813	4
800	147	**.0800.147.0**	417800	417890	403	29	42	813	4
800	231	**.0800.231.0**	417801	417891	519	37	54	813	4
900	84	**.0900.084.0**	417802	417892	320	27	38	914	4
900	168	**.0900.168.0**	417805	417893	440	36	52	914	4
900	231	**.0900.231.0**	417807	417894	530	43	62	914	4
1000	72	**.1000.072.0**	417808	417895	296	28	36	1016	4
1000	144	**.1000.144.0**	417809	417896	392	35	51	1016	4
1000	240	**.1000.240.0**	417811	417898	520	45	67	1016	4
1200	72	**.1200.072.0**	417812	417899	293	34	46	1220	4
1200	144	**.1200.144.0**	417813	417900	386	43	67	1220	4
1200	240	**.1200.240.0**	417814	417901	510	55	89	1220	4
1400	48	**.1400.048.0**	417815	417902	304	39	53	1420	4
1400	108	**.1400.108.0**	417816	417903	434	51	80	1420	4
1400	180	**.1400.180.0**	417817	417904	590	65	109	1420	4
1600	48	**.1600.048.0**	417818	417905	304	44	60	1620	4
1600	108	**.1600.108.0**	417819	417906	434	58	92	1620	4
1600	180	**.1600.180.0**	417820	417907	590	74	124	1620	4

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

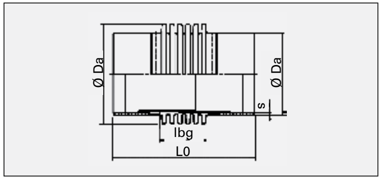
Axial expansion joints Type ARG 01...
for low pressure with weld ends

PN 1

Bellows			Nominal movement absorption[1] nominal for 1000 loading cycles		Vibrations in all planes	Adjusting force rate			Natural frequency of bellows	
outside diameter	corruga-ted length	effective cross-section	angular[1]	lateral[1]		axial	angular	lateral	axial	radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
780	112	4324	12	4	0.3	203	244	13365	90	1480
780	196	4324	21	12	1	116	139	2494	50	480
780	308	4324	30	30	1	74	89	644	30	195
882	116	5588	11	3.9	0.3	220	341	17449	85	1570
882	203	5588	19	12	1	126	196	3263	50	510
882	319	5588	28	29	1	80	124	839	30	210
992	120	7133	9.9	3.5	0.2	238	472	22421	80	1650
992	240	7133	19	14	1	119	236	2815	40	410
992	330	7133	25	27	1	86	170	1076	30	220
1095	96	8750	7.7	2.2	0.2	335	814	60745	105	2940
1095	192	8750	15	8.7	0.7	168	408	7570	50	740
1095	320	8750	23	24	1	101	245	1632	30	265
1295	93	12331	6.5	1.8	0.1	331	1134	89855	95	3210
1295	186	12331	13	7.1	0.6	165	565	11232	45	800
1295	310	12331	20	20	1	99	339	2426	30	290
1470	104	16377	3.8	1.2	0.1	932	4190	266329	150	5320
1470	234	16377	8.3	5.8	0.5	414	1865	23362	70	1050
1470	390	16377	13	16	1	249	1119	5038	40	380
1670	104	21227	3.3	1	0.1	1056	6168	391692	150	6040
1670	234	21227	7.3	5.1	0.5	470	2742	34354	70	1200
1670	390	21227	12	14	1	282	1645	7437	40	430



Type ARG without inner sleeve



Type ARG with inner sleeve

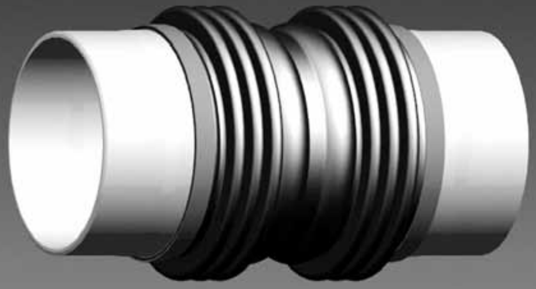
Nominal diameter	Nominal axial movement absorption	Type ARG 01 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Weld ends outside diameter	Weld ends wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
1800	48	**.1800.048.0**	417821	417908	304	49	68	1820	4
1800	108	**.1800.108.0**	417822	417909	434	65	103	1820	4
1800	180	**.1800.180.0**	417823	417910	590	84	140	1820	4
2000	48	**.2000.048.0**	417824	417911	304	55	76	2020	4
2000	108	**.2000.108.0**	417825	417912	434	72	115	2020	4
2000	180	**.2000.180.0**	417826	417913	590	93	155	2020	4
2200	48	**.2200.048.0**	417827	417914	304	82	105	2220	6
2200	108	**.2200.108.0**	417828	417915	434	101	150	2220	6
2200	180	**.2200.180.0**	417829	417917	590	124	194	2220	6
2400	48	**.2400.048.0**	417830	417918	304	89	114	2420	6
2400	108	**.2400.108.0**	417831	417919	434	110	163	2420	6
2400	180	**.2400.180.0**	417832	417920	590	135	211	2420	6
2600	48	**.2600.048.0**	417833	417921	304	97	124	2620	6
2600	108	**.2600.108.0**	417834	417922	434	119	176	2620	6
2600	180	**.2600.180.0**	417835	417923	590	146	229	2620	6
2800	48	**.2800.048.0**	417836	417924	304	104	133	2820	6
2800	108	**.2800.108.0**	417837	417926	434	128	190	2820	6
2800	180	**.2800.180.0**	417838	417927	590	158	246	2820	6
3000	48	**.3000.048.0**	417839	417928	304	112	143	3020	6
3000	108	**.3000.108.0**	417840	417929	434	137	203	3020	6
3000	180	**.3000.180.0**	417841	417930	590	169	264	3020	6

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] nominal for 1000 loading cycles angular[1)]	Nominal movement absorption lateral[1)]	Vibrations in all planes	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral	Natural frequency of bellows axial	Natural frequency of bellows radial
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	â	c_δ	c_α	c_λ	ω_a	ω_r
mm	mm	cm^2	degrees	mm	mm	N/mm	Nm/degrees	N/mm	Hz	Hz
1870	104	26706	3	0.9	–	1180	8672	550794	150	6760
1870	234	26706	6.6	4.6	0.4	524	3858	48345	70	1340
1870	390	26706	10	13	1	315	2315	10463	40	480
2070	104	32813	2.7	0.8	–	1302	11767	747440	150	7480
2070	234	32813	5.9	4.1	0.4	579	5232	65695	70	1480
2070	390	32813	9.5	11	1	347	3136	14174	40	530
2270	104	39549	2.5	0.7	–	1424	15523	986064	150	8200
2270	234	39549	5.4	3.8	0.3	633	6899	86629	70	1620
2270	390	39549	8.8	10	1	380	4142	18722	40	580
2470	104	46913	2.3	0.7	–	1545	20003	1270727	150	8900
2470	234	46913	5	3.4	0.3	687	8887	111595	70	1760
2470	390	46913	8	9.6	1	412	5330	24093	40	630
2670	104	54905	2.1	0.6	–	1667	25256	1604521	150	9620
2670	234	54905	4.6	3.2	0.3	741	11225	140948	70	1900
2670	390	54905	7.4	8.9	0.8	444	6741	30403	40	680
2870	104	63526	1.9	0.6	–	1788	31375	1993293	150	10330
2870	234	63526	4.3	3	0.2	795	13940	175043	65	2040
2870	390	63526	7	8.2	0.8	477	8364	37809	40	740
3070	104	72774	1.8	0.5	–	1909	38389	2438990	150	11050
3070	234	72774	4	2.8	0.2	849	17062	213982	65	2180
3070	390	72774	6.5	7.7	0.7	509	10229	46238	40	790

Universal expansion joint

for low pressure (exhaust-gas) with weld ends



Type URG

Designation
The designation consists of two parts
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type URG: HYDRA universal exhaust-gas expansion joint with weld ends

Standard version/materials:
multi-ply bellows: 1.4541
weld ends: P 235TR1 (1.0254)
operating temperature: up to 550°C

Designation (example):

U	R	G	0	1	.	0	1	5	0	.	1	4	4	.	0

- U R G – Type
- 0 1 – Nominal pressure (PN 1)
- 0 1 5 0 – Nominal diameter (DN150)
- 1 4 4 – Movement absorption, nominal ($2\delta = \pm 72 = 144$ mm)
- 0 – Inner sleeve (0 = without)

Order text

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

The expansion joints for low pressure (exhaust-gas) are designed for non-pressurised applications (PS < 0.5 bar gauge pressure).

The Pressure Equipment Directive 97/23/EC does not apply to this operating condition.

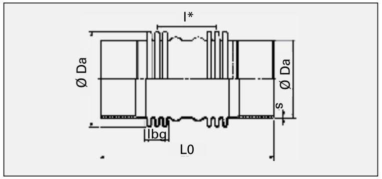
Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Universal expansion joints **Type URG 01...**

for low pressure with weld ends

PN 1

Universal expansion joints Type URG 01...
for low pressure with weld ends
PN 1

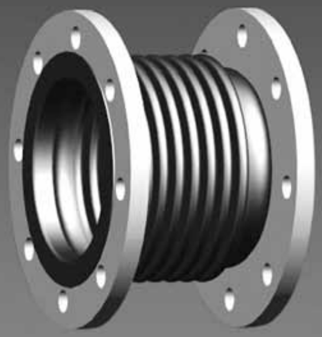


Type URG

Nenn-weite	Nominal axial movement absorption	Type URG 01 ...	Order No. standard version	Overall length	Weight approx.	Centre-to-centre spacing of bellows	Weld ends outside diameter	Weld ends wall thickness
DN	$2\delta_N$	–	–	Lo	G	l*	D	s
–	mm	–	–	mm	kg	mm	mm	mm
50	56	**.. .0050.056.0**	425696	480	1.5	257	60.3	4
65	83	**.. .0065.083.0**	425697	520	2.2	279	76.1	4
80	95	**.. .0080.095.0**	425698	530	2.6	280	88.9	4
100	119	**.. .0100.119.0**	425699	550	3.4	291	114.3	4
125	144	**.. .0125.144.0**	425700	550	4.2	286	139.7	4
150	144	**.. .0150.144.0**	423544	563	5	299	168.3	4
200	160	**.. .0200.160.0**	423545	572	6.6	292	219.1	4
250	168	**.. .0250.168.0**	423546	572	8.2	293	273	4
300	196	**.. .0300.196.0**	423547	562	9.7	269	323.9	4
350	180	**.. .0350.180.0**	423548	582	10.6	302	355.6	4
400	156	**.. .0400.156.0**	423549	552	16.5	266	406.4	4
450	140	**.. .0450.140.0**	423550	552	17.9	282	457	4
500	136	**.. .0500.136.0**	423551	602	21	310	508	4

[1] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] for 1000 loading cycles angular	Nominal movement absorption[1] for 1000 loading cycles lateral	Adjusting force rate axial	Adjusting force rate lateral	Adjusting force rate angular
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_λ	c_α
mm	mm	cm^2	degrees	mm	N/mm	N/mm	N/m degrees
89	81	45	41	200	37	1.6	1
107	81	68	49	195	28	1.6	1.1
121	90	88	49	196	26	1.9	1.3
148	99	136	49	202	24	2.5	1.9
174	104	186	51	204	18	2.6	1.9
203	104	263	43	181	21	4	3.1
255	120	430	37	149	23	7.4	5.6
312	119	658	32	127	27	13	9.7
365	133	913	31	112	26	21	13
400	120	1101	26	109	27	21	17
458	126	1439	20	71	88	114	71
513	110	1817	16	62	97	142	99
569	92	2244	14	62	107	160	135



Type ABN
Type AFN

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type ABN: HYDRA axial expansion joint with swivel flanges
Type AFN: HYDRA axial expansion joint with plain fixed flanges

Standard version/materials:
multi-ply bellows: 1.4541
flange: S 235 JRG2 (1.0038)
operating temperature: up to 300°C

Designation (example):

A	B	N	1	0	.	0	1	5	0	.	0	6	4	.	0

- A B N: Type
- 1 0: Nominal pressure (PN10)
- 0 1 5 0: Nominal diameter (DN150)
- 0 6 4: Movement absorption, nominal (2δ = ±32 = 64 mm)
- 0: Inner sleeve (0 = without, 1 = with)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]

  ____

- piping – nominal size DN

  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]

____

max./min. allowable temperature TS [°C]

____

test pressure PT [bar]

____

Optional:

category ______________________

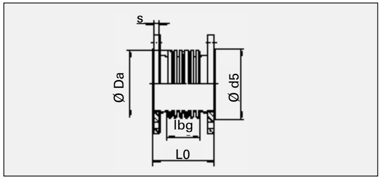
Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Axial expansion joints

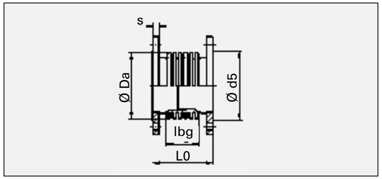
with swivel lap-joint flanges

Type ABN 02...

PN 2.5



Type ABN without inner sleeve



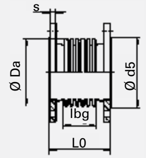
Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange rim diameter	Flange thick-ness
		ABN 02 ...								
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
50	20	**.0050.020.0**	419538	419635	115	3	3.1	6	90	16
50	40	**.0050.040.0**	419539	419636	160	3.2	3.5	6	90	16
50	70	**.0050.070.0**	419540	419637	242	3.8	4.2	6	90	16
65	23	**.0065.023.0**	419541	419638	115	3.9	4.1	6	107	16
65	60	**.0065.060.0**	419542	419639	187	4.2	4.6	6	107	16
65	87	**.0065.087.0**	419543	419640	261	4.9	5.5	6	107	16
80	27	**.0080.027.0**	419545	419641	123	6	6.2	6	122	18
80	64	**.0080.064.0**	419546	419642	193	6.3	6.8	6	122	18
80	92	**.0080.092.0**	419547	419643	272	7.1	7.7	6	122	18
100	46	**.0100.046.0**	419548	419644	150	7	7.5	6	147	18
100	73	**.0100.073.0**	419549	419645	194	7.3	8	6	147	18
100	98	**.0100.098.0**	419550	419646	283	9.4	10.3	6	147	18
125	45	**.0125.045.0**	419551	419647	152	9.5	10.2	6	178	20
125	81	**.0125.081.0**	419552	419648	204	9.9	10.8	6	178	20
125	140	**.0125.140.0**	419553	419649	369	13.7	15.1	6	178	20
150	45	**.0150.045.0**	419554	419650	152	10.5	11.3	6	202	20
150	81	**.0150.081.0**	419555	419651	204	10.9	12	6	202	20
150	160	**.0150.160.0**	419556	419652	389	16	17.9	6	202	20
200	60	**.0200.060.0**	419557	419653	180	15.2	16.4	6	258	22
200	110	**.0200.110.0**	419558	419654	267	17.1	18.9	6	258	22
200	190	**.0200.190.0**	419559	419655	415	22.6	25.6	6	258	22

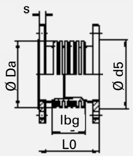
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints Type ABN 02...
with swivel lap-joint flanges
PN 2.5

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] for 1000 loading cycles angular[1)]	Nominal movement absorption[1)] for 1000 loading cycles lateral[1)]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	45	46	29	3.9	105	1.3	451
89	90	46	50	16	52	0.7	56
89	171	46	50	52	46	0.6	14
107	45	68.7	28	3.7	102	1.9	654
107	117	68.7	50	25	39	0.7	37
108	190	69.4	50	59	40	0.8	14
121	50	89.1	27	4.1	94	2.3	640
121	120	89.1	50	24	39	1	46
121	198	89.1	50	56	43	1.1	18
148	77	137	38	8.9	63	2.4	273
148	121	137	50	22	40	1.5	71
150	208	139	50	51	71	2.7	43
174	65	187	32	6.3	58	3	492
174	117	187	50	20	32	1.7	84
172	280	185	50	85	53	2.7	23
203	65	264	27	5.3	68	5	801
203	117	264	46	17	38	2.8	137
203	300	264	50	87	51	3.7	29
255	90	432	28	7.7	62	7.4	631
256	176	434	47	27	50	6	134
257	323	436	50	87	51	6.2	41



Type ABN without inner sleeve



Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange		
		ABN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
250	72	**.0250.072.0**	419560	419656	206	19.9	21.6	6	312	24
250	120	**.0250.120.0**	419561	419659	275	22.3	24.6	6	312	24
250	204	**.0250.204.0**	419562	419660	412	29.1	32.6	6	312	24
300	56	**.0300.056.0**	419563	419661	180	26.2	28	6	365	24
300	126	**.0300.126.0**	419564	419662	275	27.6	30.4	6	365	24
300	210	**.0300.210.0**	419565	419663	386	36.6	40.4	6	365	24
350	60	**.0350.060.0**	419566	419665	188	37	39.1	6	410	26
350	120	**.0350.120.0**	419567	419666	269	40	42.9	6	410	26
350	210	**.0350.210.0**	419568	419667	404	47.8	52.3	6	410	26
400	65	**.0400.065.0**	419569	419668	227	43.5	46.5	6	465	26
400	104	**.0400.104.0**	419570	419669	290	45.5	49.4	6	465	26
400	182	**.0400.182.0**	419571	419670	416	49.7	55.2	6	465	26
450	56	**.0450.056.0**	419572	419672	210	49.4	51.3	6	520	26
450	112	**.0450.112.0**	419573	419673	298	52.7	57.1	6	520	26
450	182	**.0450.182.0**	419574	419674	408	56.9	63	6	520	26
500	68	**.0500.068.0**	419575	419675	214	53.9	57.3	6	570	26
500	119	**.0500.119.0**	419576	419677	283	56.9	61.3	6	570	26
500	204	**.0500.204.0**	419577	419678	398	61.8	68	6	570	26
600	76	**.0600.076.0**	419578	419680	226	71.4	75.8	6	670	28
600	114	**.0600.114.0**	419579	419682	278	74	79.3	6	670	28
600	209	**.0600.209.0**	419580	419683	408	80.3	88.1	6	670	28

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

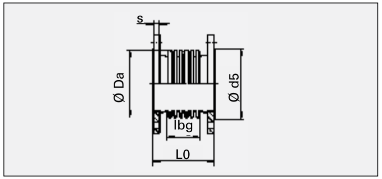
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
312	102	661	27	8.4	62	11	752
315	170	667	42	23	48	8.9	212
316	306	670	50	71	50	9.3	67
365	76	916	18	4.2	91	23	2756
365	171	916	36	21	40	10	239
371	280	932	50	57	52	13	118
400	80	1104	18	4.3	82	25	2703
402	160	1110	33	17	58	18	480
402	294	1110	50	55	60	19	147
458	105	1445	17	5.3	212	85	5283
458	168	1445	26	14	132	53	1291
458	294	1445	38	42	76	31	240
513	88	1825	13	3.4	243	123	10935
513	176	1825	24	14	122	62	1361
513	286	1825	34	36	75	38	320
569	92	2252	14	3.9	215	135	10875
569	161	2252	24	12	123	77	2025
569	276	2252	35	35	72	45	401
674	104	3202	13	4.1	215	191	12099
674	156	3202	19	9.3	143	127	3593
674	286	3202	30	31	78	69	583

Axial expansion joints

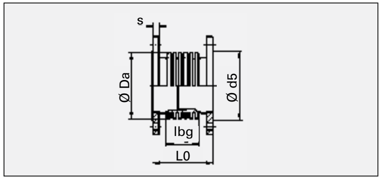
with swivel lap-joint flanges

Type ABN 02...

PN 2.5



Type ABN without inner sleeve



Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange		
		ABN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
700	80	**.0700.080.0**	419581	419684	242	95.2	100.7	6	775	32
700	120	**.0700.120.0**	419582	419685	298	98.4	105.1	6	775	32
700	220	**.0700.220.0**	419583	419686	438	106.4	116.3	6	775	32
800	63	**.0800.063.0**	419584	419688	229	122.2	125.9	6	880	34
800	126	**.0800.126.0**	419585	419689	316	127.7	135.9	6	880	34
800	210	**.0800.210.0**	419586	419690	432	135.1	146.2	6	880	34
900	63	**.0900.063.0**	419587	419692	234	132.1	136.5	6	980	35
900	126	**.0900.126.0**	419588	419693	324	138.7	148.4	6	980	35
900	210	**.0900.210.0**	419589	419695	444	147.4	160.6	6	980	35
1000	72	**.1000.072.0**	419590	419697	254	150.9	156.1	6	1080	37
1000	120	**.1000.120.0**	419591	419698	318	155.7	166.1	6	1080	37
1000	240	**.1000.240.0**	419592	419699	478	167.9	183.3	6	1080	37
1200	72	**.1200.072.0**	419593	419700	269	208.5	221.9	2	1280	40
1200	120	**.1200.120.0**	419594	419701	333	217.5	243.6	2	1280	40
1200	216	**.1200.216.0**	419595	419703	461	235.6	271.3	2	1280	40

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

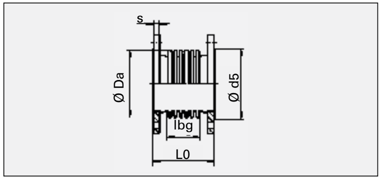
Axial expansion joints
with swivel lap-joint flanges
Type ABN 02...
PN 2.5

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
780	112	4324	12	4	203	244	13365
780	168	4324	17	9.1	135	162	3950
780	308	4324	27	30	74	89	644
882	87	5588	8.4	2.2	294	456	41313
882	174	5588	16	8.7	147	228	5182
882	290	5588	23	24	88	137	1117
992	90	7133	7.4	2	317	628	53147
992	180	7133	14	7.9	158	313	6643
992	300	7133	21	22	95	188	1438
1095	96	8750	7.7	2.2	335	814	60745
1095	160	8750	12	6.1	201	489	13121
1095	320	8750	21	24	101	245	1632
1295	96	12331	6.5	1.8	511	1750	130579
1295	160	12331	11	5.1	307	1052	28150
1295	288	12331	18	17	170	582	4827

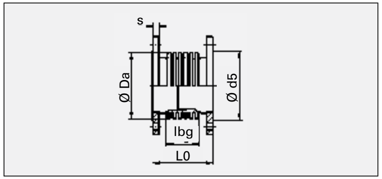
Axial expansion joints **Type ABN 06...**

with swivel lap-joint flanges

PN 6



Type ABN without inner sleeve



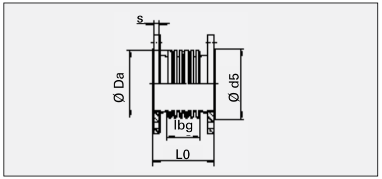
Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type ABN 06 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange rim diameter	Flange thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
50	20	**.0050.020.0**	419706	419767	115	3	3.1	6	90	16
50	52	**.0050.052.0**	419707	419769	197	3.5	3.8	6	90	16
65	23	**.0065.023.0**	419708	419770	115	3.9	4.1	6	107	16
65	41	**.0065.041.0**	419710	419771	151	4.1	4.4	6	107	16
65	72	**.0065.072.0**	419711	419772	270	6	6.6	6	107	16
80	27	**.0080.027.0**	419712	419773	123	6	6.2	6	122	18
80	42	**.0080.042.0**	419713	419774	153	6.1	6.5	6	122	18
80	77	**.0080.077.0**	419714	419775	280	8.5	9.1	6	122	18
100	33	**.0100.033.0**	419715	419776	128	6.9	7.2	6	147	18
100	59	**.0100.059.0**	419716	419777	182	7.6	8.3	6	147	18
100	87	**.0100.087.0**	419717	419778	271	9.9	10.7	6	147	18
125	36	**.0125.036.0**	419718	419779	139	9.4	9.8	6	178	20
125	63	**.0125.063.0**	419719	419780	178	9.7	10.4	6	178	20
125	98	**.0125.098.0**	419720	419781	300	13.2	14.4	6	178	20
150	40	**.0150.040.0**	419721	419782	158	10.9	11.4	6	202	20
150	72	**.0150.072.0**	419722	419783	224	12.9	14.1	6	202	20
150	124	**.0150.124.0**	419723	419784	363	18.3	20.1	6	202	20
200	40	**.0200.040.0**	419724	419785	155	15.4	16.1	6	258	22
200	80	**.0200.080.0**	419725	419786	228	18.1	19.7	6	258	22
200	140	**.0200.140.0**	419726	419787	346	24.6	26.8	6	258	22

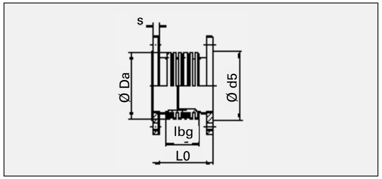
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints Type ABN 06...
with swivel lap-joint flanges
PN 6

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] for 1000 loading cycles angular[1]	Nominal movement absorption[1] for 1000 loading cycles lateral[1]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	45	46	28	3.9	105	1.3	451
89	126	46	50	28	62	0.8	34
107	45	68.7	27	3.7	102	1.9	654
107	81	68.7	41	12	56	1.1	112
110	198	70.9	50	50	91	1.8	30
121	50	89.1	26	4.1	94	2.3	640
121	80	89.1	38	11	59	1.5	154
123	204	90.8	50	48	97	2.4	40
148	55	137	27	4.6	88	3.3	752
149	108	138	43	16	71	2.7	160
151	195	140	50	42	91	3.5	63
174	52	187	25	4	72	3.7	953
174	91	187	39	12	41	2.1	177
173	210	186	50	45	89	4.6	71
202	70	263	23	5.1	117	8.5	1189
203	135	264	39	18	114	8.4	313
205	272	267	50	61	104	7.7	70
256	64	434	19	3.6	138	17	2791
257	136	436	34	15	121	15	540
260	252	441	50	50	110	13	145



Type ABN without inner sleeve

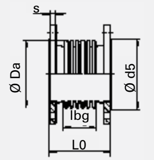


Type ABN with inner sleeve

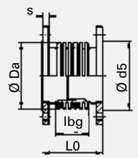
Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange		
		ABN 06 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
250	48	**.0250.048.0**	419727	419788	178	21.8	22.8	6	312	24
250	84	**.0250.084.0**	419728	419789	232	23.5	25.5	6	312	24
250	144	**.0250.144.0**	419729	419790	348	31.3	34.4	6	312	24
300	60	**.0300.060.0**	419730	419791	186	29.2	31	6	365	24
300	90	**.0300.090.0**	419731	419792	226	30.7	32.9	6	365	24
300	135	**.0300.135.0**	419732	419793	306	37.7	40.9	6	365	24
350	45	**.0350.045.0**	419733	419794	173	38.8	40	6	410	26
350	105	**.0350.105.0**	419734	419795	257	42.1	45	6	410	26
350	165	**.0350.165.0**	419735	419796	365	51.6	55.8	6	410	26
400	52	**.0400.052.0**	419736	419797	211	47.9	49.7	6	465	28
400	104	**.0400.104.0**	419737	419798	299	52.1	56.2	6	465	28
400	169	**.0400.169.0**	419738	419799	423	62.6	68.4	6	465	28
450	56	**.0450.056.0**	419739	419800	215	54.8	56.8	6	520	28
450	98	**.0450.098.0**	419740	419801	284	58.5	62.8	6	520	28
450	182	**.0450.182.0**	419741	419802	436	72.7	79.4	6	520	28
500	66	**.0500.066.0**	419742	419803	224	63.1	66.8	6	570	28
500	116	**.0500.116.0**	419743	419804	299	69.2	74.1	6	570	28
500	198	**.0500.198.0**	419744	419805	450	93.1	100.7	6	570	28
600	76	**.0600.076.0**	419746	419806	244	86.9	91.7	6	670	32
600	114	**.0600.114.0**	419747	419807	300	92.1	98	6	670	32
600	198	**.0600.198.0**	419748	419808	453	121.3	130.5	6	670	32

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
316	72	670	18	3.9	211	39	5156
316	126	670	29	12	120	22	967
319	240	677	45	39	110	21	245
371	80	932	19	4.6	183	47	5062
371	120	932	27	10	122	32	1496
374	198	940	39	26	128	33	582
402	63	1110	13	2.5	282	87	15014
402	147	1110	28	14	121	37	1178
405	253	1119	40	37	120	37	397
461	88	1456	13	3.5	361	146	12887
461	176	1456	23	14	180	73	1606
462	299	1459	32	39	148	60	461
514	92	1828	13	3.6	366	186	15018
514	161	1828	20	11	209	106	2802
515	312	1832	30	39	150	76	539
572	100	2265	14	4.1	414	260	17778
572	175	2265	22	12	236	148	3319
574	324	2273	33	40	208	131	856
677	112	3217	13	4.4	414	370	20180
677	168	3217	19	10	276	247	5986
678	319	3222	28	33	236	211	1421



Type ABN without inner sleeve



Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version without inner sleeve	with inner sleeve	Overall length	Weight approx. without inner sleeve	with inner sleeve	Flange drilling EN 1092	rim diameter	thick-ness
		ABN 06 ...								
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
700	60	**.0700.060.0**	419749	419809	224	110.2	113.5	6	775	36
700	120	**.0700.120.0**	419750	419810	308	119.8	126.8	6	775	36
700	200	**.0700.200.0**	419751	419811	442	150.4	160.6	6	775	36
800	63	**.0800.063.0**	419753	419812	251	147.3	151.5	6	880	37
800	105	**.0800.105.0**	419755	419813	317	158.9	167.5	6	880	37
800	210	**.0800.210.0**	419757	419814	482	188	200.9	6	880	37
900	63	**.0900.063.0**	419758	419815	253	161.1	165.9	6	980	38
900	105	**.0900.105.0**	419759	419816	319	174.4	184.2	6	980	38
900	210	**.0900.210.0**	419760	419817	484	207.8	222.7	6	980	38
1000	66	**.1000.066.0**	419761	419818	277	190.8	196.8	6	1080	42
1000	110	**.1000.110.0**	419762	419819	347	205.7	217.7	6	1080	42
1000	198	**.1000.198.0**	419763	419820	487	235.7	252.4	6	1080	42
1200	69	**.1200.069.0**	419764	419821	295	305.1	320.3	6	1295	47
1200	115	**.1200.115.0**	419765	419822	365	323.3	353.3	6	1295	47
1200	207	**.1200.207.0**	419766	419823	505	359.6	400.6	6	1295	47

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints **Type ABN 06...**

with swivel lap-joint flanges

PN 6

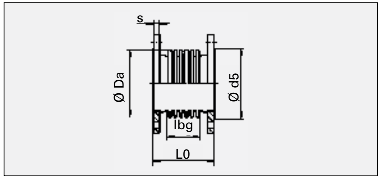
Bellows outside diameter	corrugated length	effective cross-section	Nominal movement absorption[1] for 1000 loading cycles angular[1]	lateral[1]	Adjusting force rate axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
780	84	4324	9.1	2.3	585	703	68235
780	168	4324	17	9.1	293	352	8544
783	300	4342	25	27	255	308	2331
887	99	5621	8.4	2.5	856	1337	93326
887	165	5621	14	6.8	514	803	20150
887	330	5621	23	27	257	401	2524
996	99	7163	7.4	2.2	953	1896	132463
996	165	7163	12	6	572	1138	28592
996	330	7163	20	24	286	569	3580
1100	105	8791	7	2.2	974	2379	147726
1100	175	8791	11	6.1	584	1426	31909
1100	315	8791	18	20	325	794	5466
1296	105	12341	6.2	1.9	1092	3743	232590
1296	175	12341	10	5.4	655	2245	50255
1296	315	12341	16	17	364	1248	8622

Axial expansion joints

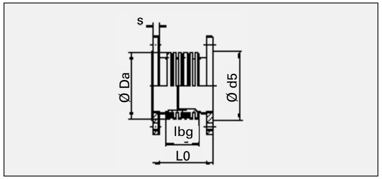
with swivel lap-joint flanges

Type ABN 10...

PN 10



Type ABN without inner sleeve



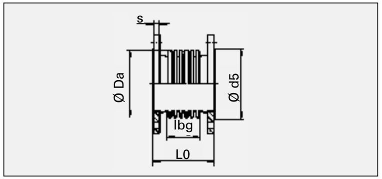
Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type ABN 10 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange rim diameter	Flange thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
50	24	**.0050.024.0**	419824	419901	130	5.3	5.4	16	92	19
50	46	**.0050.046.0**	419825	419902	218	6.1	6.5	16	92	19
65	18	**.0065.018.0**	419826	419903	114	6.3	6.5	16	107	20
65	48	**.0065.048.0**	419827	419904	212	7.9	8.3	16	107	20
80	20	**.0080.020.0**	419828	419905	122	7.5	7.7	16	122	20
80	41	**.0080.041.0**	419829	419906	166	7.8	8.3	16	122	20
80	54	**.0080.054.0**	419830	419907	224	9	9.6	16	122	20
100	26	**.0100.026.0**	419831	419908	130	9.1	9.4	16	147	22
100	46	**.0100.046.0**	419832	419909	166	9.4	9.9	16	147	22
100	80	**.0100.080.0**	419833	419910	295	13.2	14.1	16	147	22
125	30	**.0125.030.0**	419834	419911	148	11.9	12.3	16	178	22
125	45	**.0125.045.0**	419835	419912	176	12.2	13	16	178	22
125	85	**.0125.085.0**	419836	419913	303	16.4	17.6	16	178	22
150	32	**.0150.032.0**	419837	419914	157	16.4	16.9	16	208	24
150	64	**.0150.064.0**	419838	419915	217	17.5	18.7	16	208	24
150	95	**.0150.095.0**	419839	419916	307	21.4	22.8	16	208	24
200	40	**.0200.040.0**	419840	419917	164	21.3	22	10	258	24
200	80	**.0200.080.0**	419841	419918	232	23	24.7	10	258	24
200	110	**.0200.110.0**	419842	419919	296	27.4	29.6	10	258	24
250	48	**.0250.048.0**	419843	419920	182	27.9	28.9	10	320	26
250	84	**.0250.084.0**	419855	419921	236	29.6	31.6	10	320	26
250	130	**.0250.130.0**	419856	419922	416	41.8	45.1	10	320	26

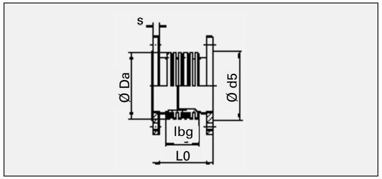
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints
with swivel lap-joint flanges
Type ABN 10...
PN 10

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] for 1000 loading cycles angular[1]	Nominal movement absorption[1] for 1000 loading cycles lateral[1]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	54	46	31	5.6	87	1.1	259
90	140	46.6	50	28	115	1.5	51
107	36	68.7	21	2.3	127	2.4	1275
110	132	70.9	47	22	136	2.7	103
121	44	89.1	20	2.8	192	4.8	1670
121	88	89.1	35	11	96	2.4	209
123	144	90.8	45	24	137	3.5	113
149	48	138	21	3.1	161	6.2	1817
149	84	138	33	9.7	92	3.5	340
152	210	141	48	41	131	5.1	78
171	56	184	21	3.7	148	7.6	1646
171	84	184	29	8.2	99	5.1	488
174	208	187	46	38	138	7.2	113
203	60	264	19	3.5	257	19	3564
203	120	264	33	14	128	9.4	445
205	208	267	43	35	136	10	157
257	68	436	19	3.8	242	29	4318
257	136	436	31	15	121	15	540
260	198	441	41	31	140	17	297
316	72	670	18	3.9	211	39	5156
316	126	670	27	12	120	22	967
319	304	677	31	45	201	38	278



Type ABN without inner sleeve



Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type ABN 10 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange rim diameter	Flange thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
300	45	**.0300.045.0**	419857	419923	174	32.4	33.5	10	370	26
300	90	**.0300.090.0**	419858	419924	237	35.1	37.5	10	370	26
300	137	**.0300.137.0**	419859	419925	443	53.4	57.5	10	370	26
350	60	**.0350.060.0**	419882	419926	203	47.4	49.7	10	410	28
350	105	**.0350.105.0**	419883	419927	269	50.4	53.5	10	410	28
350	150	**.0350.150.0**	419884	419928	479	81.3	86.2	10	410	28
400	48	**.0400.048.0**	419885	419929	230	69.3	71.2	10	465	32
400	96	**.0400.096.0**	419886	419930	326	78.1	82.7	10	465	32
400	156	**.0400.156.0**	419887	419931	474	100	105.7	10	465	32
450	70	**.0450.070.0**	419888	419932	259	79	83	10	520	32
450	98	**.0450.098.0**	419889	419933	309	84.2	89	10	520	32
450	182	**.0450.182.0**	419890	419934	459	99.7	106.1	10	520	32
500	66	**.0500.066.0**	419891	419935	246	91.7	94.3	10	570	34
500	116	**.0500.116.0**	419892	419936	327	100.9	106.4	10	570	34
500	192	**.0500.192.0**	419893	419937	476	130.2	138.4	10	570	34
600	72	**.0600.072.0**	419894	419938	258	117.6	122.8	10	670	36
600	108	**.0600.108.0**	419895	419939	316	125.5	131.8	10	670	36
600	198	**.0600.198.0**	419896	419940	474	162.3	172	10	670	36
700	57	**.0700.057.0**	419897	419941	248	162.5	166.2	10	780	40
700	114	**.0700.114.0**	419898	419942	344	182.2	190.4	10	780	40
700	190	**.0700.190.0**	419899	419943	472	208.5	219.8	10	780	40

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints **Type ABN 10...**

with swivel lap-joint flanges

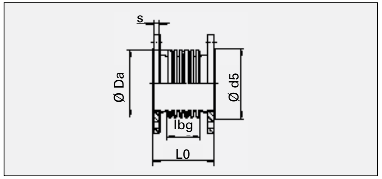
PN 10

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] for 1000 loading cycles angular[1]	Nominal movement absorption[1] for 1000 loading cycles lateral[1]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
372	63	935	15	2.7	292	76	13045
372	126	935	26	11	146	38	1631
374	330	940	30	44	240	63	391
403	88	1113	17	4.7	251	78	6864
403	154	1113	26	14	144	45	1282
412	360	1140	32	47	289	92	479
464	96	1466	12	3.6	730	297	21961
464	192	1466	22	14	365	149	2749
467	338	1476	31	41	291	119	708
518	125	1844	16	6	564	289	12620
518	175	1844	21	12	403	206	4599
518	325	1844	29	41	217	111	717
574	108	2273	14	4.4	625	395	23078
574	189	2273	21	13	357	225	4303
576	336	2282	30	40	282	179	1077
678	116	3222	12	4.3	649	581	29497
678	174	3222	17	9.8	433	388	8740
680	330	3232	27	34	318	286	1791
785	96	4353	8.6	2.4	1142	1381	102304
785	192	4353	16	9.8	571	690	12788
785	320	4353	23	27	343	415	2761

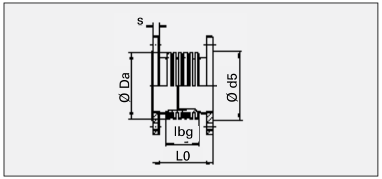
Axial expansion joints — Type ABN 16...

with swivel lap-joint flanges

PN 16



Type ABN without inner sleeve



Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type ABN 16 ...	Order No. standard version, without inner sleeve	Order No. standard version, with inner sleeve	Overall length	Weight approx., without inner sleeve	Weight approx., with inner sleeve	Flange, drilling EN 1092	Flange, rim diameter	Flange, thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
50	22	**.0050.022.0**	419944	419984	131	5.4	5.5	16	92	19
50	42	**.0050.042.0**	419945	419985	221	6.3	6.7	16	92	19
65	28	**.0065.028.0**	419946	419986	139	6.5	6.7	16	107	20
65	48	**.0065.048.0**	419947	419987	212	7.9	8.3	16	107	20
80	23	**.0080.023.0**	419948	419988	139	8	8.2	16	122	20
80	50	**.0080.050.0**	419949	419989	212	8.9	9.4	16	122	20
100	31	**.0100.031.0**	419950	419990	148	9.7	10	16	147	22
100	53	**.0100.053.0**	419951	419991	225	11.8	12.5	16	147	22
125	21	**.0125.021.0**	419952	419992	135	12.3	12.7	16	178	22
125	42	**.0125.042.0**	419953	419993	177	13	13.5	16	178	22
125	59	**.0125.059.0**	419954	419994	239	14.9	15.8	16	178	22
150	24	**.0150.024.0**	419955	419995	142	16.1	16.6	16	208	24
150	48	**.0150.048.0**	419956	419996	187	16.9	17.9	16	208	24
150	66	**.0150.066.0**	419957	419997	243	19.5	20.7	16	208	24
200	30	**.0200.030.0**	419958	419998	156	23	23.7	16	258	26
200	60	**.0200.060.0**	419959	419999	210	25.1	26.6	16	258	26
200	97	**.0200.097.0**	419960	420000	373	34.1	36.4	16	258	26
250	32	**.0250.032.0**	419961	420001	193	33.7	34.8	16	320	29
250	56	**.0250.056.0**	419962	420002	250	36	37.4	16	320	29
250	103	**.0250.103.0**	419963	420003	379	46.5	49.5	16	320	29

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

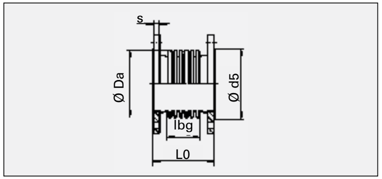
Bellows, outside diameter	Bellows, corrugated length	Bellows, effective cross-section	Nominal movement absorption[1] for 1000 loading cycles, angular[1]	Nominal movement absorption[1] for 1000 loading cycles, lateral[1]	Adjusting force rate, axial	Adjusting force rate, angular	Adjusting force rate, lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	54	46	29	5.2	146	1.9	430
91	143	47.2	41	25	153	2	66
108	60	69.4	28	5.7	126	2.4	457
110	132	70.9	40	22	136	2.7	103
122	60	89.9	23	4.3	278	6.9	1302
123	132	90.8	38	20	150	3.8	146
150	65	139	23	4.9	227	8.8	1400
152	140	141	36	18	196	7.7	264
172	42	185	15	1.9	350	18	6932
172	84	185	27	7.7	175	9	867
174	144	187	34	18	200	10	338
203	45	264	14	2	342	25	8455
203	90	264	25	7.8	171	13	1054
205	144	267	32	17	196	15	475
260	54	441	14	2.3	514	63	14678
260	108	441	26	9.1	257	31	1835
262	270	445	29	36	276	34	316
318	76	674	12	2.8	640	120	14135
318	133	674	18	8.5	366	69	2635
320	260	679	27	30	300	57	568

Axial expansion joints

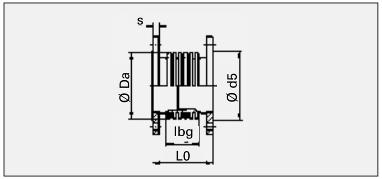
with swivel lap-joint flanges

Type ABN 16...

PN 16



Type ABN without inner sleeve



Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange		
		ABN 16 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
300	30	**.0300.030.0**	419964	420004	187	46.7	48	16	375	32
300	80	**.0300.080.0**	419965	420005	292	54.4	57.2	16	375	32
300	120	**.0300.120.0**	419966	420006	472	73	77.3	16	375	32
350	30	**.0350.030.0**	419967	420007	187	61	62.4	16	410	32
350	80	**.0350.080.0**	419968	420008	292	69.8	72.8	16	410	32
350	130	**.0350.130.0**	419969	420009	439	87.2	91.6	16	410	32
400	48	**.0400.048.0**	419970	420010	244	82.1	84.2	16	465	34
400	84	**.0400.084.0**	419971	420011	322	91.1	94.9	16	465	34
400	132	**.0400.132.0**	419972	420012	426	103.1	108.2	16	465	34
450	52	**.0450.052.0**	419974	420014	250	102.4	104.8	16	520	37
450	91	**.0450.091.0**	419975	420015	328	112.9	118.1	16	520	37
450	143	**.0450.143.0**	419976	420016	432	126.9	132.8	16	520	37
500	48	**.0500.048.0**	419977	420017	232	126.5	129	16	570	38
500	96	**.0500.096.0**	419978	420018	316	139.1	144.6	16	570	38
500	144	**.0500.144.0**	419979	420019	400	151.6	158.5	16	570	38

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints
with swivel lap-joint flanges
Type ABN 16...
PN 16

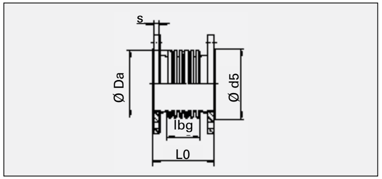
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
374	63	940	9.6	1.8	940	246	42077
374	168	940	21	13	352	92	2220
376	345	946	25	40	327	86	489
408	63	1128	8.8	1.7	920	288	49455
408	168	1128	19	12	345	108	2611
412	312	1140	26	35	334	106	736
467	104	1476	12	3.8	946	388	24342
467	182	1476	19	12	541	222	4544
467	286	1476	25	29	344	141	1172
520	104	1851	12	3.7	954	491	30826
520	182	1851	19	11	545	280	5753
520	286	1851	24	28	347	178	1483
576	84	2282	9.9	2.5	1128	715	68986
576	168	2282	18	10	564	357	8616
576	252	2282	24	22	376	238	2553

Axial expansion joints

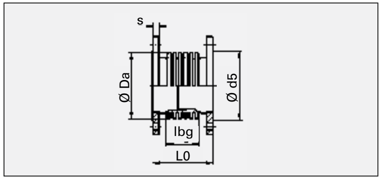
with swivel lap-joint flanges

Type ABN 25...

PN 25



Type ABN without inner sleeve



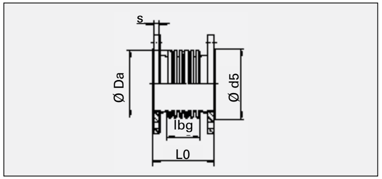
Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange		
		ABN 25 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	rim diameter	Blatt-dicke
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
50	13	**.0050.013.0**	420020	420071	120	5.7	5.8	40	92	20
50	29	**.0050.029.0**	420021	420072	179	6.3	6.5	40	92	20
65	17	**.0065.017.0**	420022	420073	128	7.3	7.5	40	107	22
65	40	**.0065.040.0**	420023	420073	218	8.8	9.1	40	107	22
80	23	**.0080.023.0**	420024	420075	148	9.2	9.5	40	122	24
80	42	**.0080.042.0**	420025	420076	219	10.7	11.1	40	122	24
100	23	**.0100.023.0**	420044	420077	140	12	12.3	40	147	24
100	48	**.0100.048.0**	420045	420078	215	13.9	14.5	40	147	24
125	26	**.0125.026.0**	420046	420079	167	17.6	18.1	40	178	26
125	52	**.0125.052.0**	420049	420080	231	19	19.8	40	178	26
150	29	**.0150.029.0**	420052	420081	171	22.1	22.7	40	208	28
150	58	**.0150.058.0**	420053	420082	235	23.9	25.1	40	208	28
200	26	**.0200.026.0**	420054	420083	186	33.1	34	25	258	32
200	46	**.0200.046.0**	420056	420098	240	35.3	36.4	25	258	32
200	71	**.0200.071.0**	420057	420099	313	39.8	41.7	25	258	32
250	24	**.0250.024.0**	420058	420100	191	46.5	47.6	25	320	35
250	48	**.0250.048.0**	420059	420101	251	50	51.5	25	320	35
250	80	**.0250.080.0**	420061	420102	331	54.8	57.4	25	320	35
300	27	**.0300.027.0**	420062	420103	203	61.4	62.8	25	375	38
300	55	**.0300.055.0**	420063	420104	269	66	67.8	25	375	38
300	82	**.0300.082.0**	420064	420107	335	70.6	73.6	25	375	38

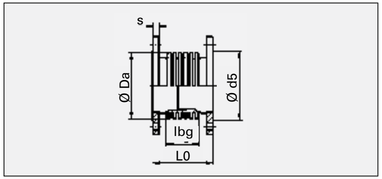
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints
with swivel lap-joint flanges
Type ABN 25...
PN 25

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
90	40	46,6	18	2.3	401	5.2	2173
91	99	47.2	31	12	221	2.9	198
109	44	70.1	18	2.5	340	6.6	2311
111	132	71.6	33	18	218	4.3	166
123	60	90.8	21	4.1	329	8.3	1555
125	130	92.5	32	17	222	5.7	227
151	52	140	18	3	340	13	3302
152	126	141	30	15	218	8.5	361
174	64	187	18	3.6	450	23	3864
174	128	187	29	14	225	12	483
205	64	267	17	3.4	440	33	5410
205	128	267	27	13	220	16	676
261	72	443	12	2.6	855	105	13759
261	126	443	18	8	489	60	2569
262	198	445	23	19	376	46	802
320	60	679	8.7	1.6	1298	245	46135
320	120	679	16	6.4	649	122	5762
320	200	679	21	18	390	74	1245
374	66	940	8.6	1.7	1200	313	48892
374	132	940	15	6.9	600	157	6112
374	198	940	19	16	400	104	1809



Type ABN without inner sleeve



Type ABN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange		
		ABN 25 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	d5	s
–	mm	–	–	–	mm	kg	kg	–	mm	mm
350	30	**.0350.030.0**	420065	420108	219	95.3	97	25	410	42
350	50	**.0350.050.0**	420066	420109	267	100.1	102.1	25	410	42
350	80	**.0350.080.0**	420067	420110	339	107.4	110.8	25	410	42
400	32	**.0400.032.0**	420068	420111	256	119.1	121.4	25	465	42
400	56	**.0400.056.0**	420069	420112	331	128.5	131.4	25	465	42
400	96	**.0400.096.0**	420070	420113	482	152.9	158.3	25	465	42

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints

Type ABN 25...

with swivel lap-joint flanges

PN 25

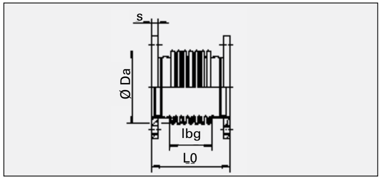
Bellows			Nominal movement absorption[1)] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1)]	lateral[1)]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
412	72	1140	8.8	1.9	1445	458	59854
412	120	1140	14	5.2	867	275	12928
412	192	1140	19	13	542	172	3154
466	100	1473	8.1	2.5	1934	791	53659
466	175	1473	13	7.5	1105	452	10010
469	324	1483	18	24	700	288	1859

Axial expansion joints

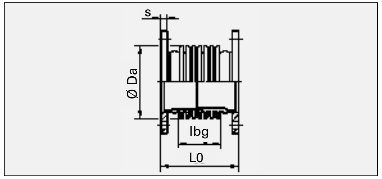
with plain fixed flanges

Type AFN 02...

PN 2.5



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
50	20	**.0050.020.0**	421681	421833	129	3	3.2	6	16
50	40	**.0050.040.0**	421682	421834	174	3.2	3.4	6	16
50	70	**.0050.070.0**	421683	421835	255	3.7	4.1	6	16
65	23	**.0065.023.0**	421684	421836	129	3.9	4.1	6	16
65	60	**.0065.060.0**	421685	421837	201	4.2	4.6	6	16
65	87	**.0065.087.0**	421686	421838	274	4.9	5.4	6	16
80	27	**.0080.027.0**	421687	421839	136	5.9	6.1	6	18
80	64	**.0080.064.0**	421688	421840	206	6.3	6.7	6	18
80	92	**.0080.092.0**	421689	421841	284	7	7.6	6	18
100	46	**.0100.046.0**	421690	421842	163	7	7.4	6	18
100	73	**.0100.073.0**	421691	421843	207	7.3	7.9	6	18
100	98	**.0100.098.0**	421692	421844	294	9.3	10.1	6	18
125	45	**.0125.045.0**	421693	421845	163	9.4	10	6	20
125	81	**.0125.081.0**	421694	421846	215	9.8	10.6	6	20
125	140	**.0125.140.0**	421695	421847	378	13.4	14.8	6	20
150	45	**.0150.045.0**	421696	421848	163	10.4	11.1	6	20
150	81	**.0150.081.0**	421697	421849	215	10.8	11.8	6	20
150	160	**.0150.160.0**	421698	421850	398	16	18	6	20
200	60	**.0200.060.0**	421699	421851	190	10.8	11.8	6	20
200	110	**.0200.110.0**	421700	421852	276	12.6	14.2	6	20
200	190	**.0200.190.0**	421701	421853	423	22	25	6	22

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints

with plain fixed flanges

Type AFN 02...

PN 2.5

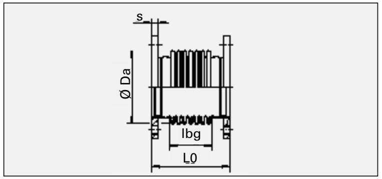
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	45	46	29	3.9	105	1.3	451
89	90	46	50	16	52	0.7	56
89	171	46	50	52	46	0.6	14
107	45	68.7	28	3.7	102	1.9	654
107	117	68.7	50	25	39	0.7	37
108	190	69.4	50	59	40	0.8	14
121	50	89.1	27	4.1	94	2.3	640
121	120	89.1	50	24	39	1	46
121	198	89.1	50	56	43	1.1	18
148	77	137	38	8.9	63	2.4	273
148	121	137	50	22	40	1.5	71
150	208	139	50	51	71	2.7	43
174	65	187	32	6.3	58	3	492
174	117	187	50	20	32	1.7	84
172	280	185	50	85	53	2.7	23
203	65	264	27	5.3	68	5	801
203	117	264	46	17	38	2.8	137
203	300	264	50	87	51	3.7	29
255	90	432	28	7.7	62	7.4	631
256	176	434	47	27	50	6	134
257	323	436	50	87	51	6.2	41

Axial expansion joints

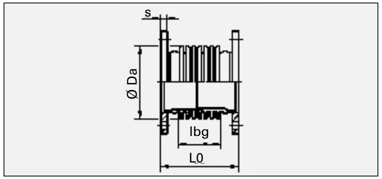
Type AFN 02...

with plain fixed flanges

PN 2.5



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
250	72	**.0250.072.0**	421702	421854	214	16	17	6	22
250	120	**.0250.120.0**	421703	421855	282	18	20	6	22
250	204	**.0250.204.0**	421704	421856	418	29	32	6	24
300	56	**.0300.056.0**	421705	421857	188	26	28	6	24
300	126	**.0300.126.0**	421706	421858	283	27	30	6	24
300	210	**.0300.210.0**	421707	421859	392	36	39	6	24
350	60	**.0350.060.0**	421708	421860	194	37	38	6	26
350	120	**.0350.120.0**	421709	421861	274	39	42	6	26
350	210	**.0350.210.0**	421710	421863	408	47	51	6	26
400	65	**.0400.065.0**	421711	421864	229	43	45	6	26
400	104	**.0400.104.0**	421712	421865	292	45	48	6	26
400	182	**.0400.182.0**	421713	421866	418	49	54	6	26
450	56	**.0450.056.0**	421714	421867	212	48	51	6	26
450	112	**.0450.112.0**	421715	421868	300	52	56	6	26
450	182	**.0450.182.0**	421716	421869	410	56	61	6	26
500	68	**.0500.068.0**	421717	421870	216	53	56	6	26
500	119	**.0500.119.0**	421718	421871	285	56	61	6	26
500	204	**.0500.204.0**	421719	421872	400	61	69	6	26
600	76	**.0600.076.0**	421720	421873	224	70	74	6	28
600	114	**.0600.114.0**	421721	421874	276	73	78	6	28
600	209	**.0600.209.0**	421722	421875	406	79	89	6	28

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints

Type AFN 02...

with plain fixed flanges

PN 2.5

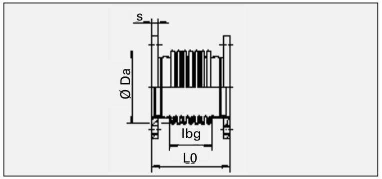
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
312	102	661	27	8.4	62	11	752
315	170	667	42	23	48	8.9	212
316	306	670	50	71	50	9.3	67
365	76	916	18	4.2	91	23	2756
365	171	916	36	21	40	10	239
371	280	932	50	57	52	13	118
400	80	1104	18	4.3	82	25	2703
402	160	1110	33	17	58	18	480
402	294	1110	50	55	60	19	147
458	105	1445	17	5.3	212	85	5283
458	168	1445	26	14	132	53	1291
458	294	1445	38	42	76	31	240
513	88	1825	13	3.4	243	123	10935
513	176	1825	24	14	122	62	1361
513	286	1825	34	36	75	38	320
569	92	2252	14	3.9	215	135	10875
569	161	2252	24	12	123	77	2025
569	276	2252	35	35	72	45	401
674	104	3202	13	4.1	215	191	12099
674	156	3202	19	9.3	143	127	3593
674	286	3202	30	31	78	69	583

Axial expansion joints **Type AFN 02...**

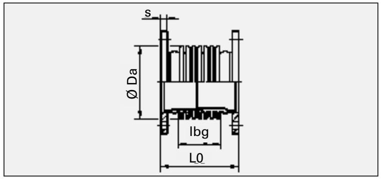
with plain fixed flanges

PN 2.5

Axial expansion joints Type AFN 02...
with plain fixed flanges
PN 2.5



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
700	80	**.0700.080.0**	421723	421876	240	94	101	6	32
700	120	**.0700.120.0**	421724	421877	296	97	103	6	32
700	220	**.0700.220.0**	421725	421878	436	105	117	6	32
800	63	**.0800.063.0**	421727	421879	227	120	128	6	34
800	126	**.0800.126.0**	421728	421880	314	126	137	6	34
800	210	**.0800.210.0**	421729	421881	430	133	146	6	34
900	63	**.0900.063.0**	421730	421882	232	130	138	6	35
900	126	**.0900.126.0**	421731	421883	322	137	149	6	35
900	210	**.0900.210.0**	421732	421884	442	145	163	6	35
1000	72	**.1000.072.0**	421733	421885	252	148	159	6	37
1000	120	**.1000.120.0**	421734	421886	316	153	167	6	37
1000	240	**.1000.240.0**	421735	421887	476	165	184	6	37
1200	72	**.1200.072.0**	421736	421888	266	204	222	2	40
1200	120	**.1200.120.0**	421737	421889	330	213	236	2	40
1200	216	**.1200.216.0**	421738	421890	458	231	258	2	40
1400	48	**.1400.048.0**	421739	421891	178	245	255	2	42
1400	108	**.1400.108.0**	421740	421892	308	257	275	2	42
1400	180	**.1400.180.0**	421741	421893	464	272	310	2	42
1600	48	**.1600.048.0**	421742	421894	186	333	344	2	46
1600	108	**.1600.108.0**	421743	421895	316	347	367	2	46
1600	180	**.1600.180.0**	421744	421896	472	364	409	2	46

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

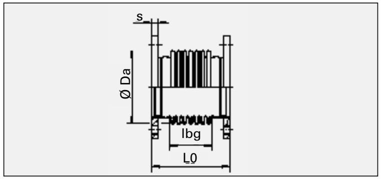
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
780	112	4324	12	4	203	244	13365
780	168	4324	17	9.1	135	162	3950
780	308	4324	27	30	74	89	644
882	87	5588	8.4	2.2	294	456	41313
882	174	5588	16	8.7	147	228	5182
882	290	5588	23	24	88	137	1117
992	90	7133	7.4	2	317	628	53147
992	180	7133	14	7.9	158	313	6643
992	300	7133	21	22	95	188	1438
1095	96	8750	7.7	2.2	335	814	60745
1095	160	8750	12	6.1	201	489	13121
1095	320	8750	21	24	101	245	1632
1295	96	12331	6.5	1.8	511	1750	130579
1295	160	12331	11	5.1	307	1052	28150
1295	288	12331	18	17	170	582	4827
1470	104	16016	3.8	1.2	922	4053	257632
1470	234	16016	8.2	5.9	410	1802	22624
1470	390	16016	12	16	246	1081	4887
1670	104	20816	3.3	1	1046	5990	380429
1670	234	20816	7.2	5.2	465	2660	33398
1670	390	20816	11	14	279	1596	7214

Axial expansion joints

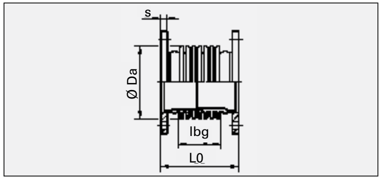
Type AFN 02...

with plain fixed flanges

PN 2.5



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
1800	48	**.1800.048.0**	421752	421897	194	404	416	2	50
1800	108	**.1800.108.0**	421753	421898	324	420	442	2	50
1800	180	**.1800.180.0**	421754	421899	480	439	489	2	50
2000	48	**.2000.048.0**	421755	421900	198	465	477	2	52
2000	108	**.2000.108.0**	421757	421901	328	482	506	2	52
2000	180	**.2000.180.0**	421759	421902	484	503	558	2	52

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints

Type AFN 02...

with plain fixed flanges

PN 2.5

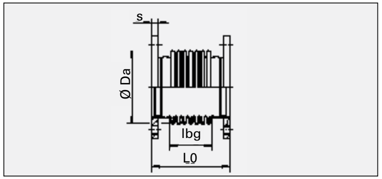
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
1870	104	26245	3	0.9	1170	8449	536643
1870	234	26245	6.4	4.6	520	3754	47143
1870	390	26245	9.9	13	312	2253	10183
2070	104	32302	2.7	0.8	1292	11503	730650
2070	234	32302	5.9	4.2	574	5114	64107
2070	390	32302	9.1	12	345	3069	13872

Axial expansion joints

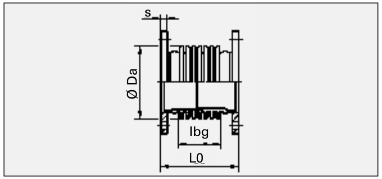
with plain fixed flanges

Type AFN 06...

PN 6



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFN 06 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
50	20	**.0050.020.0**	421903	421960	129	3	3.2	6	16
50	52	**.0050.052.0**	421904	421961	210	3.5	3.7	6	16
65	23	**.0065.023.0**	421905	421962	129	3.9	4.1	6	16
65	41	**.0065.041.0**	421906	421963	165	4	4.2	6	16
65	72	**.0065.072.0**	421907	421964	282	5.9	6.4	6	16
80	27	**.0080.027.0**	421908	421965	136	5.9	6.1	6	18
80	42	**.0080.042.0**	421909	421966	166	6.1	6.5	6	18
80	77	**.0080.077.0**	421910	421967	290	8.4	9	6	18
100	33	**.0100.033.0**	421911	421968	141	6.9	7.3	6	18
100	59	**.0100.059.0**	421912	421969	194	7.5	8.1	6	18
100	87	**.0100.087.0**	421913	421970	281	9.7	10.5	6	18
125	36	**.0125.036.0**	421914	421971	150	9.3	9.8	6	20
125	63	**.0125.063.0**	421915	421972	189	9.6	10.3	6	20
125	98	**.0125.098.0**	421916	421973	308	12.8	13.9	6	20
150	40	**.0150.040.0**	421917	422009	168	10.7	11.4	6	20
150	72	**.0150.072.0**	421918	422010	233	12.6	13.6	6	20
150	124	**.0150.124.0**	421919	422011	370	18	19	6	20
200	40	**.0200.040.0**	421920	422012	164	15	16	6	22
200	80	**.0200.080.0**	421921	422013	236	18	19	6	22
200	140	**.0200.140.0**	421922	422014	352	24	26	6	22

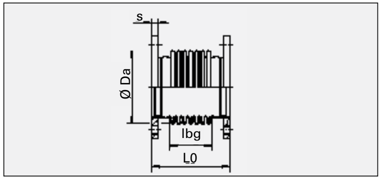
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	45	46	28	3.9	105	1.3	451
89	126	46	50	28	62	0.8	34
107	45	68.7	27	3.7	102	1.9	654
107	81	68.7	41	12	56	1.1	112
110	198	70.9	50	50	91	1.8	30
121	50	89.1	26	4.1	94	2.3	640
121	80	89.1	38	11	59	1.5	154
123	204	90.8	50	48	97	2.4	40
148	55	137	27	4.6	88	3.3	752
149	108	138	43	16	71	2.7	160
151	195	140	50	42	91	3.5	63
174	52	187	25	4	72	3.7	953
174	91	187	39	12	41	2.1	177
173	210	186	50	45	89	4.6	71
202	70	263	23	5.1	117	8.5	1189
203	135	264	39	18	114	8.4	313
205	272	267	50	61	104	7.7	70
256	64	434	19	3.6	138	17	2791
257	136	436	34	15	121	15	540
260	252	441	50	50	110	13	145

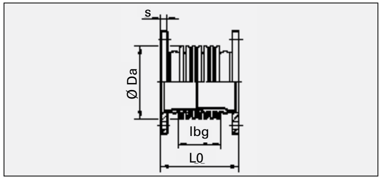
Axial expansion joints **Type AFN 06...**

with plain fixed flanges

PN 6



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type AFN 06 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
250	48	**.0250.048.0**	421923	422015	184	21	22	6	24
250	84	**.0250.084.0**	421924	422016	238	23	25	6	24
250	144	**.0250.144.0**	421925	422017	352	30	33	6	24
300	60	**.0300.060.0**	421926	422018	192	28	30	6	24
300	90	**.0300.090.0**	421927	422019	232	30	32	6	24
300	135	**.0300.135.0**	421928	422020	310	37	39	6	24
350	45	**.0350.045.0**	421929	422022	177	38	39	6	26
350	105	**.0350.105.0**	421930	422023	261	41	44	6	26
350	165	**.0350.165.0**	421931	422024	367	50	54	6	26
400	52	**.0400.052.0**	421932	422025	212	39	41	6	28
400	104	**.0400.104.0**	421933	422026	300	43	47	6	28
400	169	**.0400.169.0**	421934	422027	419	61	66	6	28
450	56	**.0450.056.0**	421935	422029	212	53	56	6	28
450	98	**.0450.098.0**	421936	422030	281	57	61	6	28
450	182	**.0450.182.0**	421937	422031	432	71	76	6	28
500	66	**.0500.066.0**	421938	422033	220	57	62	6	28
500	116	**.0500.116.0**	421939	422034	295	63	70	6	28
500	198	**.0500.198.0**	421941	422036	444	90	100	6	28
600	76	**.0600.076.0**	421942	422037	232	62	68	6	32
600	114	**.0600.114.0**	421943	422038	288	68	75	6	32
600	198	**.0600.198.0**	421944	422039	447	117	129	6	32

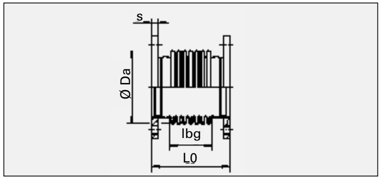
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints **Type AFN 06...**

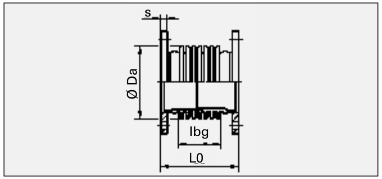
with plain fixed flanges

PN 6

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] for 1000 loading cycles angular[1]	Nominal movement absorption[1] for 1000 loading cycles lateral[1]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
316	72	670	18	3,9	211	39	5156
316	126	670	29	12	120	22	967
319	240	677	45	39	110	21	245
371	80	932	19	4.6	183	47	5062
371	120	932	27	10	122	32	1496
374	198	940	39	26	128	33	582
402	63	1110	13	2.5	282	87	15014
402	147	1110	28	14	121	37	1178
405	253	1119	40	37	120	37	397
461	88	1456	13	3.5	361	146	12887
461	176	1456	23	14	180	73	1606
462	299	1459	32	39	148	60	461
514	92	1828	13	3.6	366	186	15018
514	161	1828	20	11	209	106	2802
515	312	1832	30	39	150	76	539
572	100	2265	14	4.1	414	260	17778
572	175	2265	22	12	236	148	3319
574	324	2273	33	40	208	131	856
677	112	3217	13	4.4	414	370	20180
677	168	3217	19	10	276	247	5986
678	319	3222	28	33	236	211	1421



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type AFN 06 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
700	60	**.0700.060.0**	421945	422040	220	107	113	6	36
700	120	**.0700.120.0**	421946	422041	304	116	125	6	36
700	200	**.0700.200.0**	421947	422042	436	145	159	6	36
800	63	**.0800.063.0**	421948	422044	245	116	123	6	37
800	105	**.0800.105.0**	421949	422046	311	127	137	6	37
800	210	**.0800.210.0**	421950	422047	476	156	173	6	37
900	63	**.0900.063.0**	421951	422048	245	144	153	6	38
900	105	**.0900.105.0**	421952	422049	311	158	169	6	38
900	210	**.0900.210.0**	421953	422050	476	191	210	6	38
1000	66	**.1000.066.0**	421954	422051	271	183	194	6	42
1000	110	**.1000.110.0**	421955	422053	341	198	212	6	42
1000	198	**.1000.198.0**	421956	422054	481	228	249	6	42
1200	69	**.1200.069.0**	421957	422055	289	293	311	6	47
1200	115	**.1200.115.0**	421958	422056	359	311	336	6	47
1200	207	**.1200.207.0**	421959	422057	499	347	382	6	47

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints Type AFN 06...
with plain fixed flanges
PN 6

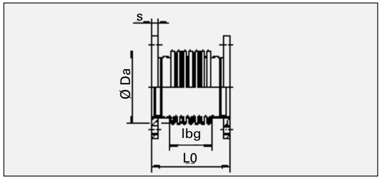
Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] for 1000 loading cycles angular[1)]	Nominal movement absorption lateral[1)]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
780	84	4324	9.1	2.3	585	703	68235
780	168	4324	17	9.1	293	352	8544
783	300	4342	25	27	255	308	2331
887	99	5621	8.4	2.5	856	1337	93326
887	165	5621	14	6.8	514	803	20150
887	330	5621	23	27	257	401	2524
996	99	7163	7.4	2.2	953	1896	132463
996	165	7163	12	6	572	1138	28592
996	330	7163	20	24	286	569	3580
1100	105	8791	7	2.2	974	2379	147726
1100	175	8791	11	6.1	584	1426	31909
1100	315	8791	18	20	325	794	5466
1296	105	12341	6.2	1.9	1092	3743	232590
1296	175	12341	10	5.4	655	2245	50255
1296	315	12341	16	17	364	1248	8622

Axial expansion joints

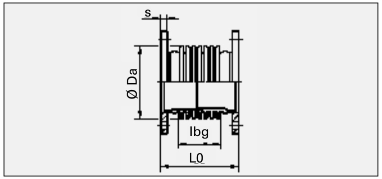
Type AFN 10...

with plain fixed flanges

PN 10



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type AFN 10 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
50	24	**.0050.024.0**	422058	422104	141	5.2	5.4	16	19
50	46	**.0050.046.0**	422059	422105	227	6	6.3	16	19
65	18	**.0065.018.0**	422060	422106	124	6.2	6.4	16	20
65	48	**.0065.048.0**	422061	422107	220	7.7	8.1	16	20
80	20	**.0080.020.0**	422062	422108	132	7.4	7.6	16	20
80	41	**.0080.041.0**	422063	422109	176	7.7	8.1	16	20
80	54	**.0080.054.0**	422064	422110	232	8.9	9.3	16	20
100	26	**.0100.026.0**	422065	422111	138	9	9.4	16	22
100	46	**.0100.046.0**	422066	422112	174	9.3	9.7	16	22
100	80	**.0100.080.0**	422067	422113	300	12.9	13.7	16	22
125	30	**.0125.030.0**	422068	422115	156	11.8	12.3	16	22
125	45	**.0125.045.0**	422069	422116	184	12	12.6	16	22
125	85	**.0125.085.0**	422070	422117	308	16	17	16	22
150	32	**.0150.032.0**	422071	422118	162	16	17	16	24
150	64	**.0150.064.0**	422072	422119	222	17	18	16	24
150	95	**.0150.095.0**	422073	422120	310	21	22	16	24
200	40	**.0200.040.0**	422074	422121	170	21	22	10	24
200	80	**.0200.080.0**	422075	422122	238	23	24	10	24
200	110	**.0200.110.0**	422076	422123	300	27	29	10	24
250	48	**.0250.048.0**	422077	422124	186	27	28	10	26
250	84	**.0250.084.0**	422078	422125	240	29	31	10	26
250	130	**.0250.130.0**	422079	422126	418	41	44	10	26

[1)] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints

Type AFN 10...

with plain fixed flanges

PN 10

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] for 1000 loading cycles angular[1)]	Nominal movement absorption[1)] for 1000 loading cycles lateral[1)]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	54	46	31	5.6	87	1.1	259
90	140	46.6	50	28	115	1.5	51
107	36	68.7	21	2.3	127	2.4	1275
110	132	70.9	47	22	136	2.7	103
121	44	89.1	20	2.8	192	4.8	1670
121	88	89.1	35	11	96	2.4	209
123	144	90.8	45	24	137	3.5	113
149	48	138	21	3.1	161	6.2	1817
149	84	138	33	9.7	92	3.5	340
152	210	141	48	41	131	5.1	78
171	56	184	21	3.7	148	7.6	1646
171	84	184	29	8.2	99	5.1	488
174	208	187	46	38	138	7.2	113
203	60	264	19	3.5	257	19	3564
203	120	264	33	14	128	9.4	445
205	208	267	43	35	136	10	157
257	68	436	19	3.8	242	29	4318
257	136	436	31	15	121	15	540
260	198	441	41	31	140	17	297
316	72	670	18	3.9	211	39	5156
316	126	670	27	12	120	22	967
319	304	677	31	45	201	38	278

Axial expansion joints
with plain fixed flanges

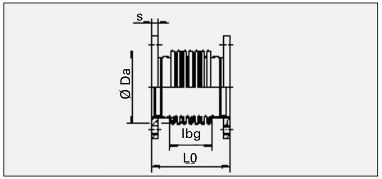
Type AFN 10...

PN 10

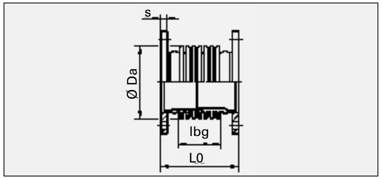
Axial expansion joints
with plain fixed flanges

Type AFN 10...

PN 10



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFN 10 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
300	45	**.0300.045.0**	422080	422127	177	31	33	10	26
300	90	**.0300.090.0**	422081	422128	240	34	36	10	26
300	137	**.0300.137.0**	422082	424785	444	52	56	10	26
350	60	**.0350.060.0**	422083	422130	199	46	48	10	28
350	105	**.0350.105.0**	422084	422131	265	49	52	10	28
350	150	**.0350.150.0**	422085	422132	471	79	83	10	28
400	48	**.0400.048.0**	422086	422133	224	51	53	10	32
400	96	**.0400.096.0**	422087	422134	320	60	63	10	32
400	156	**.0400.156.0**	422088	422135	466	96	102	10	32
450	70	**.0450.070.0**	422090	422136	253	70	73	10	32
450	98	**.0450.098.0**	422091	422137	303	75	79	10	32
450	182	**.0450.182.0**	422092	422138	453	96	102	10	32
500	66	**.0500.066.0**	422093	422139	240	88	93	10	34
500	116	**.0500.116.0**	422094	422140	321	97	104	10	34
500	192	**.0500.192.0**	422095	422141	468	125	135	10	34
600	72	**.0600.072.0**	422096	422142	252	113	119	10	36
600	108	**.0600.108.0**	422098	422143	310	121	129	10	36
600	198	**.0600.198.0**	422099	422144	466	157	169	10	36
700	57	**.0700.057.0**	422100	422145	240	119	125	10	40
700	114	**.0700.114.0**	422101	422146	336	138	148	10	40
700	190	**.0700.190.0**	422103	422147	464	201	215	10	40

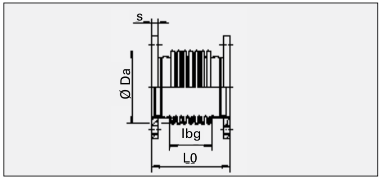
1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1)] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1)]	lateral[1)]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
372	63	935	15	2.7	292	76	13045
372	126	935	26	11	146	38	1631
374	330	940	30	44	240	63	391
403	88	1113	17	4.7	251	78	6864
403	154	1113	26	14	144	45	1282
412	360	1140	32	47	289	92	479
464	96	1466	12	3.6	730	297	21961
464	192	1466	22	14	365	149	2749
467	338	1476	31	41	291	119	708
518	125	1844	16	6	564	289	12620
518	175	1844	21	12	403	206	4599
518	325	1844	29	41	217	111	717
574	108	2273	14	4.4	625	395	23078
574	189	2273	21	13	357	225	4303
576	336	2282	30	40	282	179	1077
678	116	3222	12	4.3	649	581	29497
678	174	3222	17	9.8	433	388	8740
680	330	3232	27	34	318	286	1791
785	96	4353	8.6	2.4	1142	1381	102304
785	192	4353	16	9.8	571	690	12788
785	320	4353	23	27	343	415	2761

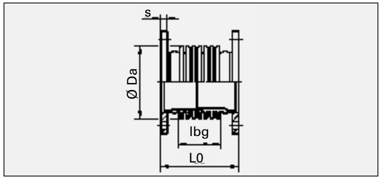
Axial-Expansion joints — Type AFN 16...

with plain fixed flanges

PN 16



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type AFN 16 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
50	22	**.0050.022.0**	422148	422183	141	5.4	5.6	16	19
50	42	**.0050.042.0**	422149	422184	230	6.2	6.5	16	19
65	28	**.0065.028.0**	422150	422185	148	6.5	6.7	16	20
65	48	**.0065.048.0**	422151	422186	220	7.7	8.1	16	20
80	23	**.0080.023.0**	422152	422187	148	7.8	8	16	20
80	50	**.0080.050.0**	422153	422188	220	8.7	9.1	16	20
100	31	**.0100.031.0**	422154	422189	155	9.6	10	16	22
100	53	**.0100.053.0**	422155	422190	230	11.5	12.1	16	22
125	21	**.0125.021.0**	422156	422191	142	12.1	12.5	16	22
125	42	**.0125.042.0**	422157	422192	184	12.7	13.3	16	22
125	59	**.0125.059.0**	422158	422193	244	14.5	15	16	22
150	24	**.0150.024.0**	422159	422194	147	16	16	16	24
150	48	**.0150.048.0**	422160	422195	192	17	17	16	24
150	66	**.0150.066.0**	422161	422196	246	19	20	16	24
200	30	**.0200.030.0**	422162	422197	158	22	23	16	26
200	60	**.0200.060.0**	422163	422198	212	24	26	16	26
200	97	**.0200.097.0**	422164	422199	374	33	35	16	26
250	32	**.0250.032.0**	422165	422200	189	33	34	16	29
250	56	**.0250.056.0**	422166	422202	246	35	37	16	29
250	103	**.0250.103.0**	422167	422203	373	45	48	16	29

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial-Expansion joints — Type AFN 16...

with plain fixed flanges

PN 16

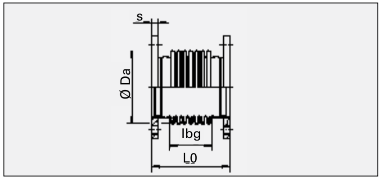
Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] for 1000 loading cycles angular[1)]	Nominal movement absorption[1)] for 1000 loading cycles lateral[1)]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	54	46	29	5.2	146	1.9	430
91	143	47.2	41	25	153	2	66
108	60	69.4	28	5.7	126	2.4	457
110	132	70.9	40	22	136	2.7	103
122	60	89.9	23	4.3	278	6.9	1302
123	132	90.8	38	20	150	3.8	146
150	65	139	23	4.9	227	8.8	1400
152	140	141	36	18	196	7.7	264
172	42	185	15	1.9	350	18	6932
172	84	185	27	7.7	175	9	867
174	144	187	34	18	200	10	338
203	45	264	14	2	342	25	8455
203	90	264	25	7.8	171	13	1054
205	144	267	32	17	196	15	475
260	54	441	14	2.3	514	63	14678
260	108	441	26	9.1	257	31	1835
262	270	445	29	36	276	34	316
318	76	674	12	2.8	640	120	14135
318	133	674	18	8.5	366	69	2635
320	260	679	27	30	300	57	568

Axial expansion joints
with plain fixed flanges

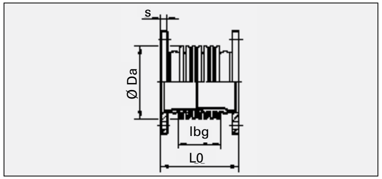
Type AFN 16...

PN 16

Axial expansion joints
with plain fixed flanges
Type AFN 16...
PN 16



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFN 16 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
300	30	**.0300.030.0**	422168	422204	182	45	46	16	32
300	80	**.0300.080.0**	422169	422205	287	52	55	16	32
300	120	**.0300.120.0**	422170	422206	464	70	74	16	32
350	30	**.0350.030.0**	422171	422207	182	59	60	16	32
350	80	**.0350.080.0**	422172	422208	287	67	70	16	32
350	130	**.0350.130.0**	422173	422209	431	84	88	16	32
400	48	**.0400.048.0**	422174	422210	236	78	81	16	34
400	84	**.0400.084.0**	422175	422211	314	87	91	16	34
400	132	**.0400.132.0**	422176	422212	418	99	104	16	34
450	52	**.0450.052.0**	422177	422213	242	98	100	16	37
450	91	**.0450.091.0**	422178	422214	320	108	112	16	37
450	143	**.0450.143.0**	422179	422215	424	122	127	16	37
500	48	**.0500.048.0**	422180	422216	224	121	125	16	38
500	96	**.0500.096.0**	422181	422217	308	134	140	16	38
500	144	**.0500.144.0**	422182	422218	392	146	154	16	38

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

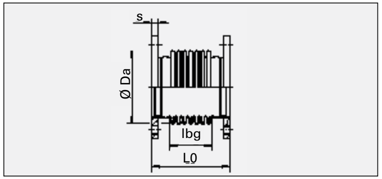
Bellows			Nominal movement absorption[1)] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1)]	lateral[1)]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
374	63	940	9.6	1.8	940	246	42077
374	168	940	21	13	352	92	2220
376	345	946	25	40	327	86	489
408	63	1128	8.8	1.7	920	288	49455
408	168	1128	19	12	345	108	2611
412	312	1140	26	35	334	106	736
467	104	1476	12	3.8	946	388	24342
467	182	1476	19	12	541	222	4544
467	286	1476	25	29	344	141	1172
520	104	1851	12	3.7	954	491	30826
520	182	1851	19	11	545	280	5753
520	286	1851	24	28	347	178	1483
576	84	2282	9.9	2.5	1128	715	68986
576	168	2282	18	10	564	357	8616
576	252	2282	24	22	376	238	2553

Axial expansion joints

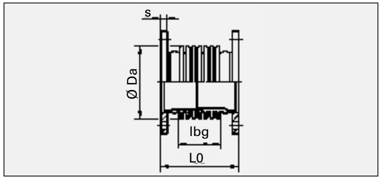
with plain fixed flanges

Type AFN 25...

PN 25



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Flange	
		AFN 25 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	drilling EN 1092	thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
50	13	**.0050.013.0**	422219	422248	128	5.7	5.9	40	20
50	29	**.0050.029.0**	422220	422249	187	6.2	6.4	40	20
65	17	**.0065.017.0**	422221	422250	134	7.2	7.4	40	22
65	40	**.0065.040.0**	422222	422251	222	8.6	9	40	22
80	23	**.0080.023.0**	422223	422252	152	9	9.2	40	24
80	42	**.0080.042.0**	422224	422253	222	10.5	10.9	40	24
100	23	**.0100.023.0**	422225	422254	144	11.8	12.2	40	24
100	48	**.0100.048.0**	422227	422255	218	13.6	14.2	40	24
125	26	**.0125.026.0**	422228	422256	168	17	18	40	26
125	52	**.0125.052.0**	422230	422257	232	19	19	40	26
150	29	**.0150.029.0**	422231	422258	166	21	22	40	28
150	58	**.0150.058.0**	422232	422259	230	23	24	40	28
200	26	**.0200.026.0**	422233	422260	181	32	33	25	32
200	46	**.0200.046.0**	422234	422261	235	34	36	25	32
200	71	**.0200.071.0**	422235	422262	307	39	40	25	32
250	24	**.0250.024.0**	422236	422263	185	45	46	25	35
250	48	**.0250.048.0**	422237	422264	245	48	50	25	35
250	79	**.0250.079.0**	422238	422265	325	53	55	25	35

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints

with plain fixed flanges

Type AFN 25...

PN 25

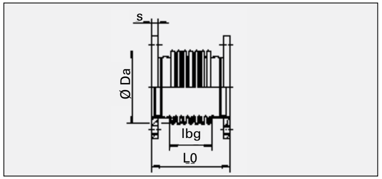
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
90	40	46.6	18	2.3	401	5.2	2173
91	99	47.2	31	12	221	2.9	198
109	44	70.1	18	2.5	340	6.6	2311
111	132	71.6	33	18	218	4.3	166
123	60	90.8	21	4.1	329	8.3	1555
125	130	92.5	32	17	222	5.7	227
151	52	140	18	3	340	13	3302
152	126	141	30	15	218	8.5	361
174	64	187	18	3.6	450	23	3864
174	128	187	29	14	225	12	483
205	64	267	17	3.4	440	33	5410
205	128	267	27	13	220	16	676
261	72	443	12	2.6	855	105	13759
261	126	443	18	8	489	60	2569
262	198	445	23	19	376	46	802
320	60	679	8.7	1.6	1298	245	46135
320	120	679	16	6.4	649	122	5762
320	200	679	21	18	390	74	1245

Axial expansion joints

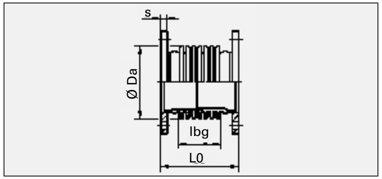
with plain fixed flanges

Type AFN 25...

PN 25



Type AFN without inner sleeve



Type AFN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type AFN 25 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Flange drilling EN 1092	Flange thick-ness
DN	$2\delta_N$	–	–	–	Lo	G	G	PN	s
–	mm	–	–	–	mm	kg	kg	–	mm
300	27	**.0300.027.0**	422239	422266	197	59	61	25	38
300	55	**.0300.055.0**	422240	422267	263	64	66	25	38
300	82	**.0300.082.0**	422241	422268	329	68	71	25	38
350	30	**.0350.030.0**	422242	422269	211	92	93	25	42
350	50	**.0350.050.0**	422243	422270	259	96	99	25	42
350	80	**.0350.080.0**	422244	422271	331	104	106	25	42
400	32	**.0400.032.0**	422245	422272	248	114	117	25	42
400	56	**.0400.056.0**	422246	422273	323	124	127	25	42
400	96	**.0400.096.0**	422247	422274	472	147	152	25	42

[1)] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

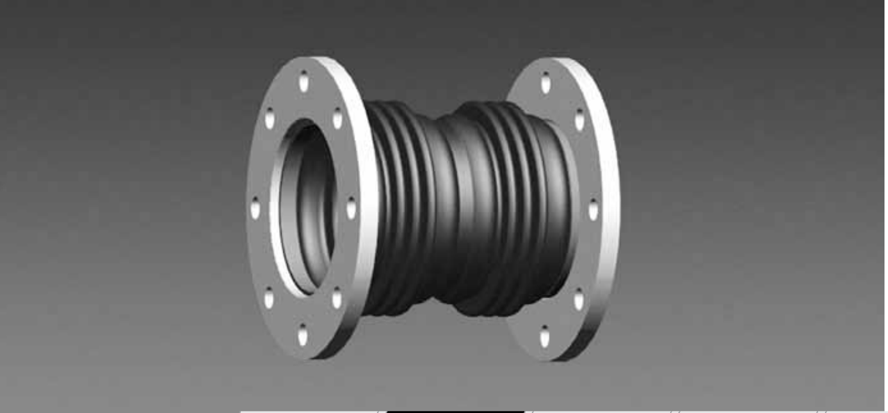
Axial expansion joints

with plain fixed flanges

Type AFN 25...

PN 25

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] for 1000 loading cycles angular[1)]	Nominal movement absorption[1)] for 1000 loading cycles lateral[1)]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm²	degrees	mm	N/mm	Nm/degrees	N/mm
374	66	940	8.6	1.7	1200	313	48892
374	132	940	15	6.9	600	157	6112
374	198	940	19	16	400	104	1809
412	72	1140	8.8	1.9	1445	458	59854
412	120	1140	14	5.2	867	275	12928
412	192	1140	19	13	542	172	3154
466	100	1473	8.1	2.5	1934	791	53659
466	175	1473	13	7.5	1105	452	10010
469	324	1483	18	24	700	288	1859



Type UBN
Type UFN

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type UBN: HYDRA universal expansion joint with swivel flanges
Type UFN: HYDRA universal expansion joint with plain fixed flanges

Standard version/materials:
multi-ply bellows: 1.4541
flange: S 235 JRG2 (1.0038)
operating temperature: up to 300°C

Designation (example):

U	B	N	0	6	.	0	1	5	0	.	0	9	6	.	0

- U B N: Type
- 0 6: Nominal pressure (PN6)
- 0 1 5 0: Nominal diameter (DN150)
- 0 9 6: Movement absorption, nominal (2δ = ±48 = 96 mm)
- 0: Inner sleeve (0 = without, 1 = with)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]

  ____

- piping – nominal size DN

  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]

____

max./min. allowable temperature TS [°C]

____

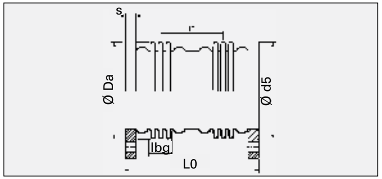
test pressure PT [bar]

____

Optional:

category ______________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.



Type UBN

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version	Overall length	Weight approx.	Centre-to-centre spacing of bellows	Flange		
		UBN 06 ...					drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	Lo	G	l*	PN	d	s
–	mm	–	–	mm	kg	mm	–	mm	mm
50	44	**.0050.044.0**	425677	341	3.8	216	6	90	16
65	55	**.0065.055.0**	425678	341	4.9	210	6	107	16
80	61	**.0080.061.0**	425680	364	7.2	224	6	122	18
100	73	**.0100.073.0**	425681	385	10	232	6	147	18
125	84	**.0125.084.0**	425683	413	13.5	240	6	178	20
150	96	**.0150.096.0**	423519	430	14.8	251	6	202	20
200	100	**.0200.100.0**	423520	470	20.8	293	6	258	22
250	120	**.0250.120.0**	423521	410	26.1	214	6	312	24
300	100	**.0300.100.0**	423522	430	31.8	230	6	365	24
350	110	**.0350.110.0**	423523	440	42.6	231	6	410	26
400	130	**.0400.130.0**	423524	460	55.7	227	6	465	28
450	140	**.0450.140.0**	423525	480	64.8	242	6	520	28
500	132	**.0500.132.0**	423526	490	75.9	266	6	570	28

[1] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Universal expansion joints Type UBN 06...
with swivel lap-joint flanges

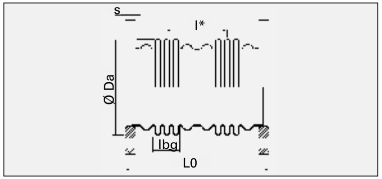
PN 06

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	lateral	angular
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_λ	c_α
mm	mm	cm^2	degrees	mm	N/mm	N/mm	N/m degrees
89	54	45	31	101	73	4.5	1.9
108	60	68	32	98	63	6.2	2.4
121	66	88	31	102	64	7.2	3.2
150	78	136	30	99	94	15	7.3
172	84	181	30	101	88	18	9
203	90	260	28	101	86	23	13
257	85	430	23	99	97	31	23
316	90	663	22	66	84	78	31
371	95	927	15	50	111	125	58
405	100	1113	15	50	109	146	68
461	110	1445	16	50	144	258	117
514	115	1817	16	51	146	289	149
572	100	2248	14	50	207	419	260

Universal expansion joints — Type UFN 06...

with plain fixed flanges

PN 06



Type UFN

Nominal dia-meter	Nominal axial movement absorption	Type UFN 06 ...	Order No. standard version	Overall length	Weight approx.	Centre-to-centre spacing of bellows	Flange drilling EN 1092	Flange thick-ness
DN	$2\delta_N$	–	–	Lo	G	l*	PN	s
–	mm	–	–	mm	kg	mm	–	mm
50	44	**.. .0050.044.0**	425690	354	4	216	6	16
65	55	**.. .0065.055.0**	425691	354	5	210	6	16
80	61	**.. .0080.061.0**	425693	376	7	224	6	18
100	73	**.. .0100.073.0**	425694	396	9	232	6	18
125	84	**.. .0125.084.0**	425695	422	13	240	6	20
150	96	**.. .0150.096.0**	423535	439	14	251	6	20
200	100	**.. .0200.100.0**	423536	478	19	293	6	22
250	120	**.. .0250.120.0**	423537	416	25	214	6	24
300	100	**.. .0300.100.0**	423538	437	30	230	6	24
350	110	**.. .0350.110.0**	423539	445	40	231	6	26
400	130	**.. .0400.130.0**	423540	457	53	227	6	28
450	140	**.. .0450.140.0**	423541	477	62	242	6	28
500	132	**.. .0500.132.0**	423542	486	71	266	6	28

[1] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Universal expansion joints — Type UFN 06...
with plain fixed flanges
PN 06

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] for 1000 loading cycles: angular[1]	Nominal movement absorption[1] for 1000 loading cycles: lateral[1]	Adjusting force rate: axial	Adjusting force rate: lateral	Adjusting force rate: angular
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_λ	c_α
mm	mm	cm^2	degrees	mm	N/mm	N/mm	N/m degrees
89	54	45	33	101	73	4.5	1.9
108	60	68	33	98	63	6.2	2.4
121	66	88	32	102	64	7.2	3.2
150	78	136	31	99	94	15	7.3
172	84	181	31	101	88	18	9
203	90	260	30	101	86	23	13
257	85	430	24	99	97	31	23
316	90	663	23	66	84	78	31
371	95	927	16	50	111	125	58
405	100	1113	17	50	109	146	68
461	110	1445	17	50	144	258	117
514	115	1817	16	51	146	289	149
572	100	2248	14	50	207	419	260

Type ARN

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type ARN: HYDRA axial expansion joint with weld ends

Standard version/materials:
multi-ply bellows: 1.4541
weld ends up to DN 300: P 235GH (1.0345), from DN 350: P 265GH (1.0425)
operating temperature: up to 400°C

Designation (example):

A	R	N	1	0	.	0	1	5	0	.	0	6	4	.	0

- A R N: Type
- 1 0: Nominal pressure (PN10)
- 0 1 5 0: Nominal diameter (DN150)
- 0 6 4: Movement absorption, nominal ($2\delta = \pm 32 = 64$ mm)
- 0: Inner sleeve (0 = without, 1 = with)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]
  ____
- piping – nominal size DN
  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]
____

max./min. allowable temperature TS [°C]
____

test pressure PT [bar]
____

Optional:

category ______________________

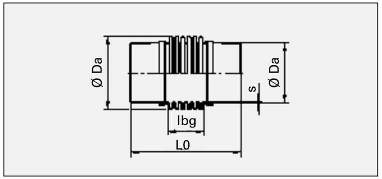
Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Axial expansion joints

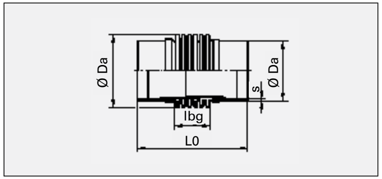
with weld ends

Type ARN 02...

PN 2.5



Type ARN without inner sleeve



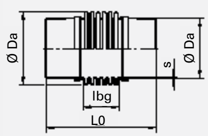
Type ARN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
50	24	**.0050.024.0**	417017	417122	214	1	1.2	60.3	4
50	44	**.0050.044.0**	417023	417123	259	1.1	1.3	60.3	4
50	70	**.0050.070.0**	417024	417124	331	1.7	2.1	60.3	4
65	28	**.0065.028.0**	417042	417125	214	1.5	1.7	76.1	4
65	60	**.0065.060.0**	417043	417126	277	1.7	2	76.1	4
65	87	**.0065.087.0**	417044	417127	350	2.4	3	76.1	4
80	27	**.0080.027.0**	417046	417128	210	1.7	2	88.9	4
80	64	**.0080.064.0**	417045	417129	280	2	2.4	88.9	4
80	92	**.0080.092.0**	417047	417130	358	2.7	3.4	88.9	4
100	46	**.0100.046.0**	417048	417131	237	2.3	2.7	114.3	4
100	86	**.0100.086.0**	417049	417132	303	2.7	3.5	114.3	4
100	122	**.0100.122.0**	417050	417133	420	5.4	6.5	114.3	4
125	45	**.0125.045.0**	417051	417134	241	2.7	3.2	139.7	4
125	90	**.0125.090.0**	417052	417135	306	3.2	4.2	139.7	4
125	140	**.0125.140.0**	417053	417136	456	6.8	8.4	139.7	4
150	54	**.0150.054.0**	417054	417137	254	3.6	4.3	168.3	4.5
150	99	**.0150.099.0**	417055	417138	319	4.1	5.4	168.3	4.5
150	160	**.0150.160.0**	417056	417139	476	8.6	10.6	168.3	4.5
200	70	**.0200.070.0**	417057	417140	285	6.4	7.8	219.1	6.3
200	130	**.0200.130.0**	417058	417141	388	8.5	10.6	219.1	6.3
200	190	**.0200.190.0**	417059	417142	503	13.2	16	219.1	6.3

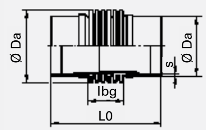
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints
with weld ends
Type ARN 02...
PN 2.5

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	54	46	35	5.6	87	1.1	259
89	99	46	50	19	48	0.6	42
89	171	46	50	52	46	0.6	14
107	54	68.7	32	5.2	85	1.6	378
107	117	68.7	50	25	39	0.7	37
108	190	69.4	50	59	40	0.8	14
121	50	89.1	27	4.1	94	2.3	640
121	120	89.1	50	24	39	1	46
121	198	89.1	50	56	43	1.1	18
148	77	137	38	8.9	63	2.4	273
148	143	137	50	31	34	1.3	42
150	260	139	50	79	57	2.2	22
174	65	187	32	6.3	58	3	492
174	130	187	50	25	29	1.5	61
172	280	185	50	85	53	2.7	23
203	78	264	32	7.7	56	4.1	465
203	143	264	50	26	31	2.3	77
203	300	264	50	87	51	3.7	29
255	105	432	32	10	53	6.4	397
256	208	434	50	38	43	5.2	80
257	323	436	50	87	51	6.2	41



Type ARN without inner sleeve



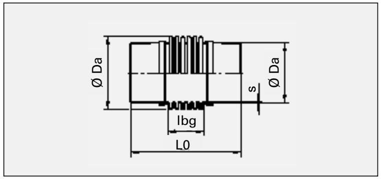
Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
250	72	**.0250.072.0**	417062	417143	282	8.9	10.6	273	7.1
250	144	**.0250.144.0**	417063	417144	384	11.6	14.1	273	7.1
250	204	**.0250.204.0**	417064	417145	486	17.3	21	273	7.1
300	70	**.0300.070.0**	417065	417146	279	11.5	14.4	323.9	8
300	126	**.0300.126.0**	417066	417147	355	12.6	16.6	323.9	8
300	210	**.0300.210.0**	417067	417148	464	21	26	323.9	8
350	75	**.0350.075.0**	417068	417149	284	9.9	13.2	355.6	6
350	150	**.0350.150.0**	417069	417150	384	13.3	18.2	355.6	6
350	210	**.0350.210.0**	417070	417151	478	19.9	26	355.6	6
400	65	**.0400.065.0**	417071	417152	289	13.1	16.3	406.4	6
400	117	**.0400.117.0**	417072	417153	373	15.9	21	406.4	6
400	195	**.0400.195.0**	417073	417154	499	20	28	406.4	6
450	56	**.0450.056.0**	417074	417155	272	14.2	17.5	457	6
450	140	**.0450.140.0**	417075	417156	404	19.2	26	457	6
450	196	**.0450.196.0**	417076	417157	492	23	31	457	6
500	68	**.0500.068.0**	417089	417158	320	19.1	23	508	6
500	136	**.0500.136.0**	417090	417159	412	23	31	508	6
500	221	**.0500.221.0**	417091	417160	527	28	39	508	6
600	76	**.0600.076.0**	417092	417161	332	23	29	610	6
600	152	**.0600.152.0**	417093	417162	436	28	38	610	6
600	228	**.0600.228.0**	417094	417163	540	33	47	610	6

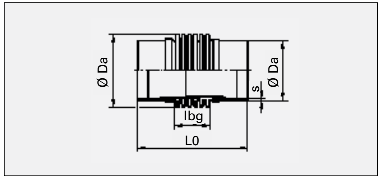
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
312	102	661	27	8.4	62	11	752
315	204	667	47	34	40	7.4	123
316	306	670	50	71	50	9.3	67
365	95	916	22	6.5	73	19	1415
365	171	916	36	21	40	10	239
371	280	932	50	57	52	13	118
400	100	1104	22	6.7	66	20	1392
402	200	1110	39	27	46	14	244
402	294	1110	50	55	60	19	147
458	105	1445	17	5.3	212	85	5283
458	189	1445	28	17	118	47	904
458	315	1445	39	48	71	29	195
513	88	1825	13	3.4	243	123	10935
513	220	1825	29	21	97	49	698
513	308	1825	35	42	70	35	253
569	92	2252	14	3.9	215	135	10875
569	184	2252	26	16	107	67	1359
569	299	2252	37	41	66	41	318
674	104	3202	13	4.1	215	191	12099
674	208	3202	24	17	107	95	1512
674	312	3202	32	37	72	64	446

PN 2.5



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
700	80	**.0700.080.0**	417095	417164	340	28	34	711	6
700	140	**.0700.140.0**	417096	417165	424	33	44	711	6
700	220	**.0700.220.0**	417097	417166	536	39	54	711	6
800	84	**.0800.084.0**	417098	417167	348	32	42	813	6
800	147	**.0800.147.0**	417099	417168	435	37	51	813	6
800	231	**.0800.231.0**	417100	417169	551	45	63	813	6
900	84	**.0900.084.0**	417101	417170	352	36	48	914	6
900	168	**.0900.168.0**	417102	417171	472	45	62	914	6
900	231	**.0900.231.0**	417103	417172	562	51	72	914	6
1000	72	**.1000.072.0**	417104	417173	332	38	47	1016	6
1000	144	**.1000.144.0**	417105	417175	428	45	62	1016	6
1000	240	**.1000.240.0**	417106	417176	556	55	78	1016	6
1200	72	**.1200.072.0**	417107	417176	332	62	77	1220	8
1200	144	**.1200.144.0**	417108	417177	428	76	103	1220	8
1200	240	**.1200.240.0**	417109	417178	556	94	131	1220	8
1400	48	**.1400.048.0**	417110	417179	304	66	81	1420	8
1400	108	**.1400.108.0**	417111	417181	434	78	108	1420	8
1400	180	**.1400.180.0**	417112	417182	590	93	136	1420	8
1600	48	**.1600.048.0**	417113	417183	304	75	92	1620	8
1600	108	**.1600.108.0**	417114	417184	434	89	123	1620	8
1600	180	**.1600.180.0**	417115	417185	590	106	156	1620	8

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

PN 2.5

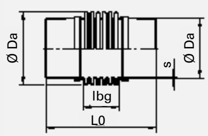
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
780	112	4324	12	4	203	244	13365
780	196	4324	20	12	116	139	2494
780	308	4324	27	30	74	89	644
882	116	5588	11	3.9	220	341	17449
882	203	5588	18	12	126	196	3263
882	319	5588	25	29	80	124	839
992	120	7133	9.8	3.5	238	472	22421
992	240	7133	18	14	119	236	2815
992	330	7133	22	27	86	170	1076
1095	96	8750	7.7	2.2	335	814	60745
1095	192	8750	14	8.7	168	408	7570
1095	320	8750	21	24	101	245	1632
1295	96	12331	6.5	1.8	511	1750	130579
1295	192	12331	13	7.4	256	877	16290
1295	320	12331	19	20	153	524	3519
1470	104	16377	3.8	1.2	932	4190	266329
1470	234	16377	8.1	5.8	414	1865	23362
1470	390	16377	12	16	249	1119	5038
1670	104	21227	3.3	1	1056	6168	391692
1670	234	21227	7.2	5.1	470	2742	34354
1670	390	21227	11	14	282	1645	7437

Axial expansion joints

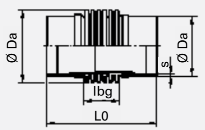
with weld ends

Type ARN 02...

PN 2.5



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 02 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
1800	48	**.1800.048.0**	417116	417186	304	85	103	1820	8
1800	108	**.1800.108.0**	417117	417187	434	100	139	1820	8
1800	180	**.1800.180.0**	417118	417188	590	119	175	1820	8
2000	48	**.2000.048.0**	417119	417189	304	94	115	2020	8
2000	108	**.2000.108.0**	417120	417190	434	111	154	2020	8
2000	180	**.2000.180.0**	417121	417191	590	132	194	2020	8

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

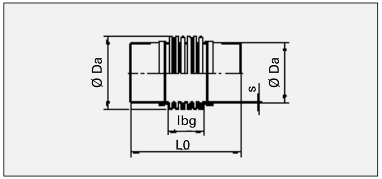
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
1870	104	26706	3	0.9	1180	8672	550794
1870	234	26706	6.4	4.6	524	3858	48345
1870	390	26706	9.8	13	315	2315	10463
2070	104	32813	2.7	0.8	1302	11767	747440
2070	234	32813	5.8	4.1	579	5232	65695
2070	390	32813	9	11	347	3136	14174

Axial expansion joints

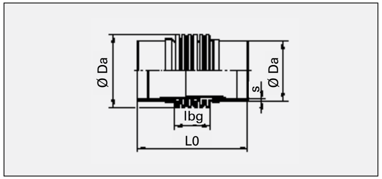
with weld ends

Type ARN 06...

PN 6



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 06 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
50	24	**.0050.024.0**	417283	417402	214	1	1.2	60.3	4
50	52	**.0050.052.0**	417184	417403	286	1.4	1.7	60.3	4
65	28	**.0065.028.0**	417186	417404	214	1.5	1.7	76.1	4
65	46	**.0065.046.0**	417198	417405	250	1.6	1.9	76.1	4
65	72	**.0065.072.0**	417199	417406	358	3.5	4.1	76.1	4
80	27	**.0080.027.0**	417300	417407	210	1.7	2	88.9	4
80	48	**.0080.048.0**	417301	417408	250	1.9	2.2	88.9	4
80	77	**.0080.077.0**	417302	417409	364	4	4.7	88.9	4
100	33	**.0100.033.0**	417303	417410	215	2.2	2.6	114.3	4
100	59	**.0100.059.0**	417304	417411	268	2.8	3.3	114.3	4
100	93	**.0100.093.0**	417305	417412	368	5.3	6.3	114.3	4
125	36	**.0125.036.0**	417306	417413	228	2.6	3.1	139.7	4
125	63	**.0125.063.0**	417307	417414	267	2.9	3.6	139.7	4
125	98	**.0125.098.0**	417308	417415	386	6.1	7.4	139.7	4
150	40	**.0150.040.0**	417309	417416	246	3.7	4.4	168.3	4.5
150	88	**.0150.088.0**	417310	417417	341	6.1	7.5	168.3	4.5
150	124	**.0150.124.0**	417311	417418	448	11	12.8	168.3	4.5
200	40	**.0200.040.0**	417312	417419	244	6.3	7.2	219.1	6.3
200	90	**.0200.090.0**	417313	417420	333	9.1	10.9	219.1	6.3
200	140	**.0200.140.0**	417314	417422	432	15.1	17.5	219.1	6.3

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints

with weld ends

Type ARN 06...

PN 6

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	54	46	33	5.6	87	1.1	259
89	126	46	50	28	62	0.8	34
107	54	68.7	30	5.2	85	1.6	378
107	90	68.7	44	15	51	1	81
110	198	70.9	50	50	91	1.8	30
121	50	89.1	26	4.1	94	2.3	640
121	90	89.1	40	13	52	1.3	109
123	204	90.8	50	48	97	2.4	40
148	55	137	27	4.6	88	3.3	752
149	108	138	43	16	71	2.7	160
151	208	140	50	48	85	3.3	52
174	52	187	25	4	72	3.7	953
174	91	187	39	12	41	2.1	177
173	210	186	50	45	89	4.6	71
202	70	263	23	5.1	117	8.5	1189
203	165	264	45	26	93	6.8	171
205	272	267	50	61	104	7.7	70
256	64	434	19	3.6	138	17	2791
257	153	436	37	19	108	13	380
260	252	441	50	50	110	13	145

Axial expansion joints

with weld ends

Type ARN 06...

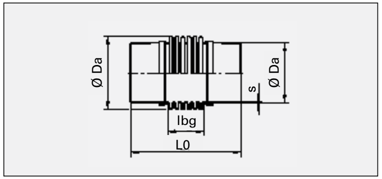
PN 6

Axial expansion joints

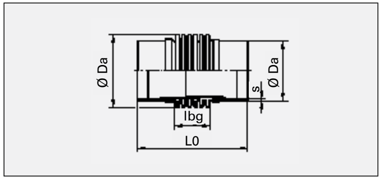
with weld ends

Type ARN 06...

PN 6



Type ARN without inner sleeve

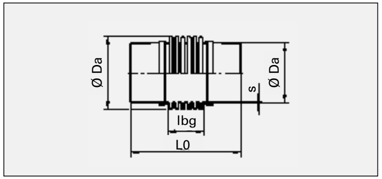


Type ARN with inner sleeve

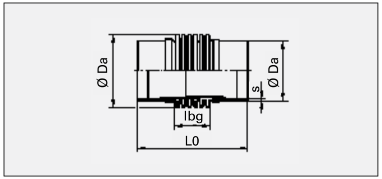
Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 06 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
250	48	**.0250.048.0**	417315	417423	252	10	11.1	273	7.1
250	96	**.0250.096.0**	417316	417424	324	12.2	14.2	273	7.1
250	144	**.0250.144.0**	417317	417425	420	19.2	22	273	7.1
300	60	**.0300.060.0**	417318	417426	264	13.3	15.5	323.9	8
300	120	**.0300.120.0**	417319	417427	344	16.3	20	323.9	8
300	165	**.0300.165.0**	417320	417428	426	24	29	323.9	8
350	60	**.0350.060.0**	417321	417429	268	11.8	14.3	355.6	6
350	120	**.0350.120.0**	417322	417430	352	15.1	19.5	355.6	6
350	165	**.0350.165.0**	417331	417431	437	24	29	355.6	6
400	52	**.0400.052.0**	417333	417432	272	14.1	16.9	406.4	6
400	117	**.0400.117.0**	417334	417433	382	19.4	25	406.4	6
400	169	**.0400.169.0**	417335	417434	483	29	36	406.4	6
450	56	**.0450.056.0**	417336	417435	276	16.1	19.4	457	6
450	112	**.0450.112.0**	417337	417436	368	21	27	457	6
450	182	**.0450.182.0**	417338	417437	496	33	42	457	6
500	66	**.0500.066.0**	417339	417438	328	24	28	508	6
500	149	**.0500.149.0**	417340	417439	453	34	42	508	6
500	215	**.0500.215.0**	417341	417440	579	56	68	508	6
600	76	**.0600.076.0**	417342	417441	340	29	35	610	6
600	133	**.0600.133.0**	417343	417442	424	37	47	610	6
600	216	**.0600.216.0**	417344	417443	576	66	80	610	6

[1)] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1)] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1)]	lateral[1)]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
316	72	670	18	3.9	211	39	5156
316	144	670	32	16	105	20	648
319	240	677	45	39	110	21	245
371	80	932	19	4.6	183	47	5062
371	160	932	34	19	92	24	633
374	242	940	44	38	104	27	319
402	84	1110	18	4.5	212	65	6311
402	168	1110	31	18	106	33	789
405	253	1119	40	37	120	37	397
461	88	1456	13	3.5	361	146	12887
461	198	1456	25	18	160	65	1135
462	299	1459	32	39	148	60	461
514	92	1828	13	3.6	366	186	15018
514	184	1828	22	14	183	93	1877
515	312	1832	30	39	150	76	539
572	100	2265	14	4.1	414	260	17778
572	225	2265	26	21	184	116	1564
574	351	2273	35	47	192	121	673
677	112	3217	13	4.4	414	370	20180
677	196	3217	21	14	237	212	3774
678	348	3222	30	39	216	193	1092



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 06 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
700	80	**.0700.080.0**	417345	417444	340	41	48	711	8
700	140	**.0700.140.0**	417388	417445	424	51	62	711	8
700	220	**.0700.220.0**	417389	417446	558	82	98	711	8
800	84	**.0800.084.0**	417390	417447	364	57	67	813	8
800	168	**.0800.168.0**	417391	417448	496	80	96	813	8
800	231	**.0800.231.0**	417392	417449	595	97	117	813	8
900	84	**.0900.084.0**	417393	417450	364	64	76	914	8
900	168	**.0900.168.0**	417394	417451	496	91	109	914	8
900	231	**.0900.231.0**	417395	417452	595	111	133	914	8
1000	66	**.1000.066.0**	417396	417453	341	64	74	1016	8
1000	132	**.1000.132.0**	417397	417454	446	87	104	1016	8
1000	220	**.1000.220.0**	417398	417455	586	117	141	1016	8
1200	69	**.1200.069.0**	417399	417456	341	89	104	1220	10
1200	138	**.1200.138.0**	417400	417457	446	116	144	1220	10
1200	230	**.1200.230.0**	417401	417458	586	153	191	1220	10

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%

Axial expansion joints Type ARN 06...
with weld ends
PN 6

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
780	112	4324	12	4	439	527	28770
780	196	4324	19	12	251	301	5374
783	330	4342	27	33	232	280	1751
887	132	5621	11	4.4	642	1002	39372
887	264	5621	20	17	321	501	4914
887	363	5621	24	33	233	364	1890
996	132	7163	9.8	3.9	715	1423	55902
996	264	7163	18	15	357	710	6988
996	363	7163	21	29	260	517	2689
1100	105	8791	7	2.2	974	2379	147726
1100	210	8791	13	8.7	487	1189	18466
1100	350	8791	19	24	292	713	3989
1296	105	12341	6.2	1.9	1092	3743	232590
1296	210	12341	12	7.7	546	1872	29074
1296	350	12341	17	21	328	1124	6291

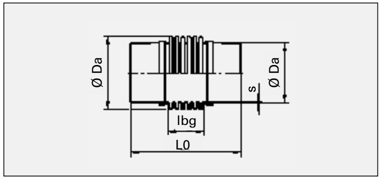
Axial expansion joints

Type ARN 10...

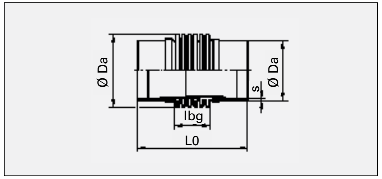
with weld ends

PN 10

Axial expansion joints Type ARN 10...
with weld ends
PN 10



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 10 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
50	24	**.0050.024.0**	417459	417506	214	1	1.2	60.3	4
50	46	**.0050.046.0**	417460	417507	300	1.9	2.2	60.3	4
65	23	**.0065.023.0**	417461	417508	205	1.4	1.6	76.1	4
65	37	**.0065.037.0**	417462	417509	232	1.5	1.8	76.1	4
65	60	**.0065.060.0**	417463	417510	325	3.2	3.6	76.1	4
80	20	**.0080.020.0**	417464	417511	204	1.7	1.9	88.9	4
80	41	**.0080.041.0**	417465	417512	248	2	2.3	88.9	4
80	63	**.0080.063.0**	417466	417513	328	3.6	4.1	88.9	4
100	26	**.0100.026.0**	417467	417514	208	2.3	2.6	114.3	4
100	53	**.0100.053.0**	417468	417515	256	2.7	3.2	114.3	4
100	80	**.0100.080.0**	417469	417516	370	6.3	7.3	114.3	4
125	30	**.0125.030.0**	417470	417517	232	2.8	3.3	139.7	4
125	53	**.0125.053.0**	417471	417518	274	3.2	3.9	139.7	4
125	85	**.0125.085.0**	417472	417519	384	7.1	8.3	139.7	4
150	32	**.0150.032.0**	417473	417520	236	4.1	4.7	168.3	4.5
150	64	**.0150.064.0**	417474	417521	296	5.2	6.1	168.3	4.5
150	95	**.0150.095.0**	417475	417522	384	9.1	10.6	168.3	4.5
200	40	**.0200.040.0**	417476	417523	248	7.1	8	219.1	6.3
200	80	**.0200.080.0**	417477	417524	316	8.7	10.3	219.1	6.3
200	110	**.0200.110.0**	417478	417525	378	13.1	15.1	219.1	6.3

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

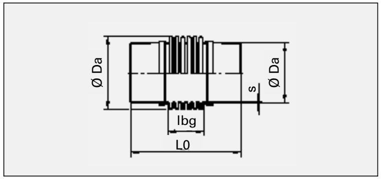
Bellows			Nominal movement absorption[1)] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1)]	lateral[1)]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	54	46	31	5.6	87	1.1	259
90	140	46.6	50	28	115	1.5	51
107	45	68.7	26	3.7	102	1.9	654
107	72	68.7	34	9.2	64	1.2	159
110	165	70.9	50	35	109	2.1	53
121	44	89.1	20	2.8	192	4.8	1670
121	88	89.1	35	11	96	2.4	209
123	168	90.8	48	33	118	3	71
149	48	138	21	3.1	161	6.2	1817
149	96	138	35	13	80	3.1	229
152	210	141	48	41	131	5.1	78
171	56	184	21	3.7	148	7.6	1646
171	98	184	31	11	84	4.3	307
174	208	187	46	38	138	7.2	113
203	60	264	19	3.5	257	19	3564
203	120	264	33	14	128	9.4	445
205	208	267	43	35	136	10	157
257	68	436	19	3.8	242	29	4318
257	136	436	31	15	121	15	540
260	198	441	41	31	140	17	297

Axial expansion joints

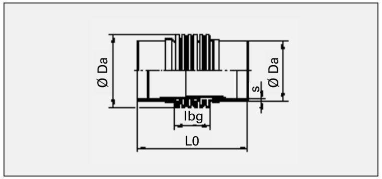
Type ARN 10...

with weld ends

PN 10



Type ARN without inner sleeve



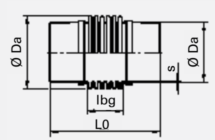
Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 10 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
250	48	**.0250.048.0**	417479	417526	252	10	11.1	273	7.1
250	84	**.0250.084.0**	417480	417527	306	11.7	13.5	273	7.1
250	130	**.0250.130.0**	417481	417528	484	24	27	273	7.1
300	45	**.0300.045.0**	417482	417529	247	13.1	15	323.9	8
300	90	**.0300.090.0**	417483	417530	310	15.8	19.2	323.9	8
300	137	**.0300.137.0**	417484	417531	514	34	39	323.9	8
350	60	**.0350.060.0**	417486	417532	272	12.6	15.1	355.6	6
350	105	**.0350.105.0**	417487	417533	338	15.5	19.7	355.6	6
350	160	**.0350.160.0**	417488	417534	568	48	55	355.6	6
400	48	**.0400.048.0**	417489	417535	280	19	22	406.4	6
400	120	**.0400.120.0**	417490	417536	424	32	38	406.4	6
400	168	**.0400.168.0**	417491	417537	548	53	61	406.4	6
450	56	**.0450.056.0**	417492	417538	284	25	29	457	8
450	112	**.0450.112.0**	417493	417539	384	36	42	457	8
450	168	**.0450.168.0**	417494	417540	484	46	54	457	8
500	66	**.0500.066.0**	417495	417541	336	33	38	508	8
500	116	**.0500.116.0**	417497	417542	417	42	50	508	8
500	192	**.0500.192.0**	417499	417543	564	71	82	508	8
600	72	**.0600.072.0**	417500	417544	344	41	46	610	8
600	144	**.0600.144.0**	417501	417545	460	56	67	610	8
600	216	**.0600.216.0**	417502	417546	588	89	103	610	8

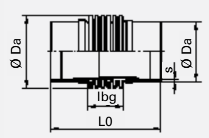
[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%

Axial expansion joints Type ARN 10...
with weld ends
PN 10

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
316	72	670	18	3.9	211	39	5156
316	126	670	27	12	120	22	967
319	304	677	31	45	201	38	278
372	63	935	15	2.7	292	76	13045
372	126	935	26	11	146	38	1631
374	330	940	30	44	240	63	391
403	88	1113	17	4.7	251	78	6864
403	154	1113	26	14	144	45	1282
412	384	1140	33	54	271	86	394
464	96	1466	12	3.6	730	297	21961
464	240	1466	26	22	292	119	1405
467	364	1476	32	47	270	111	568
518	100	1844	13	3.9	706	362	24613
518	200	1844	23	15	353	181	3081
518	300	1844	28	35	235	120	912
574	108	2273	14	4.4	625	395	23078
574	189	2273	21	13	357	225	4303
576	336	2282	30	40	282	179	1077
678	116	3222	12	4.3	649	581	29497
678	232	3222	21	17	325	291	3693
680	360	3232	28	40	292	262	1377



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 10 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
700	76	**.0700.076.0**	417503	417547	356	56	63	711	8
700	152	**.0700.152.0**	417504	417548	484	82	96	711	8
700	209	**.0700.209.0**	417505	417549	580	102	118	711	8

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

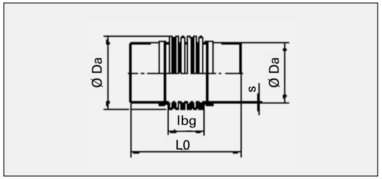
Axial expansion joints

with weld ends

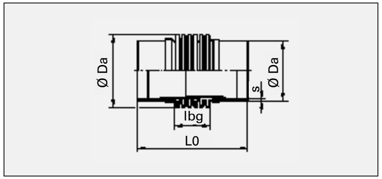
Type ARN 10...

PN 10

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
785	128	4353	11	4.4	857	1036	43134
785	256	4353	20	17	428	518	5392
785	352	4353	24	33	311	376	2073



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type ARN 16 ...	Order No. standard version without inner sleeve	Order No. standard version with inner sleeve	Overall length	Weight approx. without inner sleeve	Weight approx. with inner sleeve	Weld ends outside diameter	Weld ends wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
50	22	**.0050.022.0**	417550	417585	214	1.1	1.3	60.3	4
50	42	**.0050.042.0**	417551	417586	303	2.1	2.4	60.3	4
65	28	**.0065.028.0**	417552	417587	220	1.6	1.8	76.1	4
65	48	**.0065.048.0**	417553	417588	292	2.8	3.2	76.1	4
80	23	**.0080.023.0**	417554	417589	220	2.1	2.4	88.9	4
80	50	**.0080.050.0**	417555	417590	292	3.2	3.6	88.9	4
100	31	**.0100.031.0**	417556	417591	225	2.8	3.2	114.3	4
100	58	**.0100.058.0**	417557	417592	314	5.1	5.7	114.3	4
125	21	**.0125.021.0**	417558	417593	218	3	3.4	139.7	4
125	42	**.0125.042.0**	417559	417594	260	3.7	4.3	139.7	4
125	65	**.0125.065.0**	417560	417595	336	6.1	7	139.7	4
150	24	**.0150.024.0**	417561	417596	221	3.8	4.3	168.3	4.5
150	48	**.0150.048.0**	417562	417597	266	4.7	5.5	168.3	4.5
150	73	**.0150.073.0**	417563	417598	336	7.7	9	168.3	4.5
200	30	**.0200.030.0**	417564	417599	234	7.6	8.4	219.1	6.3
200	60	**.0200.060.0**	417565	417600	288	9.7	10.8	219.1	6.3
200	97	**.0200.097.0**	417566	417601	450	18.7	21	219.1	6.3
250	32	**.0250.032.0**	417567	417602	256	10.9	12	273	7.1
250	64	**.0250.064.0**	417568	417603	332	14	15.7	273	7.1
250	103	**.0250.103.0**	417569	417604	440	23	26	273	7.1

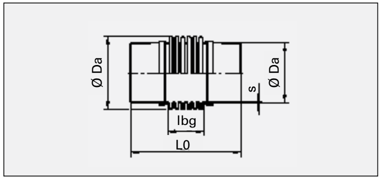
[1)] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Axial expansion joints
with weld ends

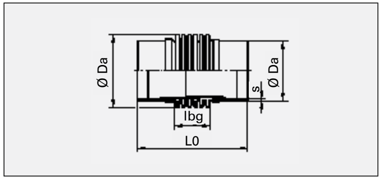
Type ARN 16...

PN 16

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] for 1000 loading cycles angular[1)]	Nominal movement absorption[1)] for 1000 loading cycles lateral[1)]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
89	54	46	29	5.2	146	1.9	430
91	143	47.2	41	25	153	2	66
108	60	69.4	28	5.7	126	2.4	457
110	132	70.9	40	22	136	2.7	103
122	60	89.9	23	4.3	278	6.9	1302
123	132	90.8	38	20	150	3.8	146
150	65	139	23	4.9	227	8.8	1400
152	154	141	37	22	178	7	198
172	42	185	15	1.9	350	18	6932
172	84	185	27	7.7	175	9	867
174	160	187	36	22	180	9.4	248
203	45	264	14	2	342	25	8455
203	90	264	25	7.8	171	13	1054
205	160	267	34	21	176	13	345
260	54	441	14	2.3	514	63	14678
260	108	441	26	9.1	257	31	1835
262	270	445	29	36	276	34	316
318	76	674	12	2.8	640	120	14135
318	152	674	20	11	320	60	1767
320	260	679	27	30	300	57	568



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 16 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
300	40	**.0300.040.0**	417570	417605	268	16.8	18.9	323.9	8
300	80	**.0300.080.0**	417571	417606	352	23	27	323.9	8
300	120	**.0300.120.0**	417572	417607	529	42	48	323.9	8
350	40	**.0350.040.0**	417573	417608	268	18.8	21	355.6	8
350	90	**.0350.090.0**	417574	417609	373	28	32	355.6	8
350	130	**.0350.130.0**	417575	417611	496	43	50	355.6	8
400	48	**.0400.048.0**	417576	417612	288	26	29	406.4	8
400	96	**.0400.096.0**	417577	417613	392	38	43	406.4	8
400	132	**.0400.132.0**	417578	417614	470	47	54	406.4	8
450	52	**.0450.052.0**	417579	417615	288	29	33	457	8
450	104	**.0450.104.0**	417580	417616	392	43	50	457	8
450	143	**.0450.143.0**	417581	417617	470	54	62	457	8
500	48	**.0500.048.0**	417582	417618	312	34	37	508	8
500	96	**.0500.096.0**	417583	417619	396	46	53	508	8
500	144	**.0500.144.0**	417584	417620	480	59	68	508	8

1) Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%

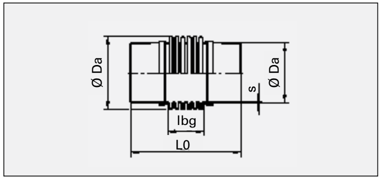
Bellows			Nominal movement absorption[1) for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1)	lateral[1)	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
374	84	940	13	3.2	705	184	17764
374	168	940	21	13	352	92	2220
376	345	946	25	40	327	86	489
408	84	1128	12	3	690	216	20856
408	189	1128	20	15	307	96	1834
412	312	1140	26	35	334	106	736
467	104	1476	12	3.8	946	388	24342
467	208	1476	22	15	473	194	3043
467	286	1476	25	29	344	141	1172
520	104	1851	12	3.7	954	491	30826
520	208	1851	21	15	477	245	3857
520	286	1851	24	28	347	178	1483
576	84	2282	9.9	2.5	1128	715	68986
576	168	2282	18	10	564	357	8616
576	252	2282	24	22	376	238	2553

Axial expansion joints
with weld ends

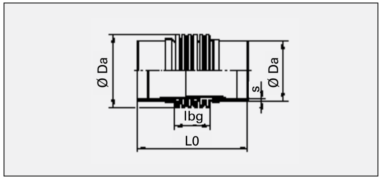
Type ARN 25...

PN 25

Axial expansion joints
with weld ends
Type ARN 25...
PN 25



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 25 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
50	17	**.0050.017.0**	417621	417650	210	1.2	1.4	60.3	4
50	32	**.0050.032.0**	417622	417651	270	1.8	2	60.3	4
65	21	**.0065.021.0**	417623	417652	215	1.8	2	76.1	4
65	40	**.0065.040.0**	417624	417653	292	3.2	3.6	76.1	4
80	23	**.0080.023.0**	417625	417654	220	2.3	2.6	88.9	4
80	42	**.0080.042.0**	417626	417655	290	3.6	4	88.9	4
100	23	**.0100.023.0**	417627	417656	212	2.8	3.1	114.3	4
100	48	**.0100.048.0**	417629	417657	286	4.6	5.2	114.3	4
125	26	**.0125.026.0**	417630	417658	240	3.9	4.4	139.7	4
125	52	**.0125.052.0**	417631	417659	304	5.3	6.1	139.7	4
150	29	**.0150.029.0**	417632	417660	240	4.9	5.5	168.3	4.5
150	58	**.0150.058.0**	417633	417661	304	6.8	7.7	168.3	4.5
200	26	**.0200.026.0**	417635	417662	252	8.5	9.4	219.1	6.3
200	52	**.0200.052.0**	417636	417663	324	11.3	12.6	219.1	6.3
200	71	**.0200.071.0**	417637	417664	378	15.2	17.1	219.1	6.3
250	24	**.0250.024.0**	417638	417665	240	11.5	12.5	273	7.1
250	48	**.0250.048.0**	417639	417666	300	15.1	16.5	273	7.1
250	79	**.0250.079.0**	417640	417667	380	19.8	22	273	7.1

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%

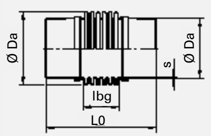
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
90	50	46.6	22	3.5	321	4.2	1113
91	110	47.2	33	15	199	2.6	144
109	55	70.1	23	4.1	272	5.3	1182
111	132	71.6	33	18	218	4.3	166
123	60	90.8	21	4.1	329	8.3	1555
125	130	92.5	32	17	222	5.7	227
151	52	140	18	3	340	13	3302
152	126	141	30	15	218	8.5	361
174	64	187	18	3.6	450	23	3864
174	128	187	29	14	225	12	483
205	64	267	17	3.4	440	33	5410
205	128	267	27	13	220	16	676
261	72	443	12	2.6	855	105	13759
261	144	443	20	11	428	53	1722
262	198	445	23	19	376	46	802
320	60	679	8.7	1.6	1298	245	46135
320	120	679	16	6.4	649	122	5762
320	200	679	21	18	390	74	1245

Axial expansion joints

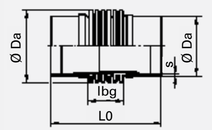
with weld ends

Type ARN 25...

PN 25



Type ARN without inner sleeve



Type ARN with inner sleeve

Nominal diameter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 25 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
300	27	**.0300.027.0**	417641	417668	250	15.2	17	323.9	8
300	55	**.0300.055.0**	417642	417669	316	19.8	23	323.9	8
300	82	**.0300.082.0**	417643	417670	382	24	29	323.9	8
350	30	**.0350.030.0**	417644	417671	256	19.2	21	355.6	8
350	70	**.0350.070.0**	417645	417672	352	29	33	355.6	8
350	100	**.0350.100.0**	417646	417673	424	36	41	355.6	8
400	40	**.0400.040.0**	417647	417674	309	29	32	406.4	8
400	80	**.0400.080.0**	417648	417675	434	45	51	406.4	8
400	112	**.0400.112.0**	417649	417676	562	66	74	406.4	8

[1] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

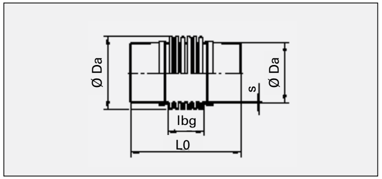
Axial expansion joints

with weld ends

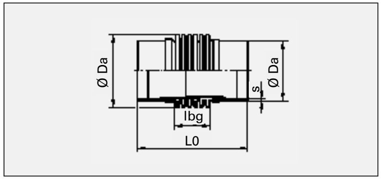
Type ARN 25...

PN 25

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
374	66	940	8.6	1.7	1200	313	48892
374	132	940	15	6.9	600	157	6112
374	198	940	19	16	400	104	1809
412	72	1140	8.8	1.9	1445	458	59854
412	168	1140	18	10	619	196	4714
412	240	1140	21	21	434	137	1618
466	125	1473	10	3.8	1548	633	27484
466	250	1473	17	15	774	317	3433
469	378	1483	19	32	600	247	1171



Type ARN without inner sleeve

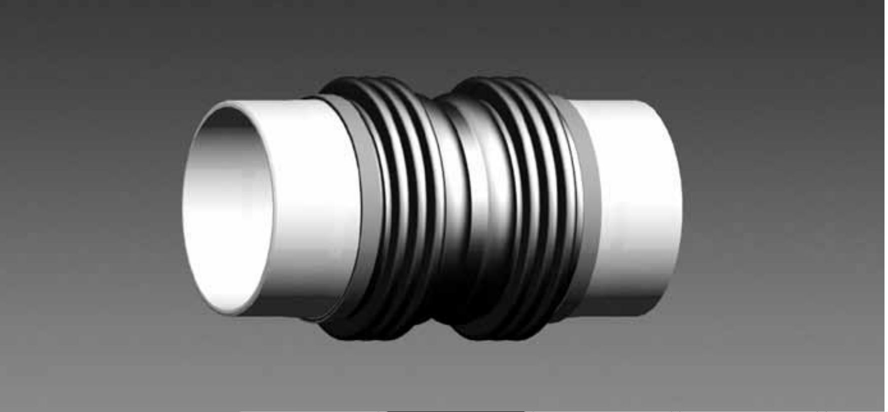


Type ARN with inner sleeve

Nominal dia-meter	Nominal axial movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Weld ends	
		ARN 40 ...	without inner sleeve	with inner sleeve		without inner sleeve	with inner sleeve	outside diameter	wall thickness
DN	$2\delta_N$	–	–	–	Lo	G	G	D	s
–	mm	–	–	–	mm	kg	kg	mm	mm
50	13	**.0050.013.0**	417677	417699	204	1.2	1.3	60.3	4
50	26	**.0050.026.0**	417678	417700	248	1.6	1.8	60.3	4
65	18	**.0065.018.0**	417679	417701	220	2.2	2.4	76.1	4
65	32	**.0065.032.0**	417680	417702	268	2.9	3.2	76.1	4
80	17	**.0080.017.0**	417681	417703	212	2.4	2.7	88.9	4
80	34	**.0080.034.0**	417682	417704	264	3.2	3.6	88.9	4
100	16	**.0100.016.0**	417683	417705	225	2.7	3.1	114.3	4
100	36	**.0100.036.0**	417684	417706	329	4.7	5.4	114.3	4
125	24	**.0125.024.0**	417685	417707	272	4.7	5.3	139.7	4
125	44	**.0125.044.0**	417687	417708	363	7.6	8.5	139.7	4
150	29	**.0150.029.0**	417688	417709	272	6	6.8	168.3	4.5
150	52	**.0150.052.0**	417689	417710	427	13.6	15	168.3	4.5
200	22	**.0200.022.0**	417690	417711	260	10.5	11.4	219.1	6.3
200	44	**.0200.044.0**	417691	417712	340	15.1	16.5	219.1	6.3
200	61	**.0200.061.0**	417692	417713	400	18.6	20	219.1	6.3
250	21	**.0250.021.0**	417693	417714	243	13	14	273	7.1
250	49	**.0250.049.0**	417694	417715	327	19.4	21	273	7.1
250	70	**.0250.070.0**	417695	417717	390	24	27	273	7.1
300	24	**.0300.024.0**	417696	417718	276	19.6	22	323.9	8
300	54	**.0300.054.0**	417697	417719	391	30	34	323.9	8
300	77	**.0300.077.0**	417698	417720	534	47	53	323.9	8

[1)] Inner sleeve, movement absorption: The inner sleeve is designed for axial movement only. The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1)] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1)]	lateral[1)]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degrees	mm	N/mm	Nm/degrees	N/mm
91	44	47.2	16	2.3	497	6.5	2252
91	88	47.2	25	9.5	248	3.2	282
111	60	71.6	19	3.8	481	9.6	1775
111	108	71.6	26	12	267	5.3	304
125	52	92.5	16	2.6	556	14	3540
125	104	92.5	25	11	278	7.1	442
147	65	136	12	2.5	715	27	4316
147	169	136	18	15	410	15	365
174	96	187	15	5	696	36	2646
175	187	189	21	18	470	25	472
206	96	269	15	4.8	644	48	3521
208	247	272	20	23	543	41	449
263	80	447	10	2.5	1530	190	19958
263	160	447	17	9.8	765	95	2493
263	220	447	19	18	556	69	959
322	63	683	7.8	1.5	1779	338	57458
322	147	683	16	8.1	762	145	4525
322	210	683	18	17	534	101	1551
376	92	946	7.5	2.1	2379	625	49912
376	207	946	14	11	1057	278	4380
378	350	951	15	26	775	205	1127



Type URN

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type URN: HYDRA universal expansion joint with weld ends

Standard version/materials:
multi-ply bellows: 1.4541
weld ends up to DN 300: P 235GH (1.0345), from DN 350: P 265GH (1.0425)
operating temperature: up to 400°C

Designation (example):

U	R	N	0	6	.	0	1	5	0	.	0	9	6	.	0

- U R N: Type
- 0 6: Nominal pressure (PN6)
- 0 1 5 0: Nominal diameter (DN150)
- 0 9 6: Movement absorption, nominal (2δ = ±48 = 96 mm)
- 0: Inner sleeve (0 = without, 1 = with)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]
  ____
- piping – nominal size DN
  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]
____

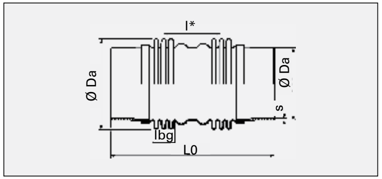
max./min. allowable temperature TS [°C]
____

test pressure PT [bar]
____

Optional:

category ______________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

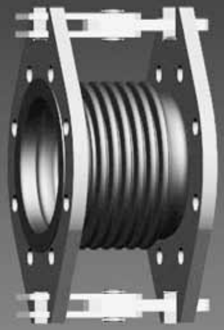


Type URN

Nominal dia- meter	Nominal axial movement absorption	Type URN 06 ...	Order No. standard version	Overall length	Weight approx.	Centre- to-centre spacing of bellows	Weld ends outside diameter	Weld ends wall thickness
DN	$2\delta_N$	–	–	Lo	G	I*	D	s
–	mm	–	–	mm	kg	mm	mm	mm
50	44	**.0050.044.0**	425701	430	1.6	216	60.3	4
65	55	**.0065.055.0**	425702	430	2.3	210	76.1	4
80	61	**.0080.061.0**	425703	450	2.7	224	88.9	4
100	73	**.0100.073.0**	425704	470	4.7	232	114.3	4
125	84	**.0125.084.0**	425705	500	5.9	240	139.7	4
150	96	**.0150.096.0**	423552	517	7.5	251	168.3	4.5
200	100	**.0200.100.0**	423553	558	11.5	293	219.1	6.3
250	120	**.0250.120.0**	423554	484	14.9	214	273	7.1
300	100	**.0300.100.0**	423555	509	16.6	230	323.9	8
350	110	**.0350.110.0**	423557	515	15.6	231	355.6	6
400	130	**.0400.130.0**	423558	521	22.8	227	406.4	6
450	140	**.0450.140.0**	423559	541	26.3	242	457	6
500	132	**.0500.132.0**	423560	594	37.1	266	508	6

[1)] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1)] for 1000 loading cycles angular[1)]	Nominal movement absorption[1)] lateral[1)]	Adjusting force rate axial	Adjusting force rate lateral	Adjusting force rate angular
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_λ	c_α
mm	mm	cm^2	degrees	mm	N/mm	N/mm	N/m degrees
89	54	45	33	101	73	4.5	1.9
108	60	68	33	98	63	6.2	2.4
121	66	88	32	102	64	7.2	3.2
150	78	136	31	99	94	15	7.3
172	84	181	31	101	88	18	9
203	90	260	30	101	86	23	13
257	85	430	24	99	97	31	23
316	90	663	23	66	84	78	31
371	95	927	16	50	111	125	58
405	100	1113	17	50	109	146	68
461	110	1445	17	50	144	258	117
514	115	1817	16	51	146	289	149
572	100	2248	14	50	207	419	260



Type WBN
Type WBK

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type WBN: HYDRA single hinge angular expansion joint with swivel flanges
Type WBK: HYDRA gimbal hinge angular expansion joint with swivel flanges

Standard version/materials:
multi-ply bellows: 1.4541
flange: P 265 GH (1.0425)
operating temperature: up to 400°C

Designation (example)

W	B	N	1	0	.	0	1	5	0	.	3	6	0	.	0

Type – Nominal pressure (PN10) – Nominal diameter (DN150) – Movement absorption, nominal ($2\alpha = \pm 18 = 36°$) – Inner sleeve (0 = without, 1 = with)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]
  ____
- piping – nominal size DN
  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]
____

max./min. allowable temperature TS [°C]
____

test pressure PT [bar]
____

Optional:

category ______________________

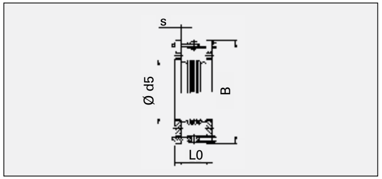
Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Angular expansion joints with swivel flanges

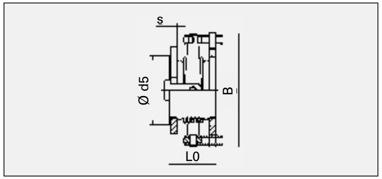
Single hinge version **Type WBN 06...**

Gimbal hinge version **Type WBK 06...**

PN 6



Type WBN



Type WBK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WBN 06 ... **WBK 06 ...**	**WBN**	**WBK**		**WBN**	**WBK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
50	33	**.0050.330.0**	441221	441136	121	7	11
50	41	**.0050.410.0**	441222	441137	141	7	11
65	27	**.0065.270.0**	441223	441138	111	8	13
65	39	**.0065.390.0**	441224	441139	141	8	13
80	27	**.0080.270.0**	441225	441140	121	11	16
80	38	**.0080.380.0**	441226	441141	151	11	16
100	27	**.0100.270.0**	441227	441142	131	12	17
100	38	**.0100.380.0**	441228	441143	161	12	17
125	30	**.0125.300.0**	441229	441144	151	15	21
125	39	**.0125.390.0**	441230	441145	181	16	22
150	23	**.0150.230.0**	441231	441146	162	16	22
150	36	**.0150.360.0**	441232	441147	212	18	24
200	23	**.0200.230.0**	441233	441148	172	22	32
200	34	**.0200.340.0**	441234	441149	233	25	35
250	18	**.0250.180.0**	441235	441150	183	29	44
250	32	**.0250.320.0**	441236	441151	253	32	46
300	19	**.0300.190.0**	441237	–	183	38	–
300	34	**.0300.340.0**	441238	441153	263	41	59
350	18	**.0350.180.0**	441239	–	193	59	–
350	34	**.0350.340.0**	441240	441155	314	68	100
400	13	**.0400.130.0**	441241	–	213	68	–
400	27	**.0400.270.0**	441242	441157	343	77	116
450	13	**.0450.130.0**	441243	–	213	76	–
450	24	**.0450.240.0**	441244	441158	333	85	134

Angular expansion joints with swivel flanges

Single hinge version **Type WBN 06...**

Gimbal hinge version **Type WBK 06...**

PN 6

Max. width approx.	Flange			Adjusting moment rate		
	drilling DIN 1092	rim diameter	thick-ness			
B	PN	d5	s	c_r	c_α	c_p
mm	–	mm	mm	Nm/bar	Nm/degrees	Nm/degrees bar
250	6	90	16	0.5	1.1	0.1
250	6	90	16	0.5	0.8	0.1
285	6	107	16	0.7	1.9	0.1
285	6	107	16	0.7	1.2	0.1
310	6	122	18	0.9	2.3	0.1
310	6	122	18	0.9	1.5	0.2
325	6	147	18	1.4	3.3	0.2
325	6	147	18	1.4	2.1	0.4
355	6	178	20	1.9	3	0.4
355	6	178	20	1.9	2.1	0.5
370	6	202	20	2.6	8.5	0.5
370	6	202	20	2.6	4.7	1.0
425	6	258	22	4	13	1.0
425	6	258	22	4	15	1.7
485	6	312	24	7	39	1.4
485	6	312	24	7	20	2.8
565	6	365	24	9	47	2.2
565	6	365	24	9	24	4.3
650	6	410	26	20	65	2.7
650	6	410	26	20	35	6.4
680	6	465	28	26	146	3.7
680	6	465	28	26	58	9.3
740	6	520	28	33	186	4.9
740	6	520	28	33	83	11.0

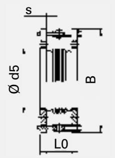
Angular expansion joints with swivel flanges

Single hinge version **Type WBN 06...**

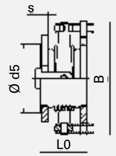
Gimbal hinge version **Type WBK 06...**

PN 6

Angular expansion joints with swivel flanges
Single hinge version **Type WBN 06...**
Gimbal hinge version **Type WBK 06...**
PN 6



Type WBN



Type WBK

Nominal diameter	Nominal angular movement absorption	Type **WBN 06 ...** **WBK 06 ...**	Order No. standard version		Overall length	Weight approx.	
			WBN	**WBK**		**WBN**	**WBK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
500	14	**.0500.140.0**	441245	–	224	86	–
500	26	**.0500.260.0**	441246	441159	354	99	159
600	13	**.0600.130.0**	441247	–	254	151	–
600	25	**.0600.250.0**	441248	441160	394	170	285
700	14	**.0700.140.0**	441249	–	284	173	–
700	25	**.0700.250.0**	441250	441161	446	217	380
800	11	**.0800.110.0**	441251	–	296	238	–
800	23	**.0800.230.0**	441252	441162	496	282	496

Max. width approx.	Flange			Adjusting moment rate		
	drilling DIN 1092	rim diameter	thick-ness			
B	PN	d5	s	c_r	c_α	c_p
mm	–	mm	mm	Nm/bar	Nm/degrees	Nm/degrees bar
800	6	570	28	41	260	6.6
800	6	570	28	41	116	15.0
950	6	670	37	77	370	10.0
950	6	670	37	77	164	24.0
1060	6	775	37	104	422	18.0
1060	6	775	37	104	308	38.0
1180	6	880	43	135	1002	22.0
1180	6	880	43	135	401	54.0

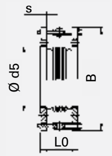
Angular expansion joints with swivel flanges

Single hinge version **Type WBN 10...**

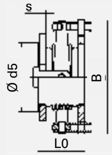
Gimbal hinge version **Type WBK 10...**

PN 10

Angular expansion joints with swivel flanges
Single hinge version Type WBN 10...
Gimbal hinge version Type WBK 10...
PN 10



Type WBN

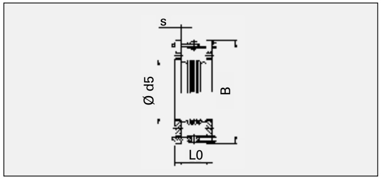


Type WBK

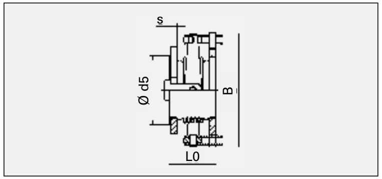
Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WBN 10 ... **WBK 10 ...**	**WBN**	**WBK**		**WBN**	**WBK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
50	31	**.0050.310.0**	441253	441163	131	10	14
50	37	**.0050.370.0**	441254	441164	151	10	14
65	26	**.0065.260.0**	441255	441165	121	11	16
65	37	**.0065.370.0**	441256	441166	162	12	16
80	25	**.0080.250.0**	441257	441167	132	12	17
80	36	**.0080.360.0**	441258	441168	162	13	18
100	26	**.0100.260.0**	441259	441169	142	15	20
100	36	**.0100.360.0**	441260	441170	182	16	22
125	25	**.0125.250.0**	441261	441171	162	18	23
125	34	**.0125.340.0**	441262	441172	202	19	25
150	23	**.0150.230.0**	441263	441173	173	23	32
150	36	**.0150.360.0**	441264	441174	233	24	33
200	22	**.0200.220.0**	441265	441175	183	29	43
200	32	**.0200.320.0**	441266	441176	234	31	45
250	18	**.0250.180.0**	441267	441177	183	45	69
250	30	**.0250.300.0**	441268	441178	264	50	74
300	23	**.0300.230.0**	441269	–	224	57	–
300	29	**.0300.290.0**	441270	441180	264	60	91
350	17	**.0350.170.0**	441271	–	204	68	–
350	26	**.0350.260.0**	441272	441181	274	73	113
400	12	**.0400.120.0**	441273	–	226	92	–
400	26	**.0400.260.0**	441274	441182	376	108	161
450	13	**.0450.130.0**	441275	–	246	135	–
450	25	**.0450.250.0**	441276	441183	366	154	244

Max. width approx.	Flange			Adjusting moment rate		
	drilling DIN 1092	rim diameter	thick- ness			
B	PN	d5	s	c_r	c_α	c_p
mm	–	mm	mm	Nm/bar	Nm/degrees	Nm/degrees bar
275	16	92	19	0.5	1.1	0.1
275	16	92	19	0.5	0.8	0.1
295	16	107	20	0.7	1.9	0.1
295	16	107	20	0.7	1.8	0.2
310	16	122	20	0.9	3.8	0.1
310	16	122	20	0.9	2.4	0.2
335	16	147	22	1.4	4.9	0.2
335	16	147	22	1.4	3.1	0.4
355	16	178	22	1.8	6	0.4
355	16	178	22	1.8	3.8	0.6
385	16	208	24	2.6	15	0.6
385	16	208	24	2.6	8.4	1.0
450	10	258	24	4	23	1.1
450	10	258	24	4	17	1.7
540	10	320	26	12	39	1.4
540	10	320	26	12	22	3.0
600	10	370	28	17	45	2.9
600	10	370	28	17	32	4.0
660	10	410	28	20	78	2.8
660	10	410	28	20	45	5.0
710	10	465	32	26	297	4.1
710	10	465	32	26	119	10.0
810	10	520	37	33	362	5.4
810	10	520	37	33	161	12.0

Angular expansion joints with swivel flanges
Single hinge version **Type WBN 10...**
Gimbal hinge version **Type WBK 10...**
PN 10



Type WBN



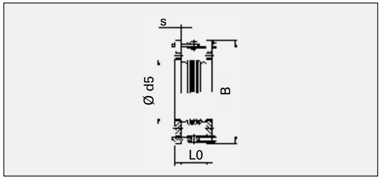
Type WBK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WBN 10 ... **WBK 10 ...**	**WBN**	**WBK**		**WBN**	**WBK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
500	14	**.0500.140.0**	441277	–	256	148	–
500	25	**.0500.250.0**	441278	441184	386	169	272
600	12	**.0600.120.0**	441279	–	276	196	–
600	23	**.0600.230.0**	441280	441185	416	222	377

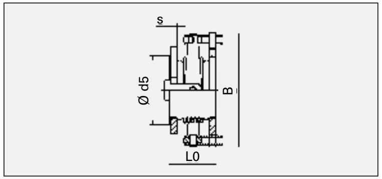
Max. width approx.	Flange			Adjusting moment rate		
	drilling DIN 1092	rim diameter	thick-ness			
B	PN	d5	s	c_r	c_α	c_p
mm	–	mm	mm	Nm/bar	Nm/degrees	Nm/degrees bar
860	10	570	37	55	395	7.1
860	10	570	37	55	176	16.0
980	10	670	43	77	581	11.0
980	10	670	43	77	259	24.0

Angular expansion joints with swivel flanges
Single hinge version **Type WBN 16...**
Gimbal hinge version **Type WBK 16...**
PN 16

Angular expansion joints with swivel flanges
Single hinge version **Type WBN 16...**
Gimbal hinge version **Type WBK 16...**
PN 16



Type WBN

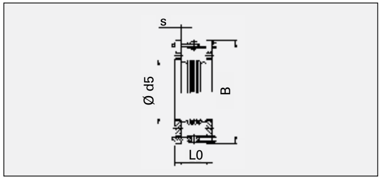


Type WBK

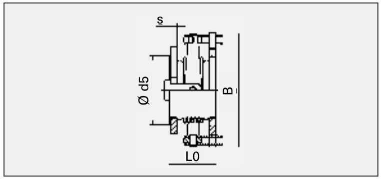
Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WBN 16 ... WBK 16 ...	WBN	WBK		WBN	WBK
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
50	25	**.0050.250.0**	441281	441186	122	10	14
50	34	**.0050.340.0**	441282	441187	152	10	14
65	25	**.0065.250.0**	441283	441188	132	11	16
65	34	**.0065.340.0**	441284	441189	163	12	17
80	23	**.0080.230.0**	441285	441190	143	13	18
80	32	**.0080.320.0**	441286	441191	173	14	19
100	24	**.0100.240.0**	441287	441192	153	16	22
100	33	**.0100.330.0**	441288	441193	183	17	24
125	24	**.0125.240.0**	441289	441194	163	19	27
125	33	**.0125.330.0**	441290	441195	214	20	29
150	22	**.0150.220.0**	441291	441196	173	23	36
150	31	**.0150.310.0**	441292	441197	224	25	37
200	22	**.0200.220.0**	441293	441198	195	43	64
200	31	**.0200.310.0**	441294	441199	245	46	67
250	14	**.0250.140.0**	441295	441200	214	52	81
250	23	**.0250.230.0**	441296	441201	285	59	88
300	15	**.0300.150.0**	441297	–	235	76	–
300	22	**.0300.220.0**	441298	441202	325	83	121
350	12	**.0350.120.0**	441299	–	215	116	–
350	19	**.0350.190.0**	441300	441203	305	126	195

Max. width approx.	Flange			Adjusting moment rate		
	drilling DIN 1092	rim diameter	thick-ness			
B	PN	d5	s	c_r	c_α	c_p
mm	–	mm	mm	Nm/bar	Nm/degrees	Nm/degrees bar
275	16	92	19	0.5	2.2	0.1
275	16	92	19	0.5	1.4	0.1
295	16	107	20	0.7	2.9	0.1
295	16	107	20	0.7	3.3	0.2
310	16	122	20	0.9	6.9	0.2
310	16	122	20	0.9	4.3	0.3
335	16	147	22	1.4	8.8	0.3
335	16	147	22	1.4	5.5	0.4
365	16	178	22	1.9	11	0.4
365	16	178	22	1.9	8.1	0.7
395	16	208	24	2.6	15	0.6
395	16	208	24	2.7	11	1.0
500	16	258	26	8	38	1.2
500	16	258	26	8	24	1.8
540	16	320	29	12	96	1.9
540	16	320	29	12	67	3.4
600	16	375	37	17	147	2.9
600	16	375	37	17	82	5.2
720	16	410	37	20	216	2.8
720	16	410	37	20	108	5.5

Angular expansion joints with swivel flanges
Single hinge version **Type WBN 25...**
Gimbal hinge version **Type WBK 25...**
PN 25

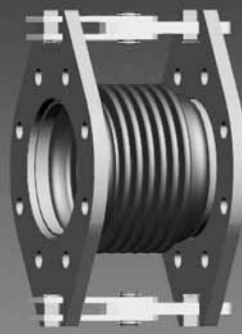


Type WBN



Type WBK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.		Max. width approx.	Flange			Adjusting moment rate		
		WBN 25 ... **WBK 25 ...**	**WBN**	**WBK**		**WBN**	**WBK**		drilling DIN 1092	rim diameter	thick-ness			
DN	$2\alpha_N$	–	–	–	Lo	G	G	B	PN	d5	s	c_r	c_α	c_p
–	degrees	–	–	–	mm	kg	kg	mm	–	mm	mm	Nm/bar	Nm/degrees	Nm/degrees bar
50	22	**.0050.220.0**	441301	441204	133	10	15	275	40	92	20	0.5	4.2	0.1
50	30	**.0050.300.0**	441302	441205	163	11	15	275	40	92	20	0.5	2.6	0.1
65	23	**.0065.230.0**	441303	441206	143	12	17	295	40	107	22	0.7	5.3	0.1
65	30	**.0065.300.0**	441304	441207	173	13	18	295	40	107	22	0.7	3.3	0.2
80	22	**.0080.220.0**	441305	441208	144	15	21	310	40	122	24	0.9	8.3	0.2
80	28	**.0080.280.0**	441306	441209	174	16	22	310	40	122	24	0.9	5.9	0.2
100	22	**.0100.220.0**	441307	441210	154	18	26	340	40	147	24	1.4	11	0.3
100	27	**.0100.270.0**	441308	441211	184	19	27	340	40	147	24	1.4	7.5	0.4
125	22	**.0125.220.0**	441309	441212	185	24	35	365	40	178	26	1.9	19	0.4
125	29	**.0125.290.0**	441310	441213	235	25	36	365	40	178	26	1.9	12	0.7
150	20	**.0150.200.0**	441311	441214	185	41	64	460	40	208	28	4.8	26	0.6
150	27	**.0150.270.0**	441312	441215	235	43	66	460	40	208	28	4.8	16	1.0
200	14	**.0200.140.0**	441313	441216	205	52	78	500	25	258	32	8	84	1.2
200	22	**.0200.220.0**	441314	441217	276	58	84	500	25	258	32	8	57	2.1
250	14	**.0250.140.0**	441315	–	236	74	–	570	25	320	37	12	147	2.0
250	20	**.0250.200.0**	441316	441218	296	79	118	570	25	320	37	12	92	3.2
300	14	**.0300.140.0**	441317	–	256	121	–	670	25	375	43	23	188	3.0
300	19	**.0300.190.0**	441318	441219	346	131	203	670	25	375	43	23	104	5.4
350	11	**.0350.110.0**	441319	–	258	163	–	750	25	410	47	27	343	3.2
350	18	**.0350.180.0**	441320	441220	328	173	265	750	25	410	47	27	196	5.6



Type WFN
Type WFK

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type WFN: HYDRA single hinge angular expansion joint with plain fixed flanges
Type WFK: HYDRA gimbal hinge angular expansion joint with plain fixed flanges

Standard version/materials:
multi-ply bellows: 1.4541
flange: P 265 GH (1.0425)
operating temperature: up to 400°C

Designation (example):

W	F	N	1	0	.	0	1	5	0	.	3	6	0	.	0

- W F N: Type
- 1 0: Nominal pressure (PN10)
- 0 1 5 0: Nominal diameter (DN150)
- 3 6 0: Movement absorption, nominal ($2\alpha = \pm 18 = 36^\circ$)
- 0: Inner sleeve (0 = without, 1 = with)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> for different materials
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l] ______________________
- piping – nominal size DN ______________________

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar] ______________________

max./min. allowable temperature TS [°C] ______________________

test pressure PT [bar] ______________________

Optional:

category ______________________

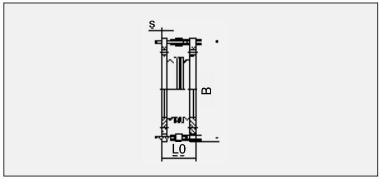
Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Angular expansion joints with plain fixed flanges

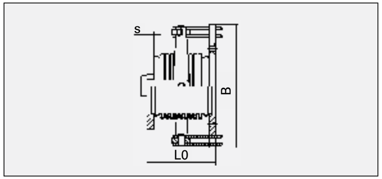
Single hinge version **Type WFN 06...**

Gimbal hinge version **Type WFK 06...**

PN 6



Type WFN



Type WFK

Nominal diameter	Nominal angular movement absorption	Type WFN 06 ... WFK 06 ...	Order No. standard version WFN	 WFK	Overall length	Weight approx. WFN	 WFK
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
50	33	**.0050.330.0**	442098	441321	140	7	11
50	41	**.0050.410.0**	442099	441322	160	7	11
65	27	**.0065.270.0**	442100	441323	130	8	13
65	39	**.0065.390.0**	442101	441324	160	9	13
80	27	**.0080.270.0**	442102	441325	140	11	16
80	38	**.0080.380.0**	442103	441326	170	12	17
100	27	**.0100.270.0**	442104	441327	140	12	17
100	38	**.0100.380.0**	442105	441328	170	13	18
125	30	**.0125.300.0**	442106	441329	160	15	21
125	39	**.0125.390.0**	442107	441330	190	16	22
150	23	**.0150.230.0**	442108	441331	170	17	23
150	36	**.0150.360.0**	442109	441332	220	17	24
200	23	**.0200.230.0**	442110	441333	180	22	32
200	34	**.0200.340.0**	442111	441334	240	24	35
250	18	**.0250.180.0**	442112	441335	180	29	44
250	32	**.0250.320.0**	442113	441336	260	31	46
300	19	**.0300.190.0**	442114	–	190	37	–
300	34	**.0300.340.0**	442115	441338	270	41	58
350	18	**.0350.180.0**	442116	–	200	58	–
350	34	**.0350.340.0**	442117	441340	310	67	98
400	13	**.0400.130.0**	442118	–	210	66	–
400	27	**.0400.270.0**	442119	441342	340	76	114
450	13	**.0450.130.0**	442120	–	210	74	–
450	24	**.0450.240.0**	442121	441343	330	83	132

Angular expansion joints with plain fixed flanges

Single hinge version **Type WFN 06...**

Gimbal hinge version **Type WFK 06...**

PN 6

Max. width approx.	Flange drilling DIN 1092	 thick-ness	Adjusting moment rate		
B	PN	s	c_r	c_α	c_p
mm	–	mm	Nm/bar	Nm/degrees	Nm/degrees bar
250	6	16	0.5	1.1	0.07
250	6	16	0.5	0.8	0.1
285	6	16	0.7	1.9	0.1
285	6	16	0.7	1.2	0.1
310	6	18	0.9	2.3	0.1
310	6	18	0.9	1.5	0.2
325	6	18	1.4	3.3	0.2
325	6	18	1.4	2.1	0.4
355	6	20	1.9	3	0.4
355	6	20	1.9	2.1	0.5
370	6	20	2.6	8.5	0.5
370	6	20	2.6	4.7	1.0
425	6	22	4	13	1.0
425	6	22	4	15	1.7
485	6	24	7	39	1.4
485	6	24	7	20	2.8
565	6	24	9	47	2.2
565	6	24	9	24	4.3
650	6	26	20	65	2.7
650	6	26	20	35	6.4
680	6	28	26	146	3.7
680	6	28	26	58	9.3
740	6	28	33	186	4.9
740	6	28	33	83	11.0

Angular expansion joints with plain fixed flanges

Single hinge version **Type WFN 06...**

Gimbal hinge version **Type WFK 06...**

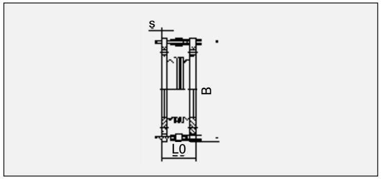
PN 6

Angular expansion joints with plain fixed flanges

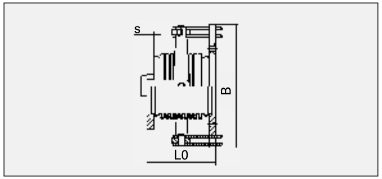
Single hinge version **Type WFN 06...**

Gimbal hinge version **Type WFK 06...**

PN 6



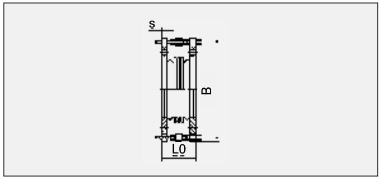
Type WFN



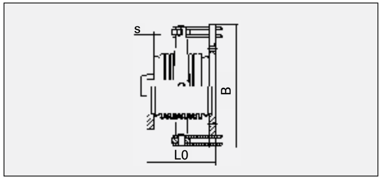
Type WFK

Nominal diameter	Nominal angular movement absorption	Type **WFN 06 ...** **WFK 06 ...**	Order No. standard version **WFN**	 **WFK**	Overall length	Weight approx. **WFN**	 **WFK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
500	14	**.0500.140.0**	442122	–	220	83	–
500	26	**.0500.260.0**	442123	441344	350	96	156
600	13	**.0600.130.0**	442124	–	250	148	–
600	25	**.0600.250.0**	442125	441345	390	167	282
700	14	**.0700.140.0**	442126	–	280	170	–
700	25	**.0700.250.0**	442127	441346	440	212	375
800	11	**.0800.110.0**	442128	–	290	231	–
800	23	**.0800.230.0**	442129	441347	490	275	489

Max. width approx.	Flange drilling DIN 1092	 thick-ness	Adjusting moment rate		
B	PN	s	c_r	c_α	c_p
mm	–	mm	Nm/bar	Nm/degrees	Nm/degrees bar
800	6	28	41	260	6.6
800	6	28	41	116	15.0
950	6	37	77	370	10.0
950	6	37	77	164	24.0
1060	6	37	104	422	18.0
1060	6	37	104	308	38.0
1180	6	43	135	1002	22.0
1180	6	43	135	401	54.0



Type WFN



Type WFK

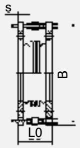
Nominal diameter	Nominal angular movement absorption	Type **WFN 10 ...** **WFK 10 ...**	Order No. standard version **WFN**	 **WFK**	Overall length	Weight approx. **WFN**	 **WFK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
50	31	**.0050.310.0**	442130	441348	140	10	14
50	37	**.0050.370.0**	442131	441349	160	10	14
65	26	**.0065.260.0**	442132	441350	130	11	16
65	37	**.0065.370.0**	442133	441351	170	11	17
80	25	**.0080.250.0**	442134	441352	140	12	17
80	36	**.0080.360.0**	442135	441353	180	13	18
100	26	**.0100.260.0**	442136	441354	150	15	20
100	36	**.0100.360.0**	442137	441355	190	16	21
125	25	**.0125.250.0**	442138	441356	170	17	24
125	34	**.0125.340.0**	442139	441357	210	18	24
150	23	**.0150.230.0**	442140	441358	180	23	32
150	36	**.0150.360.0**	442141	441359	240	24	33
200	22	**.0200.220.0**	442142	441360	190	28	42
200	32	**.0200.320.0**	442143	441361	240	30	44
250	18	**.0250.180.0**	442144	441362	190	38	68
250	30	**.0250.300.0**	442145	441363	270	42	73
300	23	**.0300.230.0**	442146	–	220	49	–
300	29	**.0300.290.0**	442147	441365	260	51	90
350	17	**.0350.170.0**	442148	–	200	67	–
350	26	**.0350.260.0**	442149	441366	270	72	112
400	12	**.0400.120.0**	442150	–	220	88	–
400	26	**.0400.260.0**	442151	441367	370	104	158
450	13	**.0450.130.0**	442152	–	240	116	–
450	25	**.0450.250.0**	442153	441368	360	132	241

Angular expansion joints with plain fixed flanges
Single hinge version **Type WFN 10...**
Gimbal hinge version **Type WFK 10...**
PN 10

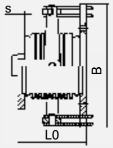
Max. width approx.	Flange drilling DIN 1092	 thick-ness	Adjusting moment rate		
B	PN	s	c_r	c_α	c_p
mm	–	mm	Nm/bar	Nm/degrees	Nm/degrees bar
275	16	19	0.5	1.1	0.07
275	16	19	0.5	0.8	0.1
295	16	20	0.7	1.9	0.1
295	16	20	0.7	1.8	0.2
310	16	20	0.9	3.8	0.1
310	16	20	0.9	2.4	0.2
335	16	22	1.4	4.9	0.2
335	16	22	1.4	3.1	0.4
355	16	22	1.8	6	0.4
355	16	22	1.8	3.8	0.6
385	16	24	2.6	15	0.6
385	16	24	2.6	8.4	1.0
450	10	24	4	23	1.1
450	10	24	4	17	1.7
540	10	26	12	39	1.4
540	10	26	12	22	3.0
600	10	28	17	45	2.9
600	10	28	17	32	4.0
660	10	28	20	78	2.8
660	10	28	20	45	5.0
710	10	32	26	297	4.1
710	10	32	26	119	10.0
810	10	37	33	362	5.4
810	10	37	33	161	12.0

Angular expansion joints with plain fixed flanges
Single hinge version **Type WFN 10...**
Gimbal hinge version **Type WFK 10...**
PN 10

Angular expansion joints with plain fixed flanges
Single hinge version Type WFN 10...
Gimbal hinge version Type WFK 10...
PN 10



Type WFN



Type WFK

Nominal diameter	Nominal angular movement absorption	Type **WFN 10 ...** **WFK 10 ...**	Order No. standard version **WFN**	 **WFK**	Overall length	Weight approx. **WFN**	 **WFK**	Max. width approx.	Flange drilling DIN 1092	 thick-ness	Adjusting moment rate		
DN	$2\alpha_N$	–	–	–	Lo	G	G	B	PN	s	c_r	c_α	c_p
–	degrees	–	–	–	mm	kg	kg	mm	–	mm	Nm/bar	Nm/degrees	Nm/degrees bar
500	14	**.0500.140.0**	442154	–	250	128	–	860	10	37	55	395	7.1
500	25	**.0500.250.0**	442155	441369	380	146	267	860	10	37	55	176	16.0
600	12	**.0600.120.0**	442156	–	270	190	–	980	10	43	77	581	11.0
600	23	**.0600.230.0**	442157	441370	410	216	372	980	10	43	77	259	24.0

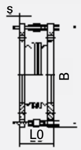
Angular expansion joints with plain fixed flanges

Single hinge version **Type WFN 16...**

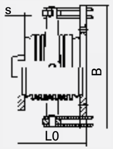
Gimbal hinge version **Type WFK 16...**

PN 16

Angular expansion joints with plain fixed flanges
Single hinge version **Type WFN 16...**
Gimbal hinge version **Type WFK 16...**
PN 16



Type WFN



Type WFK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WFN 16 ... **WFK 16 ...**	**WFN**	**WFK**		**WFN**	**WFK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
50	25	**.0050.250.0**	442158	441371	130	10	14
50	34	**.0050.340.0**	442159	441372	160	10	14
65	25	**.0065.250.0**	442160	441373	140	11	16
65	34	**.0065.340.0**	442161	441374	180	12	17
80	23	**.0080.230.0**	442162	441375	150	13	18
80	32	**.0080.320.0**	442163	441376	180	13	19
100	24	**.0100.240.0**	442164	441377	160	15	22
100	33	**.0100.330.0**	442165	441378	190	16	23
125	24	**.0125.240.0**	442166	441379	170	19	28
125	33	**.0125.330.0**	442167	441380	220	20	29
150	22	**.0150.220.0**	442168	441381	180	23	35
150	31	**.0150.310.0**	442169	441382	230	25	37
200	22	**.0200.220.0**	442170	441383	190	42	63
200	31	**.0200.310.0**	442171	441384	250	45	66
250	14	**.0250.140.0**	442172	441385	210	51	79
250	23	**.0250.230.0**	442173	441386	280	58	86
300	15	**.0300.150.0**	442174	–	230	74	–
300	22	**.0300.220.0**	442175	441387	320	81	120
350	12	**.0350.120.0**	442176	–	210	113	–
350	19	**.0350.190.0**	442177	441388	300	123	193

Max. width approx.	Flange		Adjusting moment rate		
	drilling DIN 1092	thick-ness			
B	PN	s	c_r	c_α	c_p
mm	–	mm	Nm/bar	Nm/degrees	Nm/degrees bar
275	16	19	0.5	2.2	0.06
275	16	19	0.5	1.4	0.1
295	16	20	0.7	2.9	0.1
295	16	20	0.7	3.3	0.2
310	16	20	0.9	6.9	0.2
310	16	20	0.9	4.3	0.3
335	16	22	1.4	8.8	0.3
335	16	22	1.4	5.5	0.4
365	16	22	1.9	11	0.4
365	16	22	1.9	8.1	0.7
395	16	24	2.6	15	0.6
395	16	24	2.7	11	1.0
500	16	26	8	38	1.2
500	16	26	8	24	1.8
540	16	29	12	96	1.9
540	16	29	12	67	3.4
600	16	37	17	147	2.9
600	16	37	17	82	5.2
720	16	37	20	216	2.8
720	16	37	20	108	5.5

Angular expansion joints with plain fixed flanges

Single hinge version **Type WFN 25...**

Gimbal hinge version **Type WFK 25...**

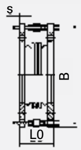
PN 25

Angular expansion joints with plain fixed flanges

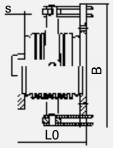
Single hinge version **Type WFN 25...**

Gimbal hinge version **Type WFK 25...**

PN 25



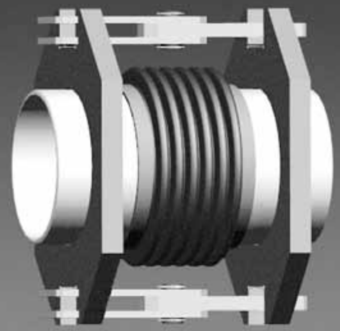
Type WFN



Type WFK

Nominal diameter	Nominal angular movement absorption	Type **WFN 25 ...** **WFK 25 ...**	Order No. standard version **WFN**	 **WFK**	Overall length	Weight approx. **WFN**	 **WFK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degrees	–	–	–	mm	kg	kg
50	22	**.0050.220.0**	442178	441389	140	10	15
50	30	**.0050.300.0**	442179	441390	170	11	16
65	23	**.0065.230.0**	442180	441391	150	13	17
65	30	**.0065.300.0**	442181	441392	180	13	18
80	22	**.0080.220.0**	442182	441393	150	15	21
80	28	**.0080.280.0**	442183	441394	180	16	22
100	22	**.0100.220.0**	442184	441395	160	18	26
100	27	**.0100.270.0**	442185	441396	180	19	27
125	22	**.0125.220.0**	442186	441397	180	23	35
125	29	**.0125.290.0**	442187	441398	230	25	36
150	20	**.0150.200.0**	442188	441399	180	40	63
150	27	**.0150.270.0**	442189	441400	230	43	66
200	14	**.0200.140.0**	442190	441401	200	51	77
200	22	**.0200.220.0**	442191	441402	270	57	83
250	14	**.0250.140.0**	442192	–	230	72	–
250	20	**.0250.200.0**	442193	441403	290	77	116
300	14	**.0300.140.0**	442194	–	250	118	–
300	19	**.0300.190.0**	442195	441404	340	128	201
350	11	**.0350.110.0**	442196	–	250	159	–
350	18	**.0350.180.0**	442197	441405	320	169	261

Max. width approx.	Flange drilling DIN 1092	 thick-ness	Adjusting moment rate		
B	PN	s	c_r	c_α	c_p
mm	–	mm	Nm/bar	Nm/degrees	Nm/degrees bar
275	40	20	0.5	4.2	0.07
275	40	20	0.5	2.6	0.1
295	40	22	0.7	5.3	0.1
295	40	22	0.7	3.3	0.2
310	40	24	0.9	8.3	0.2
310	40	24	0.9	5.9	0.2
340	40	24	1.4	11	0.3
340	40	24	1.4	7.5	0.4
365	40	26	1.9	19	0.4
365	40	26	1.9	12	0.7
460	40	28	4.8	26	0.6
460	40	28	4.8	16	1.0
500	25	32	8	84	1.2
500	25	32	8	57	2.1
570	25	37	12	147	2.0
570	25	37	12	92	3.2
670	25	43	23	188	3.0
670	25	43	23	104	5.4
750	25	47	27	343	3.2
750	25	47	27	196	5.6



Type WRN
Type WRK

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type WRN: HYDRA single hinge angular expansion joint with weld ends
Type WRK: HYDRA gimbal hinge angular expansion joint with weld ends

Standard version/materials:
multi-ply bellows: 1.4541
weld ends up to DN 300: P 235GH (1.0345), from DN 350: P 265GH (1.0425)
operating temperature: up to 400°C

Designation (example):

W	R	N	1	0	.	0	1	5	0	.	2	4	0	.	0

- W R N: Type
- 1 0: Nominal pressure (PN10)
- 0 1 5 0: Nominal diameter (DN150)
- 2 4 0: Movement absorption, nominal ($2\alpha = \pm 12 = 24°$)
- 0: Inner sleeve (0 = ohne, 1 = mit)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]

  ____

- piping – nominal size DN

  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]

____

max./min. allowable temperature TS [°C]

____

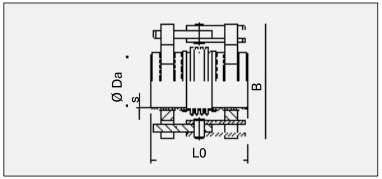
test pressure PT [bar]

____

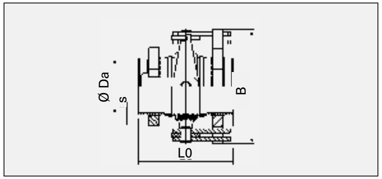
Optional:

category ____________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WRN 02 ... **WRK 02 ...**	**WRN**	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
400	10	**.. .0400.100**	441744	441436	290	32	49
400	20	**.. .0400.200**	441745	441437	350	35	52
400	28	**.. .0400.280**	441746	441438	410	37	54
450	10	**.. .0450.099**	441747	441439	290	37	58
450	19	**.. .0450.190**	441748	441440	355	41	61
450	26	**.. .0450.260**	441749	441441	420	43	64
500	11	**.. .0500.110**	441750	441442	320	44	71
500	20	**.. .0500.200**	441751	441443	385	48	75
500	30	**.. .0500.300**	441752	441444	475	53	80
600	10	**.. .0600.100**	441753	441445	345	64	104
600	22	**.. .0600.220**	441754	441446	450	70	110
600	29	**.. .0600.290**	441755	441447	550	76	116
700	9	**.. .0700.091**	441756	441448	395	92	165
700	17	**.. .0700.170**	441757	441449	475	99	172
700	25	**.. .0700.250**	441758	441450	615	110	184
800	8	**.. .0800.084**	441759	441451	440	126	229
800	18	**.. .0800.180**	441760	441452	555	136	239
800	26	**.. .0800.260**	441761	441453	670	156	261
900	7	**.. .0900.074**	441762	441454	445	146	279
900	14	**.. .0900.140**	441763	441455	530	155	288
900	20	**.. .0900.200**	441764	441456	680	169	303
1000	8	**.. .1000.077**	441765	441457	495	191	362
1000	14	**.. .1000.140**	441766	441458	590	200	372
1000	22	**.. .1000.220**	441767	441459	725	226	399

Angular expansion joint with weld ends
Single hinge version **Type WRN 02...**
Gimbal hinge version **Type WRK 02...**
PN 2.5

Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
595	406.4	6.0	14	142	2.6
595	406.4	6.0	14	71	5.3
595	406.4	6.0	14	47	7.9
655	457.0	6.0	18	165	3.5
655	457.0	6.0	18	82	7
655	457.0	6.0	18	55	11
715	508.0	6.0	23	179	4.5
715	508.0	6.0	23	89	9
715	508.0	6.0	23	54	15
815	610.0	6.0	32	254	7.3
815	610.0	6.0	32	109	17
815	610.0	6.0	32	69	27
970	711.0	6.0	78	326	11
970	711.0	6.0	78	162	21
970	711.0	6.0	78	89	39
1080	813.0	6.0	101	456	14
1080	813.0	6.0	101	196	33
1080	813.0	6.0	101	186	52
1200	914.0	6.0	128	628	19
1200	914.0	6.0	128	313	37
1200	914.0	6.0	128	170	68
1310	1016.0	6.0	157	814	24
1310	1016.0	6.0	157	408	49
1310	1016.0	6.0	158	367	84

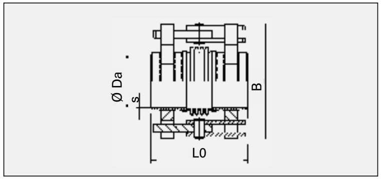
Angular expansion joint with weld ends

Single hinge version **Type WRN 02...**

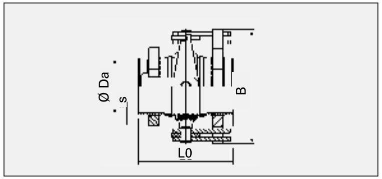
Gimbal hinge version **Type WRK 02...**

PN 2.5

Angular expansion joint with weld ends
Single hinge version **Type WRN 02...**
Gimbal hinge version **Type WRK 02...**
PN 2.5



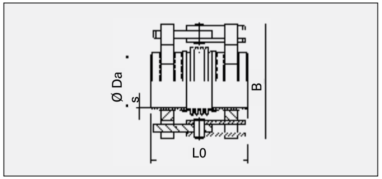
Type WRN



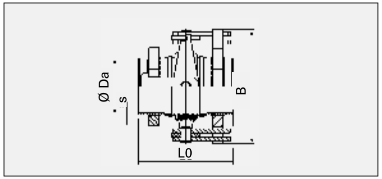
Type WRK

Nominal diameter	Nominal angular movement absorption	Type WRN 02 ... WRK 02 ...	Order No. standard version WRN	Order No. standard version WRK	Overall length	Weight approx. WRN	Weight approx. WRK	Max. width approx.	Weld ends outside-diameter	Weld ends wall thickness	Adjusting moment rate		
DN	$2\alpha_N$	–	–	–	Lo	G	G	B	Da	s	c_r	c_α	c_p
–	degree	–	–	–	mm	kg	kg	mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
1200	7	**.. .1200.065**	441768	441460	535	284	593	1540	1220.0	8.0	296	1750	34
1200	12	**.. .1200.120**	441769	441461	630	302	612	1540	1220.0	8.0	296	877	69
1200	18	**.. .1200.180**	441770	441462	755	326	637	1540	1220.0	8.0	296	524	115
1400	4	**.. .1400.040**	441771	–	565	396	–	1740	1420.0	8.0	399	5560	56
1400	8	**.. .1400.077**	441772	441463	680	416	858	1740	1420.0	8.0	399	2782	113
1400	12	**.. .1400.120**	441773	441464	850	469	913	1740	1420.0	8.0	400	2516	195
1600	4	**.. .1600.035**	441774	–	565	519	–	1995	1620.0	8.0	646	8156	73
1600	7	**.. .1600.068**	441775	441465	680	545	1231	1995	1620.0	8.0	646	4078	146
1600	11	**.. .1600.110**	441776	441466	835	580	1268	1995	1620.0	8.0	646	2446	243
1800	3	**.. .1800.031**	441777	–	565	570	–	2185	1820.0	8.0	811	11440	92
1800	6	**.. .1800.061**	441778	–	680	598	–	2185	1820.0	8.0	811	5724	183
1800	10	**.. .1800.095**	441779	441467	835	636	1516	2185	1820.0	8.0	811	3433	305
2000	3	**.. .2000.028**	441780	–	615	773	–	2425	2020.0	8.0	996	15513	112
2000	6	**.. .2000.055**	441781	–	730	802	–	2425	2020.0	8.0	996	7752	225
2000	9	**.. .2000.086**	441782	441468	885	843	1936	2425	2020.0	8.0	996	4655	375

Angular expansion joint with weld ends
Single hinge version **Type WRN 06...**
Gimbal hinge version **Type WRK 06...**
PN 6



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type WRN 06 ... WRK 06 ...	Order No. standard version WRN	Order No. standard version WRK	Overall length	Weight approx. WRN	Weight approx. WRK	Max. width approx.	Weld ends outside-diameter	Weld ends wall thickness	Adjusting moment rate		
DN	$2\alpha_N$	–	–	–	Lo	G	G	B	Da	s	c_r	c_α	c_p
–	degree	–	–	–	mm	kg	kg	mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
50	18	**.0050.180.0**	441798	441471	210	4.9	7.7	195	60.3	4.0	0.5	2.2	0.04
50	28	**.0050.280.0**	441799	441472	225	5.4	9.0	195	60.3	4.0	0.5	1.3	0.06
50	37	**.0050.370.0**	441800	441473	240	5.4	9.0	195	60.3	4.0	0.5	1	0.08
65	17	**.0065.170.0**	441801	441474	210	5.8	9.5	215	76.1	4.0	0.7	3.2	0.05
65	27	**.0065.270.0**	441802	441475	225	6.2	10	215	76.1	4.0	0.7	1.9	0.09
65	39	**.0065.390.0**	441803	441476	250	6.3	10	215	76.1	4.0	0.7	1.2	0.1
80	17	**.0080.170.0**	441804	441477	210	6.4	10	230	88.9	4.0	0.9	3.9	0.08
80	27	**.0080.270.0**	441805	441478	230	6.9	11	230	88.9	4.0	0.9	2.3	0.1
80	38	**.0080.380.0**	441806	441479	260	7.2	11	230	88.9	4.0	0.9	1.5	0.2
100	17	**.0100.170.0**	441807	441480	215	7.8	12	265	114.3	4.0	1.4	5.5	0.1
100	27	**.0100.270.0**	441808	441481	235	8.4	13	265	114.3	4.0	1.4	3.3	0.2
100	38	**.0100.380.0**	441809	441482	265	8.8	14	265	114.3	4.0	1.4	2.1	0.4
125	19	**.0125.190.0**	441810	441483	235	8.9	14	285	139.7	4.0	1.9	5	0.2
125	30	**.0125.300.0**	441811	441484	260	9.3	15	285	139.7	4.0	1.9	3	0.4
125	39	**.0125.390.0**	441812	441485	285	9.5	15	285	139.7	4.0	1.9	2.1	0.5
150	15	**.0150.150.0**	441813	441486	240	11	17	325	168.3	4.5	2.6	14	0.3
150	27	**.0150.270.0**	441814	441487	280	12	18	325	168.3	4.5	2.6	7.2	0.6
150	36	**.0150.360.0**	441815	441488	320	12	18	325	168.3	4.5	2.6	4.7	1
200	14	**.0200.140.0**	441816	441489	270	20	31	385	219.1	6.3	4.3	22	0.6
200	29	**.0200.290.0**	441817	441490	330	21	32	385	219.1	6.3	4.3	9.5	1.4
200	40	**.0200.400.0**	441818	441491	390	24	35	385	219.1	6.3	4.4	12	2.2
250	14	**.0250.140.0**	441819	441492	275	27	43	445	273.0	7.1	6.7	52	1.1
250	22	**.0250.220.0**	441820	441493	310	28	44	445	273.0	7.1	6.7	31	1.8
250	32	**.0250.320.0**	441821	441494	365	30	46	445	273.0	7.1	6.7	20	2.8

Angular expansion joint with weld ends

Single hinge version **Type WRN 06...**

Gimbal hinge version **Type WRK 06...**

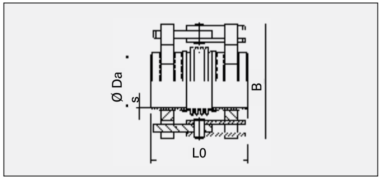
PN 6

Angular expansion joint with weld ends

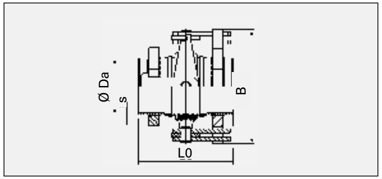
Single hinge version **Type WRN 06...**

Gimbal hinge version **Type WRK 06...**

PN 6



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WRN 06 ... **WRK 06 ...**	**WRN**	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
300	15	**.0300.150.0**	441822	441495	285	38	55
300	23	**.0300.230.0**	441823	441496	325	40	57
300	34	**.0300.340.0**	441824	441497	385	43	60
350	13	**.0350.130.0**	441825	441498	330	46	74
350	25	**.0350.250.0**	441826	441499	390	49	78
350	34	**.0350.340.0**	441827	441500	460	55	84
400	10	**.0400.100.0**	441828	441501	350	60	98
400	19	**.0400.190.0**	441829	441502	415	65	103
400	27	**.0400.270.0**	441830	441503	500	71	110
450	10	**.0450.098.0**	441831	441504	355	68	117
450	18	**.0450.180.0**	441832	441505	420	74	122
450	24	**.0450.240.0**	441833	441506	490	79	128
500	10	**.0500.100.0**	441834	441507	385	88	151
500	17	**.0500.170.0**	441835	441508	435	93	157
500	26	**.0500.260.0**	441836	441509	530	103	167
600	10	**.0600.100.0**	441837	441510	435	136	254
600	16	**.0600.160.0**	441838	441511	490	144	262
600	25	**.0600.250.0**	441839	441512	600	160	279
700	9	**.0700.091.0**	441840	–	475	195	–
700	17	**.0700.170.0**	441841	441513	555	209	374
700	24	**.0700.240.0**	441842	441514	655	238	404
800	8	**.0800.084.0**	441843	–	490	233	–
800	16	**.0800.160.0**	441844	441515	590	255	478
800	23	**.0800.230.0**	441845	441516	720	284	509

Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
495	323.9	8.0	9.3	63	1.6
495	323.9	8.0	9.3	38	2.7
495	323.9	8.0	9.3	24	4.3
580	355.6	6.0	20	87	2
580	355.6	6.0	20	43	4.1
580	355.6	6.0	20	35	6.4
640	406.4	6.0	26	194	2.8
640	406.4	6.0	26	97	5.6
640	406.4	6.0	26	58	9.3
700	457.0	6.0	33	248	3.7
700	457.0	6.0	33	124	7.3
700	457.0	6.0	33	83	11
750	508.0	6.0	41	347	4.9
750	508.0	6.0	41	208	8.2
750	508.0	6.0	41	116	15
900	610.0	6.0	77	493	7.9
900	610.0	6.0	77	296	13
900	610.0	6.0	77	164	24
1010	711.0	8.0	104	703	11
1010	711.0	8.0	104	352	21
1010	711.0	8.0	104	341	34
1120	813.0	8.0	135	1337	16
1120	813.0	8.0	135	668	32
1120	813.0	8.0	135	401	54

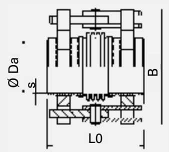
Angular expansion joint with weld ends

Single hinge version **Type WRN 06...**

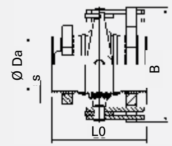
Gimbal hinge version **Type WRK 06...**

PN 6

Angular expansion joint with weld ends
Single hinge version **Type WRN 06...**
Gimbal hinge version **Type WRK 06...**
PN 6



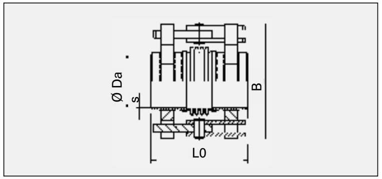
Type WRN



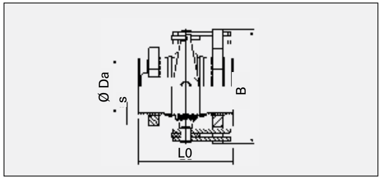
Type WRK

Nominal diameter	Nominal angular movement absorption	Type **WRN 06 ...** **WRK 06 ...**	Order No. standard version **WRN**	 **WRK**	Overall length	Weight approx. **WRN**	 **WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
900	7	**.0900.074.0**	441846	–	580	375	–
900	14	**.0900.140.0**	441847	441517	680	403	755
900	20	**.0900.200.0**	441848	441518	810	440	794
1000	7	**.1000.070.0**	441849	–	590	420	–
1000	13	**.1000.130.0**	441850	441519	695	451	888
1000	19	**.1000.190.0**	441851	441520	835	493	931
1200	6	**.1200.062.0**	441852	–	640	592	–
1200	12	**.1200.120.0**	441853	441521	745	628	1270
1200	17	**.1200.170.0**	441854	441522	885	675	1320
1400	4	**.1400.039.0**	441855	–	620	741	–
1400	8	**.1400.075.0**	441856	–	740	778	–
1400	11	**.1400.110.0**	441857	441523	900	827	1851
1600	3	**.1600.033.0**	441858	–	720	1090	–
1600	6	**.1600.063.0**	441859	–	840	1138	–
1600	9	**.1600.093.0**	441860	441524	1000	1201	2737
1800	3	**.1800.029.0**	441861	–	720	1207	–
1800	6	**.1800.056.0**	441862	–	840	1258	–
1800	9	**.1800.085.0**	441863	–	1000	1325	–
2000	3	**.2000.027.0**	441864	–	820	1844	–
2000	5	**.2000.051.0**	441865	–	940	1912	_
2000	8	**.2000.078.0**	441866	–	1100	2004	–

Max. width approx.	Weld ends outside-diameter	 wall thickness	Adjusting moment rate		
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
1285	914.0	8.0	215	1896	21
1285	914.0	8.0	215	949	41
1285	914.0	8.0	215	569	69
1395	1016.0	8.0	264	2379	27
1395	1016.0	8.0	264	1189	54
1395	1016.0	8.0	264	713	90
1615	1220.0	10.0	370	3743	38
1615	1220.0	10.0	370	1872	75
1615	1220.0	10.0	370	1124	126
1840	1420.0	10.0	666	8394	58
1840	1420.0	10.0	666	4195	117
1840	1420.0	10.0	666	2516	195
2080	1620.0	10.0	1077	12301	76
2080	1620.0	10.0	1077	6150	151
2080	1620.0	10.0	1077	3691	252
2280	1820.0	10.0	1353	17255	95
2280	1820.0	10.0	1353	8628	190
2280	1820.0	10.0	1353	5178	316
2575	2020.0	10.0	2075	23378	116
2575	2020.0	10.0	2075	11694	233
2575	2020.0	10.0	2075	7018	388



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WRN 10 ... **WRK 10 ...**	**WRN**	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
50	17	**.0050.170.0**	441867	441525	210	4.9	7.7
50	27	**.0050.270.0**	441868	441526	225	5.4	9.0
50	37	**.0050.370.0**	441869	441527	250	5.5	9.1
65	16	**.0065.160.0**	441870	441528	210	5.8	9.5
65	29	**.0065.290.0**	441871	441529	235	6.3	10
65	37	**.0065.370.0**	441872	441530	260	6.7	11
80	16	**.0080.160.0**	441873	441531	215	6.5	11
80	25	**.0080.250.0**	441874	441532	235	7	11
80	36	**.0080.360.0**	441875	441533	265	7.4	12
100	17	**.0100.170.0**	441876	441534	215	8	13
100	26	**.0100.260.0**	441877	441535	240	8.6	14
100	36	**.0100.360.0**	441878	441536	275	9.1	14
125	16	**.0125.160.0**	441879	441537	260	11.3	17
125	25	**.0125.250.0**	441880	441538	285	11.7	17
125	32	**.0125.320.0**	441881	441539	315	12	18
150	15	**.0150.150.0**	441882	441540	260	14	22
150	27	**.0150.270.0**	441883	441541	305	16	23
150	36	**.0150.360.0**	441884	441542	350	17	25
200	14	**.0200.140.0**	441885	441543	270	24	37
200	26	**.0200.260.0**	441886	441544	320	26	39
200	35	**.0200.350.0**	441887	441545	370	28	42
250	14	**.0250.140.0**	441888	441546	295	41	68
250	21	**.0250.210.0**	441889	441547	330	43	70
250	30	**.0250.300.0**	441890	441548	390	47	74

Angular expansion joint with weld ends
Single hinge version **Type WRN 10...**
Gimbal hinge version **Type WRK 10...**
PN 10

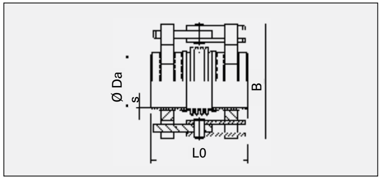
Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
195	60.3	4.0	0.5	2.2	0.04
195	60.3	4.0	0.5	1.3	0.06
195	60.3	4.0	0.5	0.8	0.1
215	76.1	4.0	0.7	3.2	0.05
215	76.1	4.0	0.7	1.6	0.1
215	76.1	4.0	0.7	1.8	0.2
230	88.9	4.0	0.9	6.3	0.09
230	88.9	4.0	0.9	3.8	0.1
230	88.9	4.0	0.9	2.4	0.2
265	114.3	4.0	1.4	8.2	0.1
265	114.3	4.0	1.4	4.9	0.2
265	114.3	4.0	1.4	3.1	0.4
285	139.7	4.0	1.8	10	0.2
285	139.7	4.0	1.8	6	0.4
285	139.7	4.0	1.8	4.3	0.5
325	168.3	4.5	2.6	25	0.3
325	168.3	4.5	2.6	13	0.7
325	168.3	4.5	2.6	8.4	1
385	219.1	6.3	4.4	39	0.6
385	219.1	6.3	4.4	20	1.3
385	219.1	6.3	4.4	15	2
480	273.0	7.1	12	52	1.1
480	273.0	7.1	12	31	1.8
480	273.0	7.1	12	22	3

Angular expansion joint with weld ends

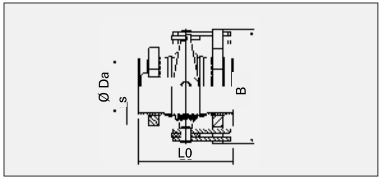
Single hinge version **Type WRN 10...**

Gimbal hinge version **Type WRK 10...**

PN 10



Type WRN



Type WRK

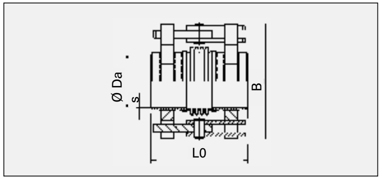
Nominal diameter	Nominal angular movement absorption	Type WRN 10 ... WRK 10 ...	Order No. standard version WRN	WRK	Overall length	Weight approx. WRN	WRK
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
300	15	**.0300.150.0**	441891	441549	330	58	90
300	23	**.0300.230.0**	441892	441550	370	61	93
300	29	**.0300.290.0**	441893	441551	410	63	95
350	13	**.0350.130.0**	441894	441552	350	53	90
350	21	**.0350.210.0**	441895	441553	395	56	93
350	26	**.0350.260.0**	441896	441554	435	59	96
400	9	**.0400.094.0**	441897	441555	355	71	122
400	18	**.0400.180.0**	441898	441556	430	79	130
400	26	**.0400.260.0**	441899	441557	520	90	141
450	10	**.0450.097.0**	441900	441558	420	131	217
450	16	**.0450.160.0**	441901	441559	470	139	225
450	23	**.0450.230.0**	441902	441560	545	150	237
500	10	**.0500.100.0**	441903	441561	470	150	254
500	16	**.0500.160.0**	441904	441562	525	158	263
500	24	**.0500.240.0**	441905	441563	605	171	277
600	9	**.0600.094.0**	441906	–	475	180	–
600	15	**.0600.150.0**	441907	441564	535	190	342
600	23	**.0600.230.0**	441908	441565	645	211	364
700	9	**.0700.086.0**	441909	–	525	288	–
700	16	**.0700.160.0**	441910	441566	620	316	574
700	22	**.0700.220.0**	441911	441567	715	344	603
800	8	**.0800.084.0**	441912	–	585	350	–
800	15	**.0800.150.0**	441913	441568	685	383	722
800	22	**.0800.220.0**	441914	441569	820	425	766

Angular expansion joint with weld ends
Single hinge version **Type WRN 10...**
Gimbal hinge version **Type WRK 10...**
PN 10

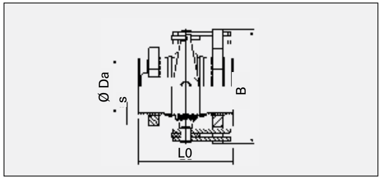
Max. width approx.	Weld ends outside-diameter	wall thickness	Adjusting moment rate		
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
540	323.9	8.0	17	76	1.7
540	323.9	8.0	17	45	2.9
540	323.9	8.0	17	32	4
580	355.6	6.0	20	104	2.1
580	355.6	6.0	20	62	3.6
580	355.6	6.0	20	45	5
640	406.4	6.0	26	397	3.1
640	406.4	6.0	26	198	6.1
640	406.4	6.0	26	119	10
740	457.0	8.0	33	482	4
740	457.0	8.0	33	289	6.7
740	457.0	8.0	33	181	11
790	508.0	8.0	55	526	5.4
790	508.0	8.0	55	316	8.9
790	508.0	8.0	55	197	14
900	610.0	8.0	77	775	8.2
900	610.0	8.0	77	465	14
900	610.0	8.0	77	259	24
1065	711.0	8.0	131	1381	12
1065	711.0	8.0	131	690	24
1065	711.0	8.0	131	461	36
1165	813.0	10.0	169	1794	17
1165	813.0	10.0	169	897	33
1165	813.0	10.0	169	538	56

Angular expansion joint with weld ends
Single hinge version **Type WRN 10...**
Gimbal hinge version **Type WRK 10...**
PN 10

Angular expansion joint with weld ends
Single hinge version **Type WRN 10...**
Gimbal hinge version **Type WRK 10...**
PN 10



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WRN 10 ... **WRK 10 ...**	**WRN**	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
900	7	**.0900.074.0**	441915	–	635	467	–
900	14	**.0900.140.0**	441916	441570	735	502	958
900	20	**.0900.200.0**	441917	441571	870	549	1006
1000	6	**.1000.057.0**	441918	–	745	689	–
1000	11	**.1000.110.0**	441919	441572	850	736	1403
1000	16	**.1000.160.0**	441920	441573	995	801	1471
1200	6	**.1200.059.0**	441921	–	750	885	–
1200	11	**.1200.110.0**	441922	–	860	942	–
1200	15	**.1200.150.0**	441923	441574	965	1000	2064
1400	4	**.1400.037.0**	441924	–	825	1389	–
1400	7	**.1400.069.0**	441925	–	950	1458	–
1400	10	**.1400.099.0**	441926	441575	1115	1551	3384

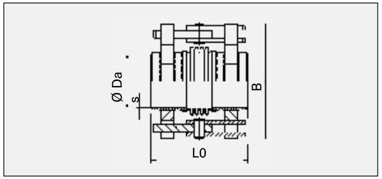
Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
1315	914.0	10.0	215	2542	21
1315	914.0	10.0	215	1272	43
1315	914.0	10.0	215	764	71
1450	1016.0	10.0	355	5007	28
1450	1016.0	10.0	355	2502	56
1450	1016.0	10.0	355	1502	93
1680	1220.0	10.0	617	5354	40
1680	1220.0	10.0	617	2677	80
1680	1220.0	10.0	617	1786	120
1975	1420.0	10.0	1041	11650	60
1975	1420.0	10.0	1041	5827	121
1975	1420.0	10.0	1041	3496	201

Angular expansion joint with weld ends

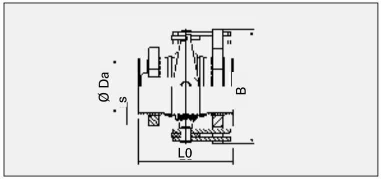
Single hinge version **Type WRN 16...**

Gimbal hinge version **Type WRK 16...**

PN 16



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WRN 16 ... WRK 16 ...	**WRN**	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
50	16	**.0050.160.0**	441927	441576	210	5	7.8
50	25	**.0050.250.0**	441928	441577	225	5.5	9.1
50	34	**.0050.340.0**	441929	441578	250	5.6	9.2
65	16	**.0065.160.0**	441930	441579	210	5.8	9.5
65	25	**.0065.250.0**	441931	441580	230	6.4	11
65	34	**.0065.340.0**	441932	441581	265	7.1	11
80	14	**.0080.140.0**	441933	441582	235	8.7	13
80	23	**.0080.230.0**	441934	441583	260	8.9	13
80	32	**.0080.320.0**	441935	441584	295	9.5	14
100	15	**.0100.150.0**	441936	441585	240	10.6	16
100	24	**.0100.240.0**	441937	441586	265	11.2	16
100	33	**.0100.330.0**	441938	441587	305	11.7	17
125	15	**.0125.150.0**	441939	441588	260	11.6	18
125	24	**.0125.240.0**	441940	441589	285	12.2	19
125	33	**.0125.330.0**	441941	441590	335	13.5	20
150	14	**.0150.140.0**	441942	441591	260	17	27
150	22	**.0150.220.0**	441943	441592	290	18	27
150	31	**.0150.310.0**	441944	441593	345	20	30
200	14	**.0200.140.0**	441945	441594	315	39	62
200	22	**.0200.220.0**	441946	441595	350	41	65
200	31	**.0200.310.0**	441947	441596	405	44	68
250	9	**.0250.091.0**	441948	441597	320	48	76
250	16	**.0250.160.0**	441949	441598	375	51	79
250	23	**.0250.230.0**	441950	441599	430	57	86

Angular expansion joint with weld ends

Single hinge version **Type WRN 16...**

Gimbal hinge version **Type WRK 16...**

PN 16

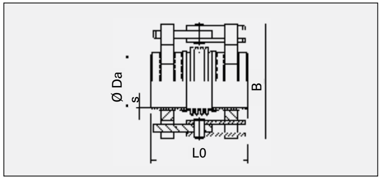
Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
195	60.3	4.0	0.5	3.7	0.04
195	60.3	4.0	0.5	2.2	0.06
195	60.3	4.0	0.5	1.4	0.1
215	76.1	4.0	0.7	4.9	0.06
215	76.1	4.0	0.7	2.9	0.1
215	76.1	4.0	0.7	3.3	0.2
230	88.9	4.0	0.9	12	0.09
230	88.9	4.0	0.9	6.9	0.2
230	88.9	4.0	0.9	4.3	0.3
265	114.3	4.0	1.4	15	0.2
265	114.3	4.0	1.4	8.8	0.3
265	114.3	4.0	1.4	5.5	0.4
285	139.7	4.0	1.9	18	0.2
285	139.7	4.0	1.9	11	0.4
285	139.7	4.0	1.9	8.1	0.7
325	168.3	4.5	2.6	25	0.3
325	168.3	4.5	2.6	15	0.6
325	168.3	4.5	2.7	11	1
420	219.1	6.3	7.9	63	0.7
420	219.1	6.3	7.9	38	1.2
420	219.1	6.3	7.9	24	1.8
480	273.0	7.1	12	160	1.1
480	273.0	7.1	12	80	2.2
480	273.0	7.1	12	67	3.4

Angular expansion joint with weld ends

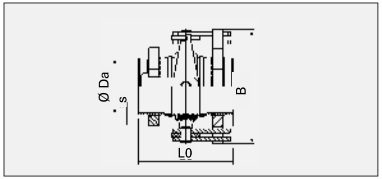
Single hinge version **Type WRN 16...**

Gimbal hinge version **Type WRK 16...**

PN 16



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type **WRN 16 ...** **WRK 16 ...**	Order No. standard version **WRN**	 **WRK**	Overall length	Weight approx. **WRN**	 **WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
300	10	**.0300.096.0**	441951	441600	350	67	107
300	15	**.0300.150.0**	441952	441601	390	71	111
300	22	**.0300.220.0**	441953	441602	470	78	118
350	9	**.0350.088.0**	441954	441603	410	101	164
350	14	**.0350.140.0**	441955	441604	450	106	169
350	20	**.0350.200.0**	441956	441605	530	116	179
400	9	**.0400.093.0**	441957	–	425	119	–
400	15	**.0400.150.0**	441958	441606	475	128	211
400	23	**.0400.230.0**	441959	441607	575	145	230
450	9	**.0450.090.0**	441960	–	425	134	–
450	14	**.0450.140.0**	441961	441608	475	144	250
450	22	**.0450.220.0**	441962	441609	575	163	271
500	10	**.0500.099.0**	441963	–	475	173	–
500	16	**.0500.160.0**	441964	441610	530	184	317
500	22	**.0500.220.0**	441965	441611	610	200	333
600	6	**.0600.063.0**	441966	–	520	255	–
600	12	**.0600.120.0**	441967	441612	610	279	515
600	16	**.0600.160.0**	441968	441613	695	303	540
700	6	**.0700.063.0**	441969	–	570	354	–
700	12	**.0700.120.0**	441970	–	665	383	–
700	16	**.0700.160.0**	441971	441614	755	412	743
800	6	**.0800.060.0**	441972	–	630	521	–
800	11	**.0800.110.0**	441973	–	725	557	–
800	15	**.0800.150.0**	441974	441615	820	595	1106

Angular expansion joint with weld ends

Single hinge version **Type WRN 16...**

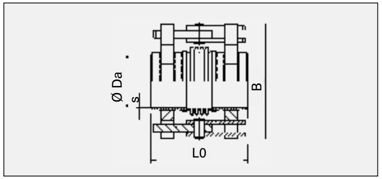
Gimbal hinge version **Type WRK 16...**

PN 16

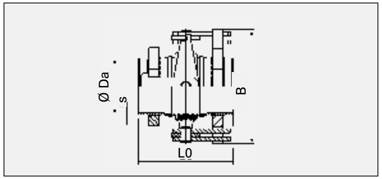
Max. width approx.	Weld ends outside-diameter	 wall thickness	Adjusting moment rate		
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
540	323.9	8.0	17	246	1.7
540	323.9	8.0	17	147	2.9
540	323.9	8.0	17	82	5.2
620	355.6	8.0	20	288	2.1
620	355.6	8.0	20	173	3.4
620	355.6	8.0	20	96	6.2
680	406.4	8.0	35	517	3.3
680	406.4	8.0	35	310	5.6
680	406.4	8.0	35	172	10
740	457.0	8.0	44	654	4.2
740	457.0	8.0	44	392	7
740	457.0	8.0	44	218	13
790	508.0	8.0	55	715	5.6
790	508.0	8.0	55	429	9.3
790	508.0	8.0	55	268	15
945	610.0	8.0	97	2052	8.5
945	610.0	8.0	97	1026	17
945	610.0	8.0	97	684	25
1085	711.0	10.0	131	2524	12
1085	711.0	10.0	131	1262	24
1085	711.0	10.0	131	841	35
1220	813.0	10.0	226	3410	16
1220	813.0	10.0	226	1705	32
1220	813.0	10.0	226	1136	47

Angular expansion joint with weld ends
Single hinge version **Type WRN 16...**
Gimbal hinge version **Type WRK 16...**
PN 16

Angular expansion joint with weld ends
Single hinge version **Type WRN 16...**
Gimbal hinge version **Type WRK 16...**
PN 16



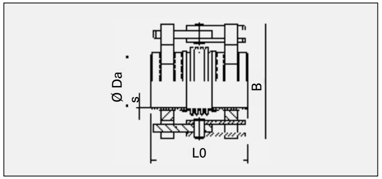
Type WRN



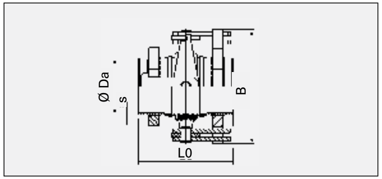
Type WRK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WRN 16 ... **WRK 16 ...**	**WRN**	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
900	6	**.0900.060.0**	441975	–	735	786	–
900	11	**.0900.110.0**	441976	441616	835	841	1591
900	16	**.0900.160.0**	441977	441617	970	913	1666
1000	6	**.1000.057.0**	441978	–	755	880	–
1000	9	**.1000.091.0**	441979	–	830	925	–
1000	14	**.1000.140.0**	441980	441618	980	1015	1957

Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
1380	914.0	10.0	362	4707	21
1380	914.0	10.0	362	2352	43
1380	914.0	10.0	362	1411	72
1490	1016.0	10.0	445	6654	29
1490	1016.0	10.0	445	3994	49
1490	1016.0	10.0	445	2218	88



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type **WRN 25 ...** **WRK 25 ...**	Order No. standard version **WRN**	**WRK**	Overall length	Weight approx. **WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
50	14	**.0050.140.0**	441981	441619	210	6.1	8.9
50	22	**.0050.220.0**	441982	441620	230	6.6	10.3
50	30	**.0050.300.0**	441983	441621	260	7.1	10.6
65	15	**.0065.150.0**	441984	441622	235	7.4	11.1
65	23	**.0065.230.0**	441985	441623	255	8	12
65	29	**.0065.290.0**	441986	441624	275	8.4	12
80	14	**.0080.140.0**	441987	441625	235	8.8	13
80	22	**.0080.220.0**	441988	441626	260	9.1	14
80	28	**.0080.280.0**	441989	441627	285	9.6	14
100	14	**.0100.140.0**	441990	441628	240	12.6	19
100	22	**.0100.220.0**	441991	441629	265	13.2	19
100	27	**.0100.270.0**	441992	441630	290	13.6	20
125	14	**.0125.140.0**	441993	441631	265	14.3	23
125	22	**.0125.220.0**	441994	441632	295	15	24
125	27	**.0125.270.0**	441995	441633	325	16	24
150	13	**.0150.130.0**	441996	441634	305	29	49
150	20	**.0150.200.0**	441997	441635	335	31	50
150	27	**.0150.270.0**	441998	441636	385	33	53
200	9	**.0200.091.0**	441999	441637	335	44	66
200	16	**.0200.160.0**	442000	441638	390	47	70
200	22	**.0200.220.0**	442001	441639	440	52	75
250	9	**.0250.090.0**	442002	441640	340	55	88
250	14	**.0250.140.0**	442003	441641	380	58	91
250	20	**.0250.200.0**	442004	441642	440	63	96

Angular expansion joint with weld ends
Single hinge version **Type WRN 25...**
Gimbal hinge version **Type WRK 25...**
PN 25

Max. width approx.	Weld ends outside-diameter	wall thickness	Adjusting moment rate		
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
195	60.3	4.0	0.5	6.9	0.04
195	60.3	4.0	0.5	4.2	0.07
195	60.3	4.0	0.5	2.6	0.1
215	76.1	4.0	0.7	8.8	0.07
215	76.1	4.0	0.7	5.3	0.1
215	76.1	4.0	0.7	3.8	0.2
230	88.9	4.0	0.9	14	0.1
230	88.9	4.0	0.9	8.3	0.2
230	88.9	4.0	0.9	5.9	0.2
265	114.3	4.0	1.4	18	0.2
265	114.3	4.0	1.4	11	0.3
265	114.3	4.0	1.4	7.5	0.4
285	139.7	4.0	1.9	31	0.3
285	139.7	4.0	1.9	19	0.4
285	139.7	4.0	1.9	13	0.6
360	168.3	4.5	4.8	44	0.4
360	168.3	4.5	4.8	26	0.6
360	168.3	4.5	4.8	16	1
420	219.1	6.3	8	140	0.7
420	219.1	6.3	8	70	1.4
420	219.1	6.3	8	57	2.1
480	273.0	7.1	12	245	1.2
480	273.0	7.1	12	147	2
480	273.0	7.1	12	92	3.2

Angular expansion joint with weld ends

Single hinge version **Type WRN 25...**

Gimbal hinge version **Type WRK 25...**

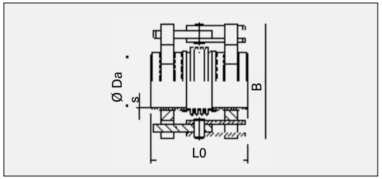
PN 25

Angular expansion joint with weld ends

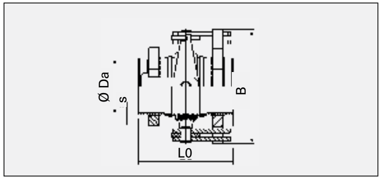
Single hinge version **Type WRN 25...**

Gimbal hinge version **Type WRK 25...**

PN 25



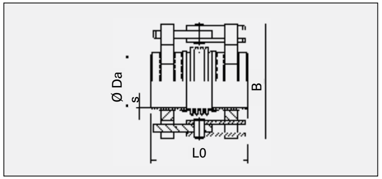
Type WRN



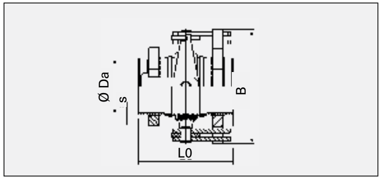
Type WRK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WRN 25 ... **WRK 25 ...**	**WRN**	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
300	9	**.0300.087.0**	442005	441643	410	105	168
300	14	**.0300.140.0**	442006	441644	455	110	173
300	18	**.0300.180.0**	442007	441645	520	118	181
350	9	**.0350.088.0**	442008	–	455	120	–
350	14	**.0350.140.0**	442009	441646	505	127	204
350	20	**.0350.200.0**	442010	441647	600	142	219
400	6	**.0400.062.0**	442011	–	460	138	–
400	12	**.0400.120.0**	442012	441648	535	151	255
400	16	**.0400.160.0**	442013	441649	605	164	268
450	6	**.0450.063.0**	442014	–	505	215	–
450	12	**.0450.120.0**	442015	441650	580	232	396
450	16	**.0450.160.0**	442016	441651	655	249	415
500	6	**.0500.062.0**	442017	–	525	248	–
500	10	**.0500.100.0**	442018	441652	585	265	467
500	16	**.0500.160.0**	442019	441653	705	299	502
600	6	**.0600.063.0**	442020	–	585	414	–
600	10	**.0600.100.0**	442021	–	645	438	–
600	15	**.0600.150.0**	442022	441654	770	484	829
700	6	**.0700.059.0**	442023	–	735	625	–
700	9	**.0700.093.0**	442024	–	800	655	–
700	14	**.0700.140.0**	442025	441655	930	716	1255

Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
580	323.9	8.0	23	313	1.8
580	323.9	8.0	23	188	3
580	323.9	8.0	23	118	4.8
620	355.6	8.0	27	458	2.4
620	355.6	8.0	27	275	4
620	355.6	8.0	27	153	7.2
680	406.4	8.0	35	1055	3.2
680	406.4	8.0	35	528	6.4
680	406.4	8.0	35	352	9.6
785	457.0	8.0	55	1336	4.2
785	457.0	8.0	55	668	8.4
785	457.0	8.0	55	445	13
845	508.0	8.0	69	1944	6
845	508.0	8.0	69	1166	10
845	508.0	8.0	69	648	18
1000	610.0	10.0	130	2543	9.1
1000	610.0	10.0	130	1526	15
1000	610.0	10.0	130	848	27
1150	711.0	10.0	219	3611	13
1150	711.0	10.0	219	2167	21
1150	711.0	10.0	219	1203	38



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type WRN 40 ... WRK 40 ...	Order No. standard version WRN	 WRK	Overall length	Weight approx. WRN	 WRK
DN	2α_N	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
50	14	**.0050.140.0**	442026	441656	235	6.4	9.2
50	21	**.0050.210.0**	442027	441657	255	6.9	10.6
50	25	**.0050.250.0**	442028	441658	275	7.3	10.8
65	12	**.0065.120.0**	442029	441659	235	8	12.2
65	19	**.0065.190.0**	442030	441660	260	8.4	13
65	26	**.0065.260.0**	442031	441661	295	9.1	13
80	13	**.0080.130.0**	442032	441662	240	10.4	16
80	20	**.0080.200.0**	442033	441663	265	11	16
80	24	**.0080.240.0**	442034	441664	290	11.4	16
100	8	**.0100.077.0**	442035	441665	240	12.4	20
100	12	**.0100.120.0**	442036	441666	265	12.9	21
100	17	**.0100.170.0**	442037	441667	315	14.3	22
125	9	**.0125.086.0**	442038	441668	305	25.4	43
125	13	**.0125.130.0**	442039	441669	335	26.9	44
125	17	**.0125.170.0**	442040	441670	365	28.3	46
150	8	**.0150.086.0**	442041	441671	325	33	50
150	13	**.0150.130.0**	442042	441672	355	34	52
150	17	**.0150.170.0**	442043	441673	385	36	54
200	8	**.0200.077.0**	442044	441674	340	53	82
200	12	**.0200.120.0**	442045	441675	380	57	85
200	17	**.0200.170.0**	442046	441676	440	61	90
250	8	**.0250.078.0**	442047	–	405	90	–
250	12	**.0250.120.0**	442048	441677	445	95	151
250	17	**.0250.170.0**	442049	441678	505	103	159

Angular expansion joint with weld ends
Single hinge version **Type WRN 40...**
Gimbal hinge version **Type WRK 40...**
PN 40

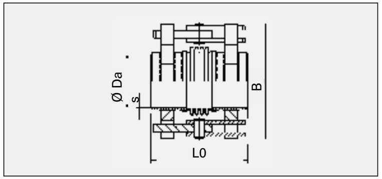
Max. width approx.	Weld ends outside-diameter	 wall thickness	Adjusting moment rate		
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
195	60.3	4.0	0.5	8.7	0.05
195	60.3	4.0	0.5	5.2	0.08
195	60.3	4.0	0.5	3.7	0.1
215	76.1	4.0	0.7	16	0.08
215	76.1	4.0	0.7	9.6	0.1
215	76.1	4.0	0.7	6	0.2
230	88.9	4.0	0.9	19	0.1
230	88.9	4.0	0.9	11	0.2
230	88.9	4.0	0.9	8.2	0.2
265	114.3	4.0	1.4	45	0.2
265	114.3	4.0	1.4	27	0.3
265	114.3	4.0	1.4	22	0.5
330	139.7	4.0	3.4	72	0.3
330	139.7	4.0	3.4	43	0.4
330	139.7	4.0	3.4	31	0.6
360	168.3	4.5	4.8	96	0.4
360	168.3	4.5	4.8	58	0.6
360	168.3	4.5	4.8	41	0.9
420	219.1	6.3	8	253	0.8
420	219.1	6.3	8	152	1.3
420	219.1	6.3	8	95	2.1
520	273.0	7.1	16	338	1.3
520	273.0	7.1	16	203	2.1
520	273.0	7.1	16	127	3.3

Angular expansion joint with weld ends

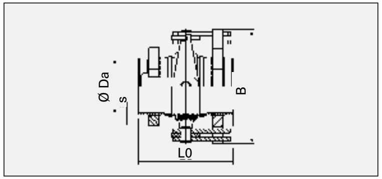
Single hinge version **Type WRN 40...**

Gimbal hinge version **Type WRK 40...**

PN 40



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type **WRN 40 ...** **WRK 40 ...**	Order No. standard version		Overall length	Weight approx.	
			WRN	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
300	6	**.0300.058.0**	442050	–	415	122	–
300	9	**.0300.092.0**	442051	441679	460	129	208
300	14	**.0300.140.0**	442052	441680	550	142	221
350	6	**.0350.061.0**	442053	–	495	173	–
350	10	**.0350.097.0**	442054	441681	545	181	307
350	14	**.0350.140.0**	442055	441682	640	200	327
400	6	**.0400.061.0**	442056	–	505	203	–
400	10	**.0400.097.0**	442057	–	560	214	–
400	14	**.0400.140.0**	442058	441683	665	238	396
450	6	**.0450.058.0**	442059	–	520	263	–
450	9	**.0450.093.0**	442060	–	575	279	–
450	13	**.0450.130.0**	442061	441684	665	300	509
500	4	**.0500.044.0**	442062	–	615	384	–
500	7	**.0500.070.0**	442063	–	675	400	–
500	11	**.0500.110.0**	442064	441685	785	436	739

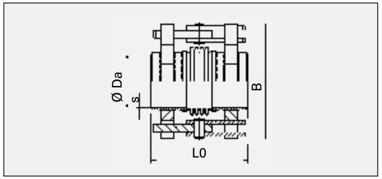
Angular expansion joint with weld ends

Single hinge version **Type WRN 40...**

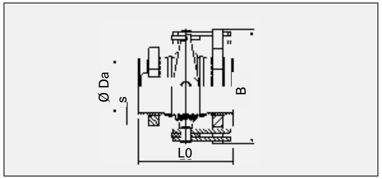
Gimbal hinge version **Type WRK 40...**

PN 40

Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
580	323.9	8.0	23	833	1.9
580	323.9	8.0	23	500	3.2
580	323.9	8.0	23	278	5.7
675	355.6	8.0	34	884	2.4
675	355.6	8.0	34	530	4
675	355.6	8.0	34	295	7.2
725	406.4	10.0	44	1154	3.5
725	406.4	10.0	44	692	5.8
725	406.4	10.0	44	385	10
815	457.0	10.0	56	1717	4.7
815	457.0	10.0	56	1030	7.9
815	457.0	10.0	56	644	13
890	508.0	10.0	91	3287	5.8
890	508.0	10.0	91	1972	9.6
890	508.0	10.0	91	1095	17



Type WRN



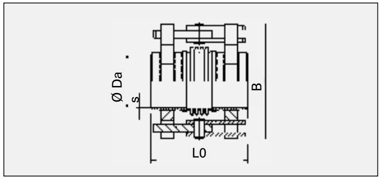
Type WRK

Nominal diameter	Nominal angular movement absorption	Type WRN 63 ... WRK 63 ...	Order No. standard version WRN	 WRK	Overall length	Weight approx. WRN	 WRK
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
50	9	**.0050.089.0**	442065	441686	235	7.7	11.0
50	13	**.0050.130.0**	442066	441687	255	7.8	11.0
50	16	**.0050.160.0**	442067	441688	275	8.2	11.0
65	9	**.0065.086.0**	442068	441689	235	9.1	13.0
65	13	**.0065.130.0**	442069	441690	260	9.6	14
65	17	**.0065.170.0**	442070	441691	295	10	14
80	8	**.0080.082.0**	442071	441692	255	11.8	17
80	13	**.0080.130.0**	442072	441693	280	12.4	17
80	16	**.0080.160.0**	442073	441694	305	12.7	18
100	7	**.0100.066.0**	442074	441695	285	25	39
100	10	**.0100.100.0**	442075	441696	310	26.3	40
100	14	**.0100.140.0**	442076	441697	350	27.9	42
125	8	**.0125.084.0**	442077	441698	330	30.9	44
125	11	**.0125.110.0**	442078	441699	345	31.3	45
125	16	**.0125.160.0**	442079	441700	395	34.3	48
150	7	**.0150.071.0**	442080	441701	360	43	60
150	11	**.0150.110.0**	442081	441702	395	45	63
150	14	**.0150.140.0**	442082	441703	430	47	65
200	5	**.0200.053.0**	442083	441704	405	86	126
200	10	**.0200.099.0**	442084	441705	465	93	133
200	13	**.0200.130.0**	442085	441706	525	100	140
250	5	**.0250.051.0**	442086	–	490	160	–
250	8	**.0250.081.0**	442087	441707	535	168	250
250	12	**.0250.120.0**	442088	441708	625	184	266

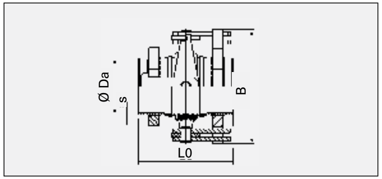
Angular expansion joint with weld ends
Single hinge version **Type WRN 63...**
Gimbal hinge version **Type WRK 63...**
PN 63

Max. width approx.	Weld ends outside-diameter	 wall thickness	Adjusting moment rate		
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
195	60.3	4.0	0.5	16	0.04
195	60.3	4.0	0.5	9.5	0.07
195	60.3	4.0	0.5	6.8	0.1
215	76.1	4.0	0.7	28	0.07
215	76.1	4.0	0.7	17	0.1
215	76.1	4.0	0.7	11	0.2
230	88.9	4.0	0.9	37	0.1
230	88.9	4.0	0.9	22	0.2
230	88.9	4.0	0.9	16	0.2
300	114.3	5.0	2.5	86	0.2
300	114.3	5.0	2.5	52	0.3
300	114.3	5.0	2.5	32	0.4
330	139.7	6.3	3.4	90	0.3
330	139.7	6.3	3.4	68	0.4
330	139.7	6.3	3.4	39	0.7
360	168.3	6.3	4.9	178	0.5
360	168.3	6.3	4.9	107	0.8
360	168.3	6.3	4.9	76	1.1
460	219.1	8.0	11	515	0.8
460	219.1	8.0	11	258	1.6
460	219.1	8.0	11	172	2.4
575	273.0	10.0	16	788	1.4
575	273.0	10.0	16	473	2.3
575	273.0	10.0	16	263	4.1

Angular expansion joint with weld ends
Single hinge version **Type WRN 63...**
Gimbal hinge version **Type WRK 63...**
PN 63



Type WRN



Type WRK

Nominal diameter	Nominal angular movement absorption	Type	Order No. standard version		Overall length	Weight approx.	
		WRN 63 ... **WRK 63 ...**	**WRN**	**WRK**		**WRN**	**WRK**
DN	$2\alpha_N$	–	–	–	Lo	G	G
–	degree	–	–	–	mm	kg	kg
300	5	**.0300.053.0**	442089	–	500	185	–
300	8	**.0300.082.0**	442090	441709	550	194	303
300	11	**.0300.110.0**	442091	441710	625	208	317
350	5	**.0350.052.0**	442092	–	570	239	–
350	10	**.0350.097.0**	442093	441711	655	260	399
350	13	**.0350.130.0**	442094	441712	740	280	419
400	4	**.0400.039.0**	442095	–	605	332	–
400	7	**.0400.072.0**	442096	–	635	353	–
400	10	**.0400.099.0**	442097	441713	740	385	602

Angular expansion joint with weld ends
Single hinge version **Type WRN 63...**
Gimbal hinge version **Type WRK 63...**
PN 63

Max. width approx.	Weld ends		Adjusting moment rate		
	outside-diameter	wall thickness			
B	Da	s	c_r	c_α	c_p
mm	mm	mm	Nm/bar	Nm/degree	Nm/degree bar
625	323.9	11.0	29	955	2.1
625	323.9	11.0	29	573	3.5
625	323.9	11.0	29	358	5.5
695	355.6	12.0	35	1448	2.9
695	355.6	12.0	35	724	5.9
695	355.6	12.0	35	483	8.8
780	406.4	15.0	59	2378	3.5
780	406.4	15.0	59	1189	7
780	406.4	15.0	59	956	11

Type LBR
Type LFR

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type LBR: HYDRA lateral expansion joint with swivel flanges, for movement in all planes

Type LFR: HYDRA lateral expansion joint with plain fixed flanges, for movement in all planes

Standard version/materials:
multi-ply bellows: 1.4541
flange: P 265 GH (1.0425)
operating temperature: up to 400°C

Designation (example):

L	B	R	1	0	.	0	1	5	0	.	1	0	2	.	0

- L B R: Type
- 1 0: Nominal pressure (PN10)
- 0 1 5 0: Nominal diameter (DN150)
- 1 0 2: Movement absorption, nominal (2λ = ±51 = 102 mm)
- 0: Inner sleeve (0 = ohne, 1 = mit)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]

  ____

- piping – nominal size DN

  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]

____

max./min. allowable temperature TS [°C]

____

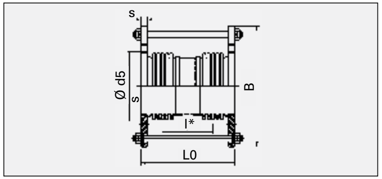
test pressure PT [bar]

____

Optional:

category ______________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.



Type LBR

Nominal diameter	Nominal lateral movement absorption	Type **LBR 06 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	51	**.0050.051.0**	439805	250	7	240
50	102	**.0050.102.0**	439806	360	7	240
50	154	**.0050.154.0**	439807	470	8	240
50	196	**.0050.196.0**	439808	560	10	240
65	53	**.0065.053.0**	439809	260	8	260
65	104	**.0065.104.0**	439810	370	8	260
65	151	**.0065.151.0**	439811	470	9	260
65	204	**.0065.204.0**	439812	580	9	260
80	53	**.0080.053.0**	439813	275	11	290
80	102	**.0080.102.0**	439814	385	11	290
80	154	**.0080.154.0**	439815	495	12	290
80	201	**.0080.201.0**	439816	595	12	290
100	52	**.0100.052.0**	439817	275	12	310
100	103	**.0100.103.0**	439818	385	13	310
100	151	**.0100.151.0**	439819	485	13	310
100	204	**.0100.204.0**	439820	595	14	310
125	51	**.0125.051.0**	439821	310	15	340
125	103	**.0125.103.0**	439822	450	16	340
125	153	**.0125.153.0**	439823	580	17	340
125	203	**.0125.203.0**	439824	710	18	340
150	53	**.0150.053.0**	439825	330	19	365
150	101	**.0150.101.0**	439826	450	20	365
150	151	**.0150.151.0**	439827	570	22	365
150	202	**.0150.202.0**	439828	690	23	365

Lateral expansion joint **Type LBR 06...**

for movement in all planes with lap-joint flanges

PN 6

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
136	6	90	16	4.9	14	0
246	6	90	16	3.6	4.2	0
356	6	90	16	2.8	2	0
445	6	90	16	2.4	1.3	0
141	6	107	16	7.2	17	0
251	6	107	16	5.3	5.3	0
351	6	107	16	4.3	2.7	0
461	6	107	16	3.5	1.6	0
146	6	122	18	8.9	20	0
256	6	122	18	6.6	6.6	0
366	6	122	18	5.3	3.2	0
466	6	122	18	4.5	2	0
141	6	147	18	14	28	0
251	6	147	18	10	8.9	0
351	6	147	18	8.3	4.6	0
461	6	147	18	6.9	2.6	0
167	6	178	20	16	31	0
307	6	178	20	12	9.2	0
437	6	178	20	9.3	4.8	0
567	6	178	20	7.7	2.8	0
166	6	202	20	22	62	0
286	6	202	20	17	21	0
406	6	202	20	14	11	0
526	6	202	20	11	6.5	0

Lateral expansion joint — Type LBR 06...

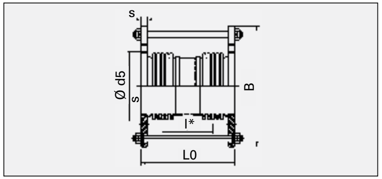
for movement in all planes with lap-joint flanges

PN 6

Lateral expansion joint — Type LBR 06...

for movement in all planes with lap-joint flanges

PN 6



Type LBR

Nominal diameter	Nominal lateral movement absorption	Type LBR 06 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	51	**.0200.051.0**	439829	345	27	420
200	100	**.0200.100.0**	439830	475	29	420
200	153	**.0200.153.0**	439831	605	30	420
200	198	**.0200.198.0**	439832	730	45	420
250	50	**.0250.050.0**	439833	365	38	503
250	102	**.0250.102.0**	439834	505	41	503
250	153	**.0250.153.0**	439835	635	43	503
250	212	**.0250.212.0**	439836	805	66	503
300	50	**.0300.050.0**	439837	380	52	600
300	101	**.0300.101.0**	439838	540	56	600
300	152	**.0300.152.0**	439839	690	60	600
300	196	**.0300.196.0**	439840	840	93	600
300	296	**.0300.296.0**	439841	1140	116	600
350	52	**.0350.052.0**	439842	410	65	650
350	102	**.0350.102.0**	439843	580	70	650
350	148	**.0350.148.0**	439844	755	94	650
350	195	**.0350.195.0**	439845	905	104	650
350	300	**.0350.300.0**	439846	1255	127	650
400	51	**.0400.051.0**	439847	465	87	724
400	100	**.0400.100.0**	439848	665	109	724
400	158	**.0400.158.0**	439849	865	125	724
400	200	**.0400.200.0**	439850	1015	137	724
400	294	**.0400.294.0**	439851	1415	168	724

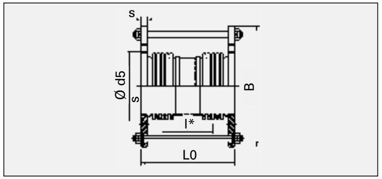
Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
166	6	258	22	42	95	0
296	6	258	22	32	30	0
426	6	258	22	26	16	0
535	6	258	22	22	9.3	0
171	6	312	24	80	123	0
311	6	312	24	61	37	0
441	6	312	24	50	20	0
590	6	312	24	41	10	0
191	6	365	24	155	146	0
351	6	365	24	115	43	0
501	6	365	24	93	21	0
630	6	365	24	78	14	0
930	6	365	24	59	6.2	0
215	6	410	26	173	160	0
385	6	410	26	129	50	0
534	6	410	26	103	26	0
684	6	410	26	87	16	0
1034	6	410	26	65	6.9	0
231	6	465	28	251	248	0
410	6	465	28	187	78	0
610	6	465	28	149	35	0
760	6	465	28	130	23	0
1160	6	465	28	96	9.9	0

Lateral expansion joint — Type LBR 06...

for movement in all planes with lap-joint flanges

PN 6

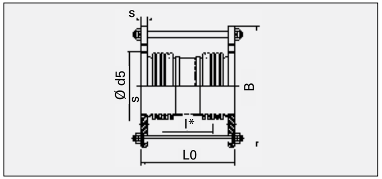
Lateral expansion joint Type LBR 06...
for movement in all planes with lap-joint flanges
PN 6



Type LBR

Nominal diameter	Nominal lateral movement absorption	Type **LBR 06 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
450	50	**.0450.050.0**	439852	475	96	779
450	97	**.0450.097.0**	439853	675	121	779
450	152	**.0450.152.0**	439854	875	139	779
450	192	**.0450.192.0**	439855	1025	152	779
450	289	**.0450.289.0**	439856	1390	189	779
500	52	**.0500.052.0**	439857	495	134	865
500	104	**.0500.104.0**	439858	710	164	865
500	147	**.0500.147.0**	439859	860	179	865
500	207	**.0500.207.0**	439860	1060	199	865
500	289	**.0500.289.0**	439861	1360	229	865

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
236	6	520	28	315	303	0
415	6	520	28	234	96	0
615	6	520	28	187	44	0
765	6	520	28	160	29	0
1120	6	520	28	122	18	0
236	6	570	32	424	422	0
425	6	570	32	313	128	0
575	6	570	32	263	71	0
775	6	570	32	219	39	0
1075	6	570	32	175	20	0



Type LBR

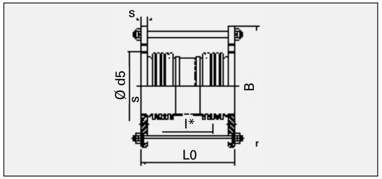
Nominal diameter	Nominal lateral movement absorption	Type LBR 10 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	51	**.0050.051.0**	439862	260	10	265
50	102	**.0050.102.0**	439863	370	10	265
50	146	**.0050.146.0**	439864	465	12	265
50	202	**.0050.202.0**	439865	615	14	265
65	53	**.0065.053.0**	439866	270	11	285
65	104	**.0065.104.0**	439867	380	12	285
65	146	**.0065.146.0**	439868	480	12	285
65	201	**.0065.201.0**	439869	630	13	285
80	53	**.0080.053.0**	439870	300	13	300
80	101	**.0080.101.0**	439871	420	14	300
80	151	**.0080.151.0**	439872	540	15	300
80	202	**.0080.202.0**	439873	660	16	300
100	50	**.0100.050.0**	439874	290	15	320
100	100	**.0100.100.0**	439875	420	16	320
100	146	**.0100.146.0**	439876	550	17	320
100	203	**.0100.203.0**	439877	730	18	320
125	50	**.0125.050.0**	439878	315	20	350
125	100	**.0125.100.0**	439879	435	21	350
125	153	**.0125.153.0**	439880	555	22	350
125	200	**.0125.200.0**	439881	665	23	350
150	51	**.0150.051.0**	439882	340	27	385
150	102	**.0150.102.0**	439883	470	29	385
150	151	**.0150.151.0**	439884	590	30	385
150	202	**.0150.202.0**	439885	710	32	385

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
136	16	92	19	4.7	13	0
246	16	92	19	3.5	4.1	0
345	16	92	19	2.8	2.1	0
495	16	92	19	2.2	1	0
141	16	107	20	6.9	17	0
251	16	107	20	5.2	5.2	0
351	16	107	20	4.2	2.7	0
501	16	107	20	3.3	1.3	0
161	16	122	20	8.2	30	0
281	16	122	20	6.1	9.9	0
401	16	122	20	4.9	4.9	0
521	16	122	20	4.1	2.9	0
159	16	147	22	13	27	0
289	16	147	22	9.4	8.3	0
419	16	147	22	7.4	4	0
599	16	147	22	5.7	1.9	0
151	16	178	22	16	53	0
271	16	178	22	12	17	0
391	16	178	22	9.9	8.6	0
501	16	178	22	8.3	5.2	0
161	16	208	24	26	79	0
291	16	208	24	20	24	0
411	16	208	24	16	13	0
531	16	208	24	14	7.7	0

Lateral expansion joint **Type LBR 10...**

for movement in all planes with lap-joint flanges

PN 10



Type LBR

Nominal diameter	Nominal lateral movement absorption	Type LBR 10 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	52	**.0200.052.0**	439886	365	37	468
200	100	**.0200.100.0**	439887	515	39	468
200	153	**.0200.153.0**	439888	675	42	468
200	206	**.0200.206.0**	439889	855	61	468
250	52	**.0250.052.0**	439890	395	52	555
250	101	**.0250.101.0**	439891	555	56	555
250	152	**.0250.152.0**	439892	715	60	555
250	198	**.0250.198.0**	439893	885	87	555
300	51	**.0300.051.0**	439894	405	72	629
300	102	**.0300.102.0**	439895	565	78	629
300	145	**.0300.145.0**	439896	715	104	629
300	196	**.0300.196.0**	439897	865	116	629
300	292	**.0300.292.0**	439898	1165	141	629
350	50	**.0350.050.0**	439899	420	87	689
350	100	**.0350.100.0**	439900	590	94	689
350	149	**.0350.149.0**	439901	775	118	689
350	195	**.0350.195.0**	439902	925	129	689
350	296	**.0350.296.0**	439903	1275	153	689
400	51	**.0400.051.0**	439904	515	147	785
400	106	**.0400.106.0**	439905	760	176	785
400	146	**.0400.146.0**	439906	910	189	785
400	200	**.0400.200.0**	439907	1110	206	785
400	287	**.0400.287.0**	439908	1460	235	785

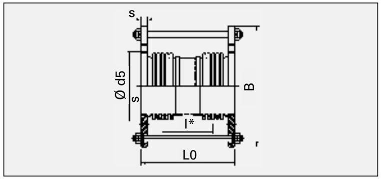
Lateral expansion joint **Type LBR 10...**

for movement in all planes with lap-joint flanges

PN 10

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
199	PN10	258	24	54	95	0
349	PN10	258	24	40	31	0
509	PN10	258	24	32	16	0
668	PN10	258	24	26	8.5	0
207	PN10	320	26	110	116	0
367	PN10	320	26	82	41	0
527	PN10	320	26	66	19	0
676	PN10	320	26	54	11	0
199	PN10	370	28	181	213	0
359	PN10	370	28	138	66	0
488	PN10	370	28	115	35	0
638	PN10	370	28	96	21	0
938	PN10	370	28	73	9.7	0
213	PN10	410	28	207	258	0
383	PN10	410	28	160	80	0
542	PN10	410	28	127	39	0
692	PN10	410	28	108	24	0
1042	PN10	410	28	81	11	0
251	PN10	465	37	266	428	0
470	PN10	465	37	193	119	0
620	PN10	465	37	163	69	0
820	PN10	465	37	137	40	0
1170	PN10	465	37	108	20	0

PN 10

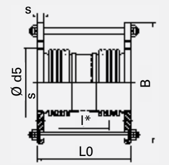


Type LBR

Nominal diameter	Nominal lateral movement absorption	Type **LBR 10 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
450	51	**.0450.051.0**	439909	505	174	756
450	98	**.0450.098.0**	439910	710	210	756
450	153	**.0450.153.0**	439911	910	235	756
450	195	**.0450.195.0**	439912	1060	254	756
450	285	**.0450.285.0**	439913	1410	298	756
500	51	**.0500.051.0**	439914	510	197	808
500	105	**.0500.105.0**	439915	735	239	808
500	148	**.0500.148.0**	439916	885	259	808
500	207	**.0500.207.0**	439917	1085	286	808
500	306	**.0500.306.0**	439918	1485	341	808

PN 10

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
246	PN10	520	32	297	543	0
425	PN10	520	32	225	176	0
625	PN10	520	32	181	83	0
775	PN10	520	32	159	54	0
1125	PN10	520	32	121	26	0
236	PN10	570	34	367	642	0
435	PN10	570	34	271	184	0
585	PN10	570	34	227	103	0
785	PN10	570	34	189	58	0
1185	PN10	570	34	142	25	0



Type LBR

Nominal diameter	Nominal lateral movement absorption	Type LBR 16 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	50	**.0050.050.0**	439919	280	10	265
50	103	**.0050.103.0**	439920	410	11	265
50	149	**.0050.149.0**	439921	530	13	265
50	199	**.0050.199.0**	439922	680	14	265
65	53	**.0065.053.0**	439923	290	12	285
65	104	**.0065.104.0**	439924	410	13	285
65	145	**.0065.145.0**	439925	520	14	285
65	198	**.0065.198.0**	439926	680	15	285
80	51	**.0080.051.0**	439927	300	14	300
80	102	**.0080.102.0**	439928	430	15	300
80	150	**.0080.150.0**	439929	550	16	300
80	205	**.0080.205.0**	439930	720	17	300
100	50	**.0100.050.0**	439931	310	16	320
100	103	**.0100.103.0**	439932	460	17	320
100	145	**.0100.145.0**	439933	590	18	320
100	202	**.0100.202.0**	439934	790	20	320
125	53	**.0125.053.0**	439935	345	23	350
125	102	**.0125.102.0**	439936	475	25	350
125	151	**.0125.151.0**	439937	595	26	350
125	196	**.0125.196.0**	439938	715	28	350
150	53	**.0150.053.0**	439939	360	32	413
150	100	**.0150.100.0**	439940	490	34	413
150	153	**.0150.153.0**	439941	630	37	413
150	194	**.0150.194.0**	439942	760	40	413

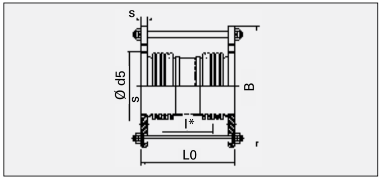
Lateral expansion joint Type LBR 16...
for movement in all planes with lap-joint flanges
PN 16

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
151	PN16	92	19	4.5	20	0
281	PN16	92	19	3.2	5.9	0
400	PN16	92	19	2.6	2.9	0
550	PN16	92	19	2	1.5	0
156	PN16	107	20	6.6	25	0
276	PN16	107	20	4.9	7.8	0
386	PN16	107	20	3.9	4	0
546	PN16	107	20	3.1	2	0
161	PN16	122	20	8.3	36	0
291	PN16	122	20	6.1	11	0
411	PN16	122	20	4.8	5.5	0
581	PN16	122	20	3.8	2.8	0
173	PN16	147	22	12	41	0
323	PN16	147	22	8.7	12	0
453	PN16	147	22	6.9	6	0
653	PN16	147	22	5.3	2.9	0
171	PN16	178	22	18	72	0
301	PN16	178	22	14	23	0
421	PN16	178	22	11	13	0
541	PN16	178	22	9.5	7.6	0
181	PN16	208	24	33	90	0
311	PN16	208	24	25	31	0
451	PN16	208	24	20	15	0
581	PN16	208	24	17	9.2	0

Lateral expansion joint **Type LBR 16...**

for movement in all planes with lap-joint flanges

PN 16



Type LBR

Nominal diameter	Nominal lateral movement absorption	Type **LBR 16 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	50	**.0200.050.0**	439943	365	46	500
200	100	**.0200.100.0**	439944	525	50	500
200	150	**.0200.150.0**	439945	675	54	500
200	200	**.0200.200.0**	439946	865	73	500
250	52	**.0250.052.0**	439947	465	77	589
250	103	**.0250.103.0**	439948	685	98	589
250	154	**.0250.154.0**	439949	885	111	589
250	207	**.0250.207.0**	439950	1135	127	589
300	50	**.0300.050.0**	439951	500	119	680
300	95	**.0300.095.0**	439952	670	134	680
300	145	**.0300.145.0**	439953	870	151	680
300	196	**.0300.196.0**	439954	1120	173	680
300	296	**.0300.296.0**	439955	1620	217	680
350	51	**.0350.051.0**	439956	520	162	667
350	100	**.0350.100.0**	439957	720	183	667
350	149	**.0350.149.0**	439958	920	204	667
350	199	**.0350.199.0**	439959	1170	231	667
350	306	**.0350.206.0**	439960	1720	288	667
400	52	**.0400.052.0**	439961	555	199	723
400	94	**.0400.094.0**	439962	725	219	723
400	147	**.0400.147.0**	439963	925	242	723
400	200	**.0400.200.0**	439964	1125	265	723
400	309	**.0400.309.0**	439965	1625	323	723

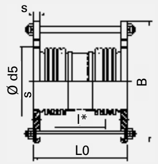
Lateral expansion joint **Type LBR 16...**

for movement in all planes with lap-joint flanges

PN 16

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
193	PN16	258	26	75	145	0
353	PN16	258	26	55	43	0
503	PN16	258	26	45	23	0
672	PN16	258	26	36	12	0
246	PN16	320	32	117	226	0
445	PN16	320	32	85	68	0
645	PN16	320	32	68	33	0
895	PN16	320	32	55	17	0
235	PN16	375	37	176	281	0
405	PN16	375	37	136	99	0
605	PN16	375	37	109	45	0
855	PN16	375	37	88	23	0
1355	PN16	375	37	63	9.1	0
260	PN16	410	32	182	330	0
460	PN16	410	32	138	110	0
660	PN16	410	32	111	54	0
910	PN16	410	32	88	28	0
1460	PN16	410	32	62	11	0
260	PN16	465	34	224	478	0
430	PN16	465	34	176	184	0
630	PN16	465	34	142	87	0
830	PN16	465	34	119	50	0
1330	PN16	465	34	85	20	0

Lateral expansion joint Type LBR 16...
for movement in all planes with lap-joint flanges
PN 16

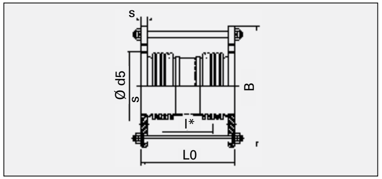


Type LBR

Nominal diameter	Nominal lateral movement absorption	Type LBR 16 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Flange drilling DIN 1092	Flange rim diameter	Flange thickness	Adjusting force rate		
DN	$2\lambda_N$	–	–	Lo	G	B	l*	PN	d5	s	c_r	c_λ	c_p
–	mm	–	–	mm	kg	mm	mm	–	mm	mm	N/bar	N/mm	N/mm bar
450	50	**.0450.050.0**	439966	560	265	815	260	PN16	520	37	307	608	0
450	104	**.0450.104.0**	439967	780	295	815	480	PN16	520	37	233	188	0
450	155	**.0450.155.0**	439968	980	323	815	680	PN16	520	37	192	95	0
450	203	**.0450.203.0**	439969	1180	350	815	880	PN16	520	37	163	57	0
450	296	**.0450.296.0**	439970	1630	412	815	1330	PN16	520	37	122	25	0

Lateral expansion joint Type LBR 25...
for movement in all planes with lap-joint flanges

PN 25



Type LBR

Nominal diameter	Nominal lateral movement absorption	Type LBR 25 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	50	**.0050.050.0**	439971	290	11	265
50	98	**.0050.098.0**	439972	420	11	265
50	148	**.0050.148.0**	439973	590	14	265
50	205	**.0050.205.0**	439974	790	16	265
65	51	**.0065.051.0**	439975	315	14	285
65	99	**.0065.099.0**	439976	465	15	285
65	153	**.0065.153.0**	439977	665	16	285
65	195	**.0065.195.0**	439978	825	17	285
80	52	**.0080.052.0**	439979	330	17	300
80	103	**.0080.103.0**	439980	470	18	300
80	155	**.0080.155.0**	439981	640	20	300
80	193	**.0080.193.0**	439982	780	21	300
100	50	**.0100.050.0**	439983	340	22	335
100	102	**.0100.102.0**	439984	510	24	335
100	144	**.0100.144.0**	439985	670	26	335
100	192	**.0100.192.0**	439986	855	29	335
125	51	**.0125.051.0**	439987	360	32	398
125	102	**.0125.102.0**	439988	520	35	398
125	153	**.0125.153.0**	439989	710	38	398
125	196	**.0125.196.0**	439990	895	45	398
150	51	**.0150.051.0**	439991	375	44	460
150	102	**.0150.102.0**	439992	545	48	460
150	151	**.0150.151.0**	439993	745	52	460
150	194	**.0150.194.0**	439994	950	63	460

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
156	PN40	92	20	4.4	24	0
286	PN40	92	20	3.2	7.1	0
455	PN40	92	20	2.4	2.8	0
655	PN40	92	20	1.8	1.4	0
185	PN40	107	22	6.3	26	0
335	PN40	107	22	4.4	8	0
535	PN40	107	22	3.2	3.1	0
695	PN40	107	22	2.6	1.9	0
176	PN40	122	24	7.8	41	0
316	PN40	122	24	5.7	13	0
486	PN40	122	24	4.3	5.4	0
626	PN40	122	24	3.6	3.2	0
197	PN40	147	24	14	56	0
367	PN40	147	24	9.7	16	0
527	PN40	147	24	7.6	7.8	0
712	PN40	147	24	6.1	4.3	0
195	PN40	178	26	23	70	0
355	PN40	178	26	17	21	0
545	PN40	178	26	13	9.4	0
714	PN40	178	26	10	5.2	0
205	PN40	208	28	44	88	0
375	PN40	208	28	33	26	0
575	PN40	208	28	25	12	0
764	PN40	208	28	20	6.3	0

Lateral expansion joint **Type LBR 25...**

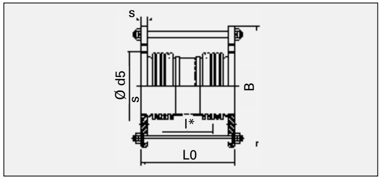
for movement in all planes with lap-joint flanges

PN 25

Lateral expansion joint Type LBR 25...

for movement in all planes with lap-joint flanges

PN 25



Type LBR

Nominal diameter	Nominal lateral movement absorption	Type **LBR 25 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	50	**.0200.050.0**	439995	445	71	544
200	101	**.0200.101.0**	439996	645	78	544
200	155	**.0200.155.0**	439997	915	99	544
200	195	**.0200.195.0**	439998	1115	109	544
250	51	**.0250.051.0**	439999	480	132	578
250	101	**.0250.101.0**	440000	700	156	578
250	149	**.0250.149.0**	440001	950	176	578
250	204	**.0250.204.0**	440002	1250	201	578
300	61	**.0300.061.0**	440003	620	182	634
300	110	**.0300.110.0**	440004	845	205	634
300	150	**.0300.150.0**	440005	1045	225	634
300	200	**.0300.200.0**	440006	1345	254	634
300	302	**.0300.302.0**	440007	1945	313	634
350	50	**.0350.050.0**	440008	550	253	735
350	100	**.0350.100.0**	440009	760	278	735
350	145	**.0350.145.0**	440010	960	302	735
350	190	**.0350.190.0**	440011	1210	330	735
350	291	**.0350.291.0**	440012	1760	395	735

Centre-to-centre spacing of bellows	Flange			Adjusting force rate		
	drilling DIN 1092	rim diameter	thickness			
l*	PN	d5	s	c_r	c_λ	c_p
mm	–	mm	mm	N/bar	N/mm	N/mm bar
241	PN25	258	32	79	199	0
441	PN25	258	32	59	64	0
690	PN25	258	32	44	24	0
890	PN25	258	32	36	15	0
251	PN25	320	35	113	266	0
450	PN25	320	35	83	81	0
700	PN25	320	35	64	34	0
1000	PN25	320	35	50	17	0
340	PN25	375	38	131	241	0
565	PN25	375	38	99	90	0
765	PN25	375	38	82	49	0
1065	PN25	375	38	65	26	0
1665	PN25	375	38	46	10	0
260	PN25	410	42	194	430	0
470	PN25	410	42	147	138	0
670	PN25	410	42	120	68	0
920	PN25	410	42	99	36	0
1470	PN25	410	42	70	14	0

Lateral expansion joint **Type LFR 06...**

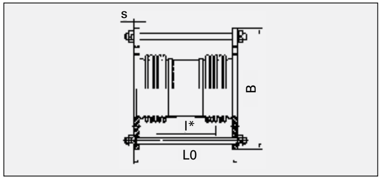
for movement in all planes with plain fixed flanges

PN 6

Lateral expansion joint Type LFR 06...

for movement in all planes with plain fixed flanges

PN 6



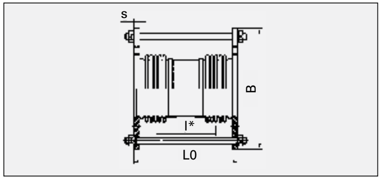
Type LFR

Nominal diameter	Nominal lateral movement absorption	Type LFR 06 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
								drilling DIN 1092	thickness			
DN	$2\lambda_N$	–	–	Lo	G	B	l*	PN	s	c_r	c_λ	c_p
–	mm	–	–	mm	kg	mm	mm	–	mm	N/bar	N/mm	N/mm bar
50	51	**.0050.051.0**	440013	265	7	240	136	6	16	4.6	14	0
50	102	**.0050.102.0**	440014	375	8	240	246	6	16	3.4	4.2	0
50	154	**.0050.154.0**	440015	485	9	240	356	6	16	2.7	2	0
50	196	**.0050.196.0**	440016	575	10	240	445	6	16	2.4	1.3	0
65	53	**.0065.053.0**	440017	275	9	260	141	6	16	6.7	17	0
65	104	**.0065.104.0**	440018	385	9	260	251	6	16	5	5.2	0
65	151	**.0065.151.0**	440019	485	9	260	351	6	16	4.1	2.7	0
65	204	**.0065.204.0**	440020	595	10	260	461	6	16	3.4	1.5	0
80	53	**.0080.053.0**	440021	285	12	290	146	6	18	8.4	20	0
80	102	**.0080.102.0**	440022	395	12	290	256	6	18	6.3	6.6	0
80	154	**.0080.154.0**	440023	505	12	290	366	6	18	5.1	3.2	0
80	201	**.0080.201.0**	440024	605	15	290	466	6	18	4.3	2	0
100	52	**.0100.052.0**	440025	285	12	310	141	6	18	13	29	0
100	103	**.0100.103.0**	440026	395	15	310	251	6	18	9.8	9	0
100	151	**.0100.151.0**	440027	495	15	310	351	6	18	8	4.6	0
100	204	**.0100.204.0**	440028	605	15	310	461	6	18	6.7	2.7	0
125	51	**.0125.051.0**	440029	320	18	340	167	6	20	16	31	0
125	103	**.0125.103.0**	440030	460	18	340	307	6	20	12	9.2	0
125	153	**.0125.153.0**	440031	590	19	340	437	6	20	9.2	4.5	0
125	203	**.0125.203.0**	440032	720	21	340	567	6	20	7.6	2.8	0
150	53	**.0150.053.0**	440033	340	23	365	166	6	20	22	62	0
150	101	**.0150.101.0**	440034	460	23	365	286	6	20	17	21	0
150	151	**.0150.151.0**	440035	580	26	365	406	6	20	13	10	0
150	202	**.0150.202.0**	440036	700	29	365	526	6	20	11	6.5	0

Lateral expansion joint — Type LFR 06...

for movement in all planes with plain fixed flanges

PN 6



Type LFR

Nominal diameter	Nominal lateral movement absorption	Type **LFR 06 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	51	**.0200.051.0**	440037	350	31	420
200	100	**.0200.100.0**	440038	480	34	420
200	153	**.0200.153.0**	440039	610	37	420
200	198	**.0200.198.0**	440040	740	43	420
250	50	**.0250.050.0**	440041	375	44	503
250	102	**.0250.102.0**	440042	515	47	503
250	153	**.0250.153.0**	440043	645	52	503
250	212	**.0250.212.0**	440044	810	63	503
300	50	**.0300.050.0**	440045	385	59	600
300	101	**.0300.101.0**	440046	545	65	600
300	152	**.0300.152.0**	440047	695	71	600
300	196	**.0300.196.0**	440048	845	90	600
300	296	**.0300.296.0**	440049	1145	113	600
350	52	**.0350.052.0**	440050	415	73	650
350	102	**.0350.102.0**	440051	585	79	650
350	148	**.0350.148.0**	440052	755	90	650
350	195	**.0350.195.0**	440053	905	100	650
350	300	**.0350.300.0**	440054	1255	123	650
400	51	**.0400.051.0**	440055	460	98	724
400	100	**.0400.100.0**	440056	665	105	724
400	158	**.0400.158.0**	440057	865	120	724
400	200	**.0400.200.0**	440058	1015	132	724
400	294	**.0400.294.0**	440059	1415	163	724

Lateral expansion joint — Type LFR 06...

for movement in all planes with plain fixed flanges

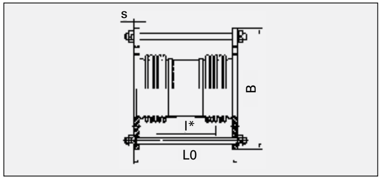
PN 6

Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
166	6	22	41	97	0
296	6	22	32	30	0
426	6	22	26	15	0
535	6	22	22	9.2	0
171	6	24	80	120	0
311	6	24	61	37	0
441	6	24	50	18	0
590	6	24	41	10	0
191	6	24	155	146	0
351	6	24	115	44	0
501	6	24	93	21	0
630	6	24	77	14	0
930	6	24	59	6.2	0
215	6	26	173	159	0
385	6	26	129	50	0
534	6	26	102	26	0
684	6	26	87	16	0
1034	6	26	64	6.9	0
231	6	28	251	250	0
410	6	28	187	77	0
610	6	28	149	35	0
760	6	28	130	23	0
1160	6	28	96	9.8	0

PN 6

Lateral expansion joint Type LFR 06...
for movement in all planes with plain fixed flanges

PN 6



Type LFR

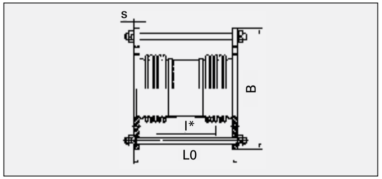
Nominal diameter	Nominal lateral movement absorption	Type LFR 06 ..	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	2λ_N	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
450	50	**.0450.050.0**	440060	470	109	779
450	97	**.0450.097.0**	440061	675	116	779
450	152	**.0450.152.0**	440062	875	133	779
450	192	**.0450.192.0**	440063	1025	146	779
450	289	**.0450.289.0**	440064	1385	181	779
500	52	**.0500.052.0**	440065	490	154	865
500	104	**.0500.104.0**	440066	705	155	865
500	147	**.0500.147.0**	440067	855	169	865
500	207	**.0500.207.0**	440068	1055	190	865
500	289	**.0500.289.0**	440069	1355	220	865

Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
236	6	28	315	305	0
415	6	28	234	96	0
615	6	28	187	44	0
765	6	28	160	29	0
1120	6	28	122	18	0
236	6	32	424	424	0
425	6	32	313	128	0
575	6	32	268	71	0
775	6	32	223	39	0
1075	6	32	178	20	0

Lateral expansion joint **Type LFR 10...**

for movement in all planes with plain fixed flanges

PN 10



Type LFR

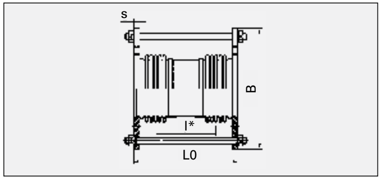
Nominal diameter	Nominal lateral movement absorption	Type **LFR 10...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	51	**.0050.051.0**	440070	270	10	265
50	102	**.0050.102.0**	440071	380	11	265
50	146	**.0050.146.0**	440072	475	12	265
50	202	**.0050.202.0**	440073	625	13	265
65	53	**.0065.053.0**	440074	280	12	285
65	104	**.0065.104.0**	440075	390	13	285
65	146	**.0065.146.0**	440076	490	13	285
65	201	**.0065.201.0**	440077	640	16	285
80	53	**.0080.053.0**	440078	310	16	300
80	101	**.0080.101.0**	440079	430	16	300
80	151	**.0080.151.0**	440080	550	18	300
80	202	**.0080.202.0**	440081	670	19	300
100	50	**.0100.050.0**	440082	300	15	320
100	100	**.0100.100.0**	440083	430	18	320
100	146	**.0100.146.0**	440084	560	19	320
100	203	**.0100.203.0**	440085	740	19	320
125	50	**.0125.050.0**	440086	320	23	350
125	100	**.0125.100.0**	440087	440	23	350
125	153	**.0125.153.0**	440088	560	26	350
125	200	**.0125.200.0**	440089	670	28	350
150	51	**.0150.051.0**	440090	345	30	385
150	102	**.0150.102.0**	440091	475	33	385
150	151	**.0150.151.0**	440092	595	35	385
150	202	**.0150.202.0**	440093	715	38	385

Lateral expansion joint **Type LFR 10...**

for movement in all planes with plain fixed flanges

PN 10

Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
136	16	19	4.6	13	0
246	16	19	3.4	4.1	0
345	16	19	2.8	2.1	0
495	16	19	2.2	1	0
141	16	20	6.7	16	0
251	16	20	5	5.2	0
351	16	20	4.1	2.7	0
501	16	20	3.2	1.3	0
161	16	20	8	30	0
281	16	20	6	9.9	0
401	16	20	4.8	4.8	0
521	16	20	4	2.9	0
159	16	22	13	27	0
289	16	22	9.2	8.3	0
419	16	22	7.2	3.9	0
599	16	22	5.6	1.9	0
151	16	22	16	54	0
271	16	22	12	17	0
391	16	22	9.7	8	0
501	16	22	8.2	4.9	0
161	16	24	26	79	0
291	16	24	20	24	0
411	16	24	16	12	0
531	16	24	14	7.7	0



Type LFR

Nominal diameter	Nominal lateral movement absorption	Type LFR 10 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	52	**.0200.052.0**	440094	370	42	468
200	100	**.0200.100.0**	440095	520	45	468
200	153	**.0200.153.0**	440096	680	51	468
200	206	**.0200.206.0**	440097	860	58	468
250	52	**.0250.052.0**	440098	400	59	555
250	101	**.0250.101.0**	440099	560	65	555
250	152	**.0250.152.0**	440100	720	71	555
250	198	**.0250.198.0**	440101	885	83	555
300	51	**.0300.051.0**	440102	400	83	629
300	102	**.0300.102.0**	440103	560	92	629
300	145	**.0300.145.0**	440104	710	98	629
300	196	**.0300.196.0**	440105	860	111	629
300	292	**.0300.292.0**	440106	1160	135	629
350	50	**.0350.050.0**	440107	415	98	689
350	100	**.0350.100.0**	440108	585	110	689
350	149	**.0350.149.0**	440109	770	112	689
350	195	**.0350.195.0**	440110	920	122	689
350	296	**.0350.296.0**	440111	1270	147	689
400	51	**.0400.051.0**	440112	510	170	785
400	106	**.0400.106.0**	440113	750	165	785
400	146	**.0400.146.0**	440114	900	178	785
400	200	**.0400.200.0**	440115	1100	195	785
400	287	**.0400.287.0**	440116	1450	224	785

Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
199	10	24	53	96	0
349	10	24	40	31	0
509	10	24	31	15	0
668	10	24	25	8.5	0
207	10	26	107	115	0
367	10	26	81	37	0
527	10	26	65	19	0
676	10	26	54	11	0
199	10	28	188	213	0
359	10	28	142	66	0
488	10	28	115	36	0
638	10	28	96	21	0
938	10	28	73	9.7	0
213	10	28	215	258	0
383	10	28	160	80	0
542	10	28	127	39	0
692	10	28	110	24	0
1042	10	28	81	11	0
251	10	37	266	426	0
470	10	37	193	120	0
620	10	37	163	70	0
820	10	37	137	40	0
1170	10	37	108	20	0

Lateral expansion joint Type LFR 10...

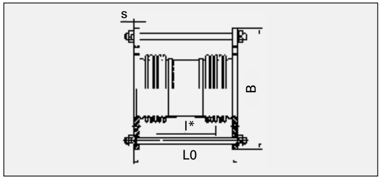
for movement in all planes with plain fixed flanges

PN 10

Lateral expansion joint Type LFR 10...

for movement in all planes with plain fixed flanges

PN 10



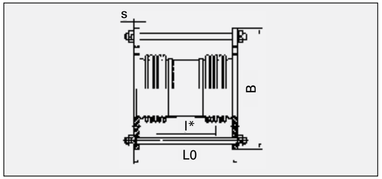
Type LFR

Nominal diameter	Nominal lateral movement absorption	Type **LFR 10 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
450	51	**.0450.051.0**	440117	500	201	756
450	98	**.0450.098.0**	440118	700	198	756
450	153	**.0450.153.0**	440119	900	223	756
450	195	**.0450.195.0**	440120	1050	242	756
450	285	**.0450.285.0**	440121	1400	286	756
500	51	**.0500.051.0**	440122	505	228	808
500	105	**.0500.105.0**	440123	730	225	808
500	148	**.0500.148.0**	440124	880	246	808
500	207	**.0500.207.0**	440125	1080	273	808
500	306	**.0500.306.0**	440126	1480	327	808

Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
246	10	32	307	541	0
425	10	32	225	178	0
625	10	32	181	83	0
775	10	32	159	54	0
1125	10	32	121	26	0
236	10	34	367	639	0
435	10	34	271	184	0
585	10	34	227	103	0
785	10	34	189	58	0
1185	10	34	142	25	0

for movement in all planes with plain fixed flanges

PN 16



Type LFR

Nominal diameter	Nominal lateral movement absorption	Type LFR 16 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	50	**.0050.050.0**	440127	290	11	265
50	103	**.0050.103.0**	440128	420	12	265
50	149	**.0050.149.0**	440129	535	12	265
50	199	**.0050.199.0**	440130	685	14	265
65	53	**.0065.053.0**	440131	300	12	285
65	104	**.0065.104.0**	440132	420	15	285
65	145	**.0065.145.0**	440133	530	15	285
65	198	**.0065.198.0**	440134	690	18	285
80	51	**.0080.051.0**	440135	310	16	300
80	102	**.0080.102.0**	440136	440	18	300
80	150	**.0080.150.0**	440137	560	19	300
80	205	**.0080.205.0**	440138	730	21	300
100	50	**.0100.050.0**	440139	315	18	320
100	103	**.0100.103.0**	440140	465	20	320
100	145	**.0100.145.0**	440141	595	21	320
100	202	**.0100.202.0**	440142	795	23	320
125	53	**.0125.053.0**	440143	350	28	350
125	102	**.0125.102.0**	440144	480	30	350
125	151	**.0125.151.0**	440145	600	33	350
125	196	**.0125.196.0**	440146	720	36	350
150	53	**.0150.053.0**	440147	365	37	413
150	100	**.0150.100.0**	440148	495	40	413
150	153	**.0150.153.0**	440149	635	45	413
150	194	**.0150.194.0**	440150	765	49	413

for movement in all planes with plain fixed flanges

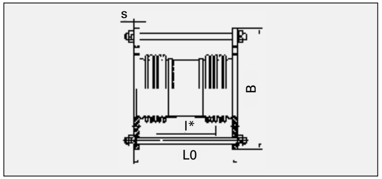
PN 16

Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
151	16	19	4.4	20	0
281	16	19	3.2	5.8	0
400	16	19	2.5	2.9	0
550	16	19	2	1.5	0
156	16	20	6.4	24	0
276	16	20	4.8	7.8	0
386	16	20	3.9	4	0
546	16	20	3	2	0
161	16	20	8.1	36	0
291	16	20	5.9	11	0
411	16	20	4.8	5.5	0
581	16	20	3.7	2.8	0
173	16	22	12	41	0
323	16	22	8.5	12	0
453	16	22	6.8	6	0
653	16	22	5.2	2.9	0
171	16	22	18	72	0
301	16	22	14	23	0
421	16	22	11	12	0
541	16	22	9.5	7.6	0
181	16	24	33	89	0
311	16	24	25	30	0
451	16	24	20	14	0
581	16	24	17	9.2	0

Lateral expansion joint — Type LFR 16...

for movement in all planes with plain fixed flanges

PN 16

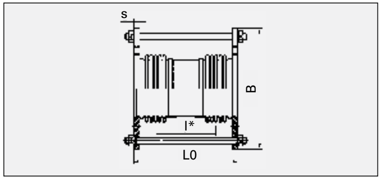


Type LFR

Nominal diameter	Nominal lateral movement absorption	Type **LFR 16 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	50	**.0200.050.0**	440151	370	53	500
200	100	**.0200.100.0**	440152	530	59	500
200	150	**.0200.150.0**	440153	680	65	500
200	200	**.0200.200.0**	440154	870	70	500
250	52	**.0250.052.0**	440155	460	88	589
250	103	**.0250.103.0**	440156	680	93	589
250	154	**.0250.154.0**	440157	880	106	589
250	207	**.0250.207.0**	440158	1130	122	589
300	50	**.0300.050.0**	440159	495	112	680
300	95	**.0300.095.0**	440160	665	127	680
300	145	**.0300.145.0**	440161	865	145	680
300	196	**.0300.196.0**	440162	1115	166	680
300	296	**.0300.296.0**	440163	1615	210	680
350	51	**.0350.051.0**	440164	515	153	667
350	100	**.0350.100.0**	440165	715	174	667
350	149	**.0350.149.0**	440166	915	196	667
350	199	**.0350.199.0**	440167	1165	222	667
350	306	**.0350.306.0**	440168	1715	279	667
400	52	**.0400.052.0**	440169	545	185	723
400	94	**.0400.094.0**	440170	715	204	723
400	147	**.0400.147.0**	440171	915	228	723
400	200	**.0400.200.0**	440172	1115	251	723
400	309	**.0400.309.0**	440173	1615	309	723

Lateral expansion joint Type LFR 16...
for movement in all planes with plain fixed flanges
PN 16

Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
193	16	26	75	143	0
353	16	26	55	43	0
503	16	26	45	21	0
672	16	26	36	12	0
246	16	32	117	226	0
445	16	32	87	68	0
645	16	32	69	33	0
895	16	32	55	17	0
235	16	37	176	281	0
405	16	37	136	99	0
605	16	37	109	45	0
855	16	37	88	23	0
1355	16	37	63	9.1	0
260	16	32	182	328	0
460	16	32	138	109	0
660	16	32	111	54	0
910	16	32	88	28	0
1460	16	32	62	11	0
260	16	34	224	481	0
430	16	34	180	185	0
630	16	34	145	87	0
830	16	34	121	51	0
1330	16	34	86	20	0



Type LFR

Nominal diameter	Nominal lateral movement absorption	Type **LFR 16 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
450	50	**.0450.050.0**	440174	550	247	815
450	104	**.0450.104.0**	440175	770	277	815
450	155	**.0450.155.0**	440176	970	305	815
450	203	**.0450.203.0**	440177	1170	332	815
450	296	**.0450.296.0**	440178	1620	395	815

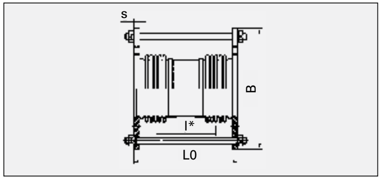
Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
260	16	37	316	612	0
480	16	37	239	189	0
680	16	37	195	95	0
880	16	37	165	57	0
1330	16	37	122	25	0

Lateral expansion joint

Type LFR 25...

for movement in all planes with plain fixed flanges

PN 25



Type LFR

Nominal diameter	Nominal lateral movement absorption	Type **LFR 25 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	50	**.0050.050.0**	440179	300	11	265
50	98	**.0050.098.0**	440180	430	13	265
50	148	**.0050.148.0**	440181	600	13	265
50	205	**.0050.205.0**	440182	800	15	265
65	51	**.0065.051.0**	440183	320	16	285
65	99	**.0065.099.0**	440184	470	16	285
65	153	**.0065.153.0**	440185	670	19	285
65	195	**.0065.195.0**	440186	830	22	285
80	52	**.0080.052.0**	440187	335	20	300
80	103	**.0080.103.0**	440188	475	22	300
80	155	**.0080.155.0**	440189	645	25	300
80	193	**.0080.193.0**	440190	785	27	300
100	50	**.0100.050.0**	440191	345	26	335
100	102	**.0100.102.0**	440192	515	29	335
100	144	**.0100.144.0**	440193	675	32	335
100	192	**.0100.192.0**	440194	860	35	335
125	51	**.0125.051.0**	440195	365	35	398
125	102	**.0125.102.0**	440196	525	40	398
125	153	**.0125.153.0**	440197	715	44	398
125	196	**.0125.196.0**	440198	900	43	398
150	51	**.0150.051.0**	440199	370	49	460
150	102	**.0150.102.0**	440200	540	53	460
150	151	**.0150.151.0**	440201	740	62	460
150	194	**.0150.194.0**	440202	945	61	460

Lateral expansion joint Type LFR 25...
for movement in all planes with plain fixed flanges
PN 25

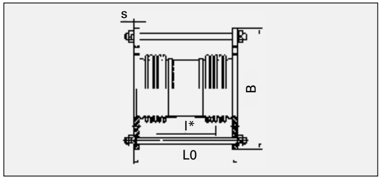
Centre-to-centre spacing of bellows	Flange		Adjusting force rate		
	drilling DIN 1092	thickness			
l*	PN	s	c_r	c_λ	c_p
mm	–	mm	N/bar	N/mm	N/mm bar
156	40	20	4.3	24	0
286	40	20	3.1	7.1	0
455	40	20	2.3	2.8	0
655	40	20	1.8	1.3	0
185	40	22	6.1	26	0
335	40	22	4.4	8	0
535	40	22	3.2	3.1	0
695	40	22	2.6	1.9	0
176	40	24	7.8	41	0
316	40	24	5.7	13	0
486	40	24	4.3	5.4	0
626	40	24	3.6	3.2	0
197	40	24	13	56	0
367	40	24	9.6	16	0
527	40	24	7.5	7.7	0
712	40	24	6.1	4.2	0
195	40	26	23	69	0
355	40	26	17	21	0
545	40	26	13	9.3	0
714	40	26	10	5.1	0
205	40	28	45	88	0
375	40	28	33	26	0
575	40	28	25	12	0
764	40	28	20	6.3	0

Lateral expansion joint **Type LFR 25...**

for movement in all planes with plain fixed flanges

PN 25

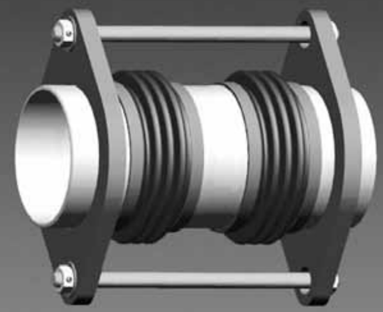
Lateral expansion joint Type LFR 25...
for movement in all planes with plain fixed flanges
PN 25



Type LFR

Nominal diameter	Nominal lateral movement absorption	Type LFR 25 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Flange drilling DIN 1092	Flange thickness	Adjusting force rate		
DN	$2\lambda_N$	–	–	Lo	G	B	l*	PN	s	c_r	c_λ	c_p
–	mm	–	–	mm	kg	mm	mm	–	mm	N/bar	N/mm	N/mm bar
200	50	**.0200.050.0**	440203	440	82	544	241	25	32	79	198	0
200	101	**.0200.101.0**	440204	640	91	544	441	25	32	59	64	0
200	155	**.0200.155.0**	440205	910	95	544	690	25	32	44	24	0
200	195	**.0200.195.0**	440206	1110	105	544	890	25	32	36	14	0
250	51	**.0250.051.0**	440207	475	145	578	251	25	35	117	264	0
250	101	**.0250.101.0**	440208	695	149	578	450	25	35	85	81	0
250	149	**.0250.149.0**	440209	945	170	578	700	25	35	64	34	0
250	204	**.0250.204.0**	440210	1245	194	578	1000	25	35	50	17	0
300	61	**.0300.061.0**	440211	610	172	634	340	25	38	131	243	0
300	110	**.0300.110.0**	440212	835	194	634	565	25	38	101	90	0
300	150	**.0300.150.0**	440213	1035	214	634	765	25	38	83	49	0
300	200	**.0300.200.0**	440214	1335	243	634	1065	25	38	66	26	0
300	302	**.0300.302.0**	440215	1935	302	634	1665	25	38	46	10	0
350	50	**.0350.050.0**	440216	545	241	735	260	25	42	194	426	0
350	100	**.0350.100.0**	440217	755	265	735	470	25	42	150	137	0
350	145	**.0350.145.0**	440218	955	289	735	670	25	42	122	68	0
350	190	**.0350.190.0**	440219	1205	318	735	920	25	42	99	36	0
350	291	**.0350.291.0**	440220	1755	382	735	1470	25	42	70	14	0

Lateral expansion joint with weld ends



Type LRR
Type LRK
Type LRN

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type LRR/LRK: HYDRA lateral expansion joint with weld ends, for movement in all planes

Type LRN: HYDRA lateral expansion joint with plain weld ends, for movement in one plane

Standard version/materials:
multi-ply bellows: 1.4541
weld ends up to DN 300: P 235GH (1.0345), from DN 350: P 265GH (1.0425)
operating temperature: up to 400°C

Designation (example):

L	R	R	1	0	.	0	1	5	0	.	1	0	2	.	0

- L R R: Type
- 1 0: Nominal pressure (PN10)
- 0 1 5 0: Nominal diameter (DN150)
- 1 0 2: Movement absorption, nominal (2λ = ±51 = 102 mm)
- 0: Inner sleeve (0 = ohne, 1 = mit)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l] ____________________
- piping – nominal size DN ____________________

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar] ____________________

max./min. allowable temperature TS [°C] ____________________

test pressure PT [bar] ____________________

Optional:

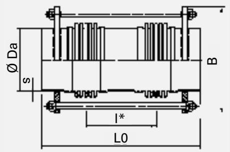
category ____________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Lateral expansion joint — Type LRR 06...

for movement in all planes with weld ends

PN 6



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type LRR 06 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	51	**.0050.051.0**	440579	360	5	205
50	102	**.0050.102.0**	440580	470	5	205
50	154	**.0050.154.0**	440581	580	6	205
50	196	**.0050.196.0**	440582	670	8	205
65	53	**.0065.053.0**	440583	370	6	225
65	104	**.0065.104.0**	440584	480	6	225
65	151	**.0065.151.0**	440585	580	7	225
65	204	**.0065.204.0**	440586	690	8	225
80	53	**.0080.053.0**	440587	380	6	240
80	102	**.0080.102.0**	440588	490	7	240
80	154	**.0080.154.0**	440589	600	8	240
80	201	**.0080.201.0**	440590	700	8	240
100	52	**.0100.052.0**	440591	380	8	265
100	103	**.0100.103.0**	440592	490	9	265
100	151	**.0100.151.0**	440593	590	9	265
100	204	**.0100.204.0**	440594	700	10	265
125	51	**.0125.051.0**	440595	420	9	290
125	103	**.0125.103.0**	440596	560	10	290
125	153	**.0125.153.0**	440597	690	11	290
125	203	**.0125.203.0**	440598	820	12	290
150	53	**.0150.053.0**	440599	455	15	320
150	101	**.0150.101.0**	440600	575	16	320
150	151	**.0150.151.0**	440601	695	17	320
150	202	**.0150.202.0**	440602	815	19	320

Lateral expansion joint — Type LRR 06...

for movement in all planes with weld ends

PN 6

Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
136	60.3	4	4.2	14	0
246	60.3	4	3.2	4.2	0
356	60.3	4	2.6	2	0
445	60.3	4	2.2	1.3	0
141	76.1	4	6.2	17	0
251	76.1	4	4.7	5.2	0
351	76.1	4	3.9	2.7	0
461	76.1	4	3.3	1.6	0
146	88.9	4	7.7	20	0
256	88.9	4	5.9	6.6	0
366	88.9	4	4.8	3.2	0
466	88.9	4	4.1	2	0
141	114.3	4	12	28	0
251	114.3	4	9.2	9	0
351	114.3	4	7.6	4.6	0
461	114.3	4	6.4	2.6	0
183	139.7	4	14	31	0
323	139.7	4	11	9.1	0
453	139.7	4	8.7	4.5	0
583	139.7	4	7.3	2.7	0
182	168.3	4.5	19	63	0
302	168.3	4.5	15	21	0
422	168.3	4.5	12	10	0
542	168.3	4.5	11	6.2	0

Lateral expansion joint **Type LRR 06...**

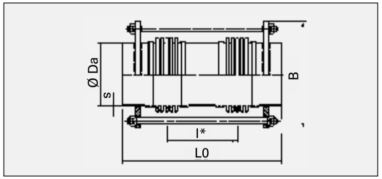
for movement in all planes with weld ends

PN 6

Lateral expansion joint **Type LRR 06...**

for movement in all planes with weld ends

PN 6



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type LRR 06 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	51	**.0200.051.0**	440603	490	23	375
200	100	**.0200.100.0**	440604	620	25	375
200	153	**.0200.153.0**	440605	750	27	375
200	198	**.0200.198.0**	440606	880	40	375
250	50	**.0250.050.0**	440607	520	37	465
250	102	**.0250.102.0**	440608	660	40	465
250	153	**.0250.153.0**	440609	790	42	465
250	212	**.0250.212.0**	440610	960	64	465
300	50	**.0300.050.0**	440611	535	50	550
300	101	**.0300.101.0**	440612	695	54	550
300	152	**.0300.152.0**	440613	845	58	550
300	196	**.0300.196.0**	440614	1000	90	550
300	296	**.0300.296.0**	440615	1300	113	550
350	52	**.0350.052.0**	440616	585	52	590
350	102	**.0350.102.0**	440617	755	57	590
350	148	**.0350.148.0**	440618	925	79	590
350	195	**.0350.195.0**	440619	1075	88	590
350	300	**.0350.300.0**	440620	1425	111	590
400	51	**.0400.051.0**	440621	645	76	665
400	100	**.0400.100.0**	440622	850	96	665
400	158	**.0400.158.0**	440623	1050	112	665
400	200	**.0400.200.0**	440624	1200	124	665
400	294	**.0400.294.0**	440625	1600	159	665

Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
186	219.1	6.3	37	97	0
316	219.1	6.3	29	30	0
446	219.1	6.3	24	15	0
535	219.1	6.3	20	9.2	0
191	273	7.1	72	122	0
331	273	7.1	57	37	0
461	273	7.1	47	18	0
590	273	7.1	38	10	0
215	323.9	8	137	148	0
375	323.9	8	105	44	0
525	323.9	8	87	22	0
630	323.9	8	73	13	0
930	323.9	8	56	6.2	0
239	355.6	6	157	159	0
409	355.6	6	120	50	0
534	355.6	6	96	26	0
684	355.6	6	82	16	0
1034	355.6	6	62	6.9	0
255	406.4	6	235	249	0
410	406.4	6	178	77	0
610	406.4	6	143	35	0
760	406.4	6	123	23	0
1210	406.4	6	92	9.8	0

Lateral expansion joint

Type LRR 06...

for movement in all planes with weld ends

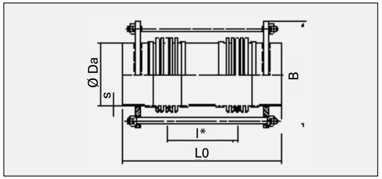
PN 6

Lateral expansion joint

Type LRR 06...

for movement in all planes with weld ends

PN 6



Type LRR

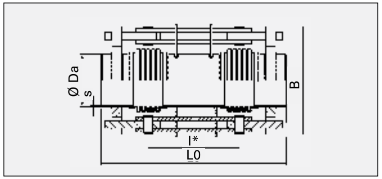
Nominal diameter	Nominal lateral movement absorption	Type LRR 06 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
								outside-diameter	wall thickness			
DN	$2\lambda_N$	–	–	Lo	G	B	l*	Da	s	c_r	c_λ	c_p
–	mm	–	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
450	50	**.0450.050.0**	440626	655	85	725	260	457	6	286	304	0
450	97	**.0450.097.0**	440627	860	107	725	415	457	6	218	95	0
450	152	**.0450.152.0**	440628	1060	124	725	615	457	6	176	44	0
450	192	**.0450.192.0**	440629	1210	137	725	765	457	6	155	29	0
450	289	**.0450.289.0**	440630	1570	172	725	1120	457	6	119	18	0
500	52	**.0500.052.0**	440631	750	130	820	264	508	6	375	424	0
500	104	**.0500.104.0**	440632	965	155	820	425	508	6	286	128	0
500	147	**.0500.147.0**	440633	1115	170	820	575	508	6	248	71	0
500	207	**.0500.207.0**	440634	1315	190	820	775	508	6	209	39	0
500	289	**.0500.289.0**	440635	1615	220	820	1075	508	6	168	20	0

Lateral expansion joint with weld ends

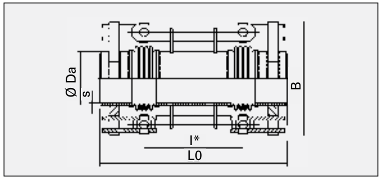
for movement in one plane **Type LRN 06...**

for movement in all planes **Type LRK 06...**

PN 6



Type LRN



Type LRK

Nominal diameter	Nominal lateral movement absorption	Type **LRN 06 ...** **LRK 06 ...**	Order No. standard version **LRN**	 **LRK**	Overall length	LRN Weight approx.	LRK Weight approx.
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
600	58	**.0600.058.0**	440395	440221	795	208	270
600	108	**.0600.108.0**	440396	440222	905	224	288
600	150	**.0600.150.0**	440397	440223	1055	245	309
600	205	**.0600.205.0**	440398	440224	1255	274	338
600	302	**.0600.302.0**	440399	440225	1605	324	388
700	53	**.0700.053.0**	440400	440226	835	287	355
700	98	**.0700.098.0**	440401	440227	945	304	375
700	152	**.0700.152.0**	440402	440228	1100	334	407
700	211	**.0700.211.0**	440403	440229	1300	373	445
700	299	**.0700.299.0**	440404	440230	1600	431	503
800	51	**.0800.051.0**	440405	440231	915	348	427
800	98	**.0800.098.0**	440406	440232	1045	379	460
800	151	**.0800.151.0**	440407	440233	1210	416	499
800	206	**.0800.206.0**	440408	440234	1410	459	542
800	303	**.0800.303.0**	440409	440235	1760	534	618
900	52	**.0900.052.0**	440410	440236	1015	541	674
900	97	**.0900.097.0**	440411	440237	1145	580	718
900	150	**.0900.150.0**	440412	440238	1395	648	786
900	197	**.0900.197.0**	440413	440239	1510	681	823
900	295	**.0900.295.0**	440414	440240	1910	790	931

Lateral expansion joint with weld ends

for movement in one plane **Type LRN 06...**

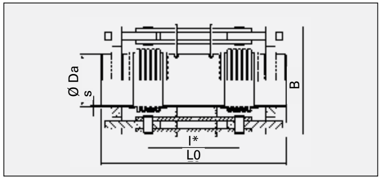
for movement in all planes **Type LRK 06...**

PN 6

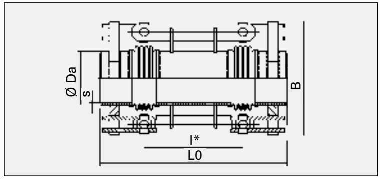
Max. width approx.	Centre-to-centre spacing of bellows	Weld ends outside-diameter	 wall thickness	Adjusting force rate		
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
900	363	610	6	462	493	8.1
900	418	610	6	396	214	9.90
900	568	610	6	286	114	5.10
900	768	610	6	209	61	2.70
900	1118	610	6	142	28	1.30
1010	363	711	8	621	702	11.00
1010	418	711	8	533	304	13.00
1010	545	711	8	401	145	9.00
1010	745	711	8	289	77	4.70
1010	1045	711	8	204	39	2.30
1120	383	813	8	770	1209	15.00
1120	448	813	8	649	503	18.00
1120	580	813	8	492	243	12.00
1120	780	813	8	361	133	6.60
1120	1130	813	8	246	63	3.10
1285	433	914	8	1073	1322	15.00
1285	498	914	8	923	575	18.00
1285	748	914	8	601	249	7.70
1285	830	914	8	539	166	7.40
1285	1230	914	8	359	75	3.30

Lateral expansion joint with weld ends

for movement in one plane **Type LRN 06...**
for movement in all planes **Type LRK 06...**
PN 6



Type LRN



Type LRK

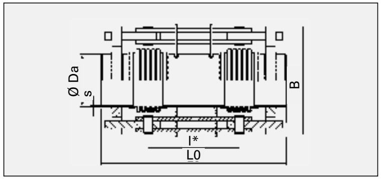
Nominal diameter	Nominal lateral movement absorption	Type **LRN 06 ...** **LRK 06 ...**	Order No. standard version		Overall length	LRN Weight approx.	LRK Weight approx.
			LRN	**LRK**			
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
1000	50	**.1000.050.0**	440415	440241	1035	598	743
1000	104	**.1000.104.0**	440416	440242	1220	655	805
1000	152	**.1000.152.0**	440417	440243	1390	706	860
1000	210	**.1000.210.0**	440418	440244	1640	780	933
1000	303	**.1000.303.0**	440419	440245	2040	897	1050
1200	63	**.1200.063.0**	440420	440246	1155	843	1020
1200	100	**.1200.100.0**	440421	440247	1320	908	1088
1200	155	**.1200.155.0**	440422	440248	1540	991	1173
1200	206	**.1200.206.0**	440423	440249	1790	1090	1272
1200	308	**.1200.308.0**	440424	440250	2290	1288	1470
1400	50	**.1400.050.0**	440425	440251	1340	1172	1480
1400	97	**.1400.097.0**	440426	440252	1480	1249	1572
1400	150	**.1400.150.0**	440427	440253	1880	1447	1770
1400	202	**.1400.202.0**	440428	440254	2280	1644	1967
1400	307	**.1400.307.0**	440429	440255	3080	2039	2363
1600	47	**.1600.047.0**	440430	440256	1540	1737	2275
1600	103	**.1600.103.0**	440431	440257	1780	1836	2398
1600	147	**.1600.147.0**	440432	440258	2180	2081	2643
1600	191	**.1600.191.0**	440433	440259	2580	2325	2887
1600	300	**.1600.300.0**	440434	440260	3580	2936	3498

Lateral expansion joint with weld ends
for movement in one plane **Type LRN 06...**
for movement in all planes **Type LRK 06...**
PN 6

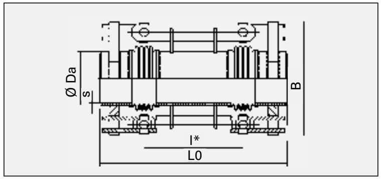
Max. width approx.	Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
		outside-diameter	wall thickness			
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
1395	443	1016	8	1298	1607	19.00
1395	560	1016	8	1007	572	19.00
1395	695	1016	8	800	302	14.00
1395	945	1016	8	580	161	7.40
1395	1345	1016	8	403	79	3.60
1615	478	1220	10	1677	1591	30.00
1615	610	1220	10	1290	755	22.00
1615	795	1220	10	976	362	15.00
1615	1045	1220	10	734	207	8.50
1615	1545	1220	10	491	93	3.80
1840	720	1420	10	1850	1834	13.00
1840	740	1420	10	1800	846	24.00
1840	1140	1420	10	1168	364	10.00
1840	1540	1420	10	865	201	5.60
1840	2340	1420	10	569	87	2.40
2080	820	1620	10	2627	2077	13.00
2080	940	1620	10	2291	779	20.00
2080	1340	1620	10	1607	388	9.60
2080	1740	1620	10	1238	231	5.70
2080	2740	1620	10	786	93	2.30

Lateral expansion joint with weld ends
for movement in one plane **Type LRN 06...**
for movement in all planes **Type LRK 06...**
PN 6

Lateral expansion joint with weld ends
for movement in one plane **Type LRN 06...**
for movement in all planes **Type LRK 06...**
PN 6



Type LRN



Type LRK

Nominal diameter	Nominal lateral movement absorption	Type **LRN 06 ...** **LRK 06 ...**	Order No. standard version **LRN**	 **LRK**	Overall length	LRN Weight approx.	LRK Weight approx.
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
1800	63	**.1800.063.0**	440435	440261	1480	1811	2449
1800	102	**.1800.102.0**	440436	440262	1880	2076	2714
1800	151	**.1800.151.0**	440437	440263	2380	2408	3045
1800	199	**.1800.199.0**	440438	440264	2880	2739	3377
1800	307	**.1800.307.0**	440439	440265	3980	3467	4105
2000	57	**.2000.057.0**	440440	–	1580	2691	–
2000	102	**.2000.102.0**	440441	–	2080	3114	–
2000	146	**.2000.146.0**	440442	–	2580	3536	–
2000	200	**.2000.200.0**	440443	–	3180	4043	–
2000	306	**.2000.306.0**	440444	–	4380	5056	–

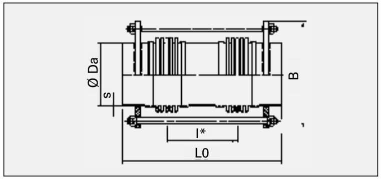
Max. width approx.	Centre-to-centre spacing of bellows	Weld ends outside-diameter	 wall thickness	Adjusting force rate		
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
2280	640	1820	10	4227	2301	53.00
2280	1040	1820	10	2601	896	20.00
2280	1540	1820	10	1757	413	9.20
2280	2040	1820	10	1326	236	5.20
2280	3140	1820	10	862	100	2.20
2575	640	2020	10	6484	3119	65.00
2575	1140	2020	10	3640	1014	20.00
2575	1640	2020	10	2530	494	9.90
2575	2240	2020	10	1853	266	5.30
2575	3440	2020	10	1206	113	2.30

Lateral expansion joint

for movement in all planes with weld ends

Type LRR 10...

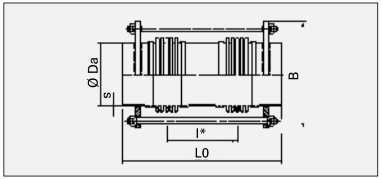
PN 10



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type **LRR 10 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld ends: outside-diameter	Weld ends: wall thickness	Adjusting force rate		
DN	$2\lambda_N$	–	–	Lo	G	B	l*	Da	s	c_r	c_λ	c_p
–	mm	–	–	mm	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
50	51	**.0050.051.0**	440636	360	5	205	136	60.3	4	4.2	14	0
50	102	**.0050.102.0**	440637	470	5	205	246	60.3	4	3.2	4.2	0
50	149	**.0050.149.0**	440638	580	6	205	356	60.3	4	2.6	2	0
50	202	**.0050.202.0**	440639	720	9	205	495	60.3	4	2.1	1	0
65	53	**.0065.053.0**	440640	370	6	225	141	76.1	4	6.2	17	0
65	104	**.0065.104.0**	440641	480	6	225	251	76.1	4	4.7	5.2	0
65	146	**.0065.146.0**	440642	580	7	225	351	76.1	4	3.9	2.7	0
65	201	**.0065.201.0**	440643	730	8	225	501	76.1	4	3.1	1.3	0
80	53	**.0080.053.0**	440644	400	7	240	161	88.9	4	7.4	30	0
80	101	**.0080.101.0**	440645	520	8	240	281	88.9	4	5.6	9.9	0
80	151	**.0080.151.0**	440646	640	9	240	401	88.9	4	4.6	4.9	0
80	202	**.0080.202.0**	440647	760	10	240	521	88.9	4	3.8	2.9	0
100	50	**.0100.050.0**	440648	410	9	265	159	114.3	4	11	27	0
100	100	**.0100.100.0**	440649	540	10	265	289	114.3	4	8.5	8.3	0
100	146	**.0100.146.0**	440650	670	11	265	419	114.3	4	6.8	3.9	0
100	203	**.0100.203.0**	440651	850	12	265	599	114.3	4	5.3	1.9	0
125	50	**.0125.050.0**	440652	435	12	290	167	139.7	4	14	54	0
125	100	**.0125.100.0**	440653	555	13	290	287	139.7	4	11	17	0
125	153	**.0125.153.0**	440654	675	14	290	407	139.7	4	9	8.1	0
125	200	**.0125.200.0**	440655	785	15	290	517	139.7	4	7.7	4.9	0
150	51	**.0150.051.0**	440656	475	17	320	177	168.3	4.5	23	81	0
150	102	**.0150.102.0**	440657	605	19	320	307	168.3	4.5	18	25	0
150	151	**.0150.151.0**	440658	725	21	320	427	168.3	4.5	15	12	0
150	202	**.0150.202.0**	440659	845	22	320	547	168.3	4.5	13	7.4	0

Lateral expansion joint **Type LRR 10...**
for movement in all planes with weld ends
PN 10



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type **LRR 10 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	52	**.0200.052.0**	440660	530	30	405
200	100	**.0200.100.0**	440661	680	32	405
200	153	**.0200.153.0**	440662	840	35	405
200	206	**.0200.206.0**	440663	1015	53	405
250	52	**.0250.052.0**	440664	565	48	495
250	101	**.0250.101.0**	440665	725	52	495
250	152	**.0250.152.0**	440666	885	56	495
250	198	**.0250.198.0**	440667	1055	81	495
300	51	**.0300.051.0**	440668	590	74	575
300	102	**.0300.102.0**	440669	750	80	575
300	145	**.0300.145.0**	440670	905	103	575
300	196	**.0300.196.0**	440671	1055	116	575
300	292	**.0300.292.0**	440672	1355	140	575
350	50	**.0350.050.0**	440673	610	72	610
350	100	**.0350.100.0**	440674	780	80	610
350	149	**.0350.149.0**	440675	965	100	610
350	195	**.0350.195.0**	440676	1115	111	610
350	296	**.0350.296.0**	440677	1465	135	610
400	51	**.0400.051.0**	440678	715	116	700
400	106	**.0400.106.0**	440679	960	138	700
400	146	**.0400.146.0**	440680	1110	151	700
400	200	**.0400.200.0**	440681	1310	168	700
400	287	**.0400.287.0**	440682	1660	198	700

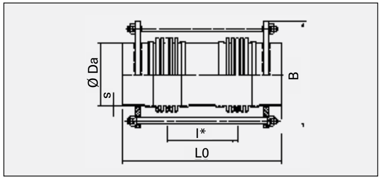
Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
219	219.1	6.3	47	95	0
369	219.1	6.3	36	31	0
529	219.1	6.3	29	15	0
668	219.1	6.3	24	8.5	0
227	273	7.1	97	116	0
387	273	7.1	75	37	0
547	273	7.1	61	18	0
676	273	7.1	51	11	0
223	323.9	8	162	216	0
383	323.9	8	127	66	0
488	323.9	8	104	35	0
638	323.9	8	90	21	0
938	323.9	8	70	9.7	0
237	355.6	6	193	256	0
407	355.6	6	147	79	0
542	355.6	6	119	39	0
692	355.6	6	102	24	0
1042	355.6	6	78	11	0
275	406.4	6	250	428	0
470	406.4	6	185	119	0
620	406.4	6	157	69	0
820	406.4	6	133	40	0
1170	406.4	6	105	20	0

Lateral expansion joint — Type LRR 10...

for movement in all planes with weld ends

PN 10

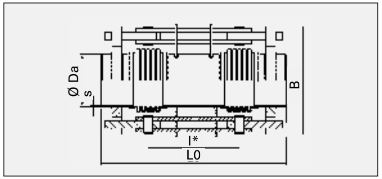
Lateral expansion joint Type LRR 10...
for movement in all planes with weld ends
PN 10



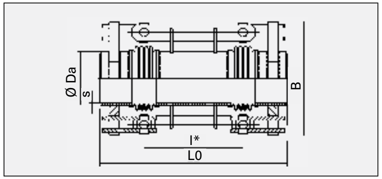
Type LRR

Nominal diameter	Nominal lateral movement absorption	Type **LRR 10 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
450	51	**.0450.051.0**	440683	715	143	690
450	98	**.0450.098.0**	440684	920	173	690
450	153	**.0450.153.0**	440685	1120	198	690
450	195	**.0450.195.0**	440686	1270	217	690
450	285	**.0450.285.0**	440687	1620	261	690
500	51	**.0500.051.0**	440688	720	161	740
500	105	**.0500.105.0**	440689	945	195	740
500	148	**.0500.148.0**	440690	1095	215	740
500	207	**.0500.207.0**	440691	1295	242	740
500	306	**.0500.306.0**	440692	1695	297	740

Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
270	457	8	279	543	0
425	457	8	214	176	0
625	457	8	174	83	0
775	457	8	151	54	0
1125	457	8	118	26	0
264	508	8	334	642	0
435	508	8	247	184	0
585	508	8	214	103	0
785	508	8	180	58	0
1185	508	8	137	25	0



Type LRN



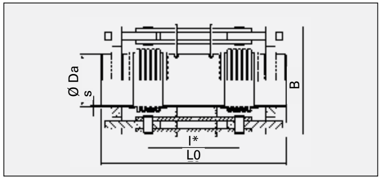
Type LRK

Nominal diameter	Nominal lateral movement absorption	Type **LRN 10 ...** **LRK 10 ...**	Order No. standard version **LRN**	 **LRK**	Overall length	LRN Weight approx.	LRK Weight approx.
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
600	55	**.0600.055.0**	440445	440266	840	266	329
600	103	**.0600.103.0**	440446	440267	955	289	354
600	155	**.0600.155.0**	440447	440268	1155	323	389
600	207	**.0600.207.0**	440448	440269	1355	358	423
600	298	**.0600.298.0**	440449	440270	1705	418	484
700	52	**.0700.052.0**	440450	440271	900	422	535
700	111	**.0700.111.0**	440451	440272	1075	471	589
700	152	**.0700.152.0**	440452	440273	1190	502	624
700	208	**.0700.208.0**	440453	440274	1390	548	670
700	307	**.0700.307.0**	440454	440275	1740	629	750
800	51	**.0800.051.0**	440455	440276	970	509	632
800	98	**.0800.098.0**	440456	440277	1105	553	681
800	150	**.0800.150.0**	440457	440278	1270	604	736
800	204	**.0800.204.0**	440458	440279	1470	663	794
800	299	**.0800.299.0**	440459	440280	1820	765	896
900	52	**.0900.052.0**	440460	440281	1070	671	804
900	97	**.0900.097.0**	440461	440282	1205	720	857
900	146	**.0900.146.0**	440462	440283	1370	776	917
900	194	**.0900.194.0**	440463	440284	1570	840	981
900	291	**.0900.291.0**	440464	440285	1970	967	1108

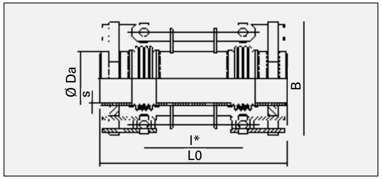
Lateral expansion joint with weld ends
for movement in one plane **Type LRN 10...**
for movement in all planes **Type LRK 10...**
PN 10

Max. width approx.	Centre-to-centre spacing of bellows	Weld ends outside-diameter	 wall thickness	Adjusting force rate		
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
900	365	610	8	459	760	8.2
900	423	610	8	392	325	10.00
900	623	610	8	260	147	4.40
900	823	610	8	195	83	2.50
900	1173	610	8	135	40	1.20
1065	375	711	8	753	1273	12.00
1065	488	711	8	568	429	11.00
1065	570	711	8	482	257	9.50
1065	770	711	8	352	140	5.10
1065	1120	711	8	239	65	2.30
1165	385	813	10	958	1594	15.00
1165	453	813	10	804	657	18.00
1165	585	813	10	611	319	12.00
1165	785	813	10	449	176	6.70
1165	1135	813	10	307	83	3.10
1315	435	914	10	1069	1747	15.00
1315	503	914	10	915	753	18.00
1315	635	914	10	714	384	13.00
1315	835	914	10	536	220	7.60
1315	1235	914	10	358	99	3.40

Lateral expansion joint with weld ends
for movement in one plane **Type LRN 10...**
for movement in all planes **Type LRK 10...**
PN 10



Type LRN



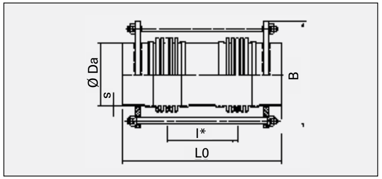
Type LRK

Nominal diameter	Nominal lateral movement absorption	Type	Order No. standard version		Overall length	LRN Weight approx.	LRK Weight approx.	Max. Width approx.	Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
		LRN 10 ... **LRK 10 ...**	**LRN**	**LRK**						outside-diameter	wall thickness			
DN	$2\lambda_N$	–	–	–	Lo	G	G	B	l*	Da	s	c_r	c_λ	c_p
–	mm	–	–	–	mm	kg	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
1000	58	**.1000.058.0**	440465	440286	1260	984	1245	1450	480	1016	10	1598	2097	22.00
1000	102	**.1000.102.0**	440466	440287	1480	1076	1342	1450	665	1016	10	1128	842	13.00
1000	155	**.1000.155.0**	440467	440288	1705	1169	1441	1450	853	1016	10	869	418	9.60
1000	212	**.1000.212.0**	440468	440289	2005	1286	1558	1450	1153	1016	10	635	226	5.10
1000	298	**.1000.298.0**	440469	440290	2455	1481	1752	1450	1603	1016	10	453	116	2.60
1200	51	**.1200.051.0**	440470	440291	1260	1305	1759	1680	480	1220	10	2797	3421	30.00
1200	102	**.1200.102.0**	440471	440292	1505	1419	1887	1680	653	1220	10	2015	1176	24.00
1200	151	**.1200.151.0**	440472	440293	1805	1520	1989	1680	953	1220	10	1355	544	11.00
1200	201	**.1200.201.0**	440473	440294	2105	1647	2116	1680	1253	1220	10	1021	311	6.00
1200	300	**.1200.300.0**	440474	440295	2705	1901	2370	1680	1853	1220	10	684	140	2.70
1400	54	**.1400.054.0**	440475	–	1660	2220	–	1975	830	1420	10	2513	2263	10.00
1400	106	**.1400.106.0**	440476	–	1815	2323	–	1975	858	1420	10	2432	1038	19.00
1400	155	**.1400.155.0**	440477	–	2215	2599	–	1975	1258	1420	10	1658	490	9.10
1400	204	**.1400.204.0**	440478	–	2615	2875	–	1975	1658	1420	10	1258	284	5.20
1400	303	**.1400.303.0**	440479	–	3415	3496	–	1975	2458	1420	10	849	130	2.40

Lateral expansion joint — Type LRR 16...

for movement in all planes with weld ends

PN 16



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type LRR 16 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	2λ_N	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	50	**.0050.050.0**	440693	380	6	205
50	103	**.0050.103.0**	440694	510	6	205
50	149	**.0050.149.0**	440695	630	7	205
50	199	**.0050.199.0**	440696	780	9	205
65	53	**.0065.053.0**	440697	410	8	225
65	104	**.0065.104.0**	440698	530	9	225
65	145	**.0065.145.0**	440699	640	9	225
65	198	**.0065.198.0**	440700	800	10	225
80	51	**.0080.051.0**	440701	420	9	240
80	102	**.0080.102.0**	440702	550	10	240
80	150	**.0080.150.0**	440703	670	11	240
80	205	**.0080.205.0**	440704	840	13	240
100	50	**.0100.050.0**	440705	425	10	265
100	103	**.0100.103.0**	440706	575	12	265
100	145	**.0100.145.0**	440707	705	13	265
100	202	**.0100.202.0**	440708	905	14	265
125	53	**.0125.053.0**	440709	485	17	290
125	102	**.0125.102.0**	440710	615	19	290
125	151	**.0125.151.0**	440711	735	21	290
125	196	**.0125.196.0**	440712	855	23	290
150	53	**.0150.053.0**	440713	515	24	350
150	100	**.0150.100.0**	440714	645	26	350
150	153	**.0150.153.0**	440715	785	29	350
150	194	**.0150.194.0**	440716	915	32	350

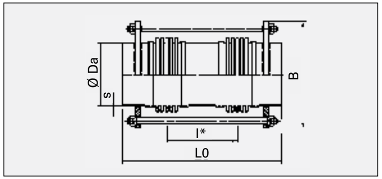
Lateral expansion joint Type LRR 16...
for movement in all planes with weld ends
PN 16

Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
151	60.3	4	4	20	0
281	60.3	4	3	5.9	0
401	60.3	4	2.4	2.9	0
550	60.3	4	1.9	1.5	0
156	76.1	4	5.8	25	0
276	76.1	4	4.4	7.9	0
386	76.1	4	3.6	4	0
546	76.1	4	2.9	2	0
161	88.9	4	7.3	36	0
291	88.9	4	5.5	11	0
411	88.9	4	4.5	5.5	0
581	88.9	4	3.5	2.8	0
173	114.3	4	11	41	0
323	114.3	4	7.9	12	0
453	114.3	4	6.4	6	0
653	114.3	4	5	2.9	0
187	139.7	4	16	73	0
317	139.7	4	12	23	0
437	139.7	4	10	12	0
557	139.7	4	8.8	7.2	0
197	168.3	4.5	29	91	0
327	168.3	4.5	23	31	0
467	168.3	4.5	19	15	0
597	168.3	4.5	16	9.2	0

Lateral expansion joint — Type LRR 16...

for movement in all planes with weld ends

PN 16



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type	Order No. standard version	Overall length	Weight approx.	Max. width approx.
		LRR 16 ...				
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	50	**.0200.050.0**	440717	545	41	435
200	100	**.0200.100.0**	440718	705	45	435
200	150	**.0200.150.0**	440719	855	49	435
200	200	**.0200.200.0**	440720	1045	65	435
250	52	**.0250.052.0**	440721	640	67	520
250	103	**.0250.103.0**	440722	860	84	520
250	154	**.0250.154.0**	440723	1060	97	520
250	207	**.0250.207.0**	440724	1310	114	520
300	50	**.0300.050.0**	440725	710	109	610
300	95	**.0300.095.0**	440726	880	124	610
300	145	**.0300.145.0**	440727	1080	141	610
300	196	**.0300.196.0**	440728	1330	164	610
300	296	**.0300.296.0**	440729	1830	207	610
350	51	**.0350.051.0**	440730	740	118	580
350	100	**.0350.100.0**	440731	940	139	580
350	149	**.0350.149.0**	440732	1140	160	580
350	199	**.0350.199.0**	440733	1390	186	580
350	306	**.0350.306.0**	440734	1940	244	580
400	52	**.0400.052.0**	440735	760	143	630
400	94	**.0400.094.0**	440736	930	163	630
400	147	**.0400.147.0**	440737	1130	186	630
400	200	**.0400.200.0**	440738	1330	209	630
400	309	**.0400.309.0**	440739	1830	266	630

Lateral expansion joint Type LRR 16...
for movement in all planes with weld ends
PN 16

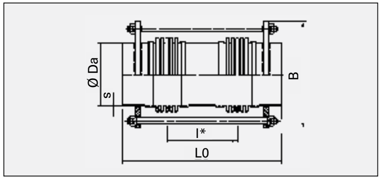
Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
213	219.1	6.3	65	144	0
373	219.1	6.3	50	43	0
523	219.1	6.3	41	21	0
672	219.1	6.3	34	12	0
266	273	7.1	106	227	0
445	273	7.1	79	68	0
645	273	7.1	64	33	0
895	273	7.1	52	17	0
235	323.9	8	156	281	0
405	323.9	8	127	99	0
605	323.9	8	103	45	0
855	323.9	8	83	23	0
1355	323.9	8	60	9.1	0
260	355.6	8	166	328	0
460	355.6	8	129	109	0
660	355.6	8	105	54	0
910	355.6	8	84	28	0
1460	355.6	8	60	11	0
260	406.4	8	211	476	0
430	406.4	8	168	183	0
630	406.4	8	137	87	0
830	406.4	8	115	50	0
1330	406.4	8	83	20	0

Lateral expansion joint

Type LRR 16...

for movement in all planes with weld ends

PN 16



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type **LRR 16 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
450	50	**.0450.050.0**	440740	800	201	720
450	104	**.0450.104.0**	440741	1020	232	720
450	155	**.0450.155.0**	440742	1220	259	720
450	203	**.0450.203.0**	440743	1420	287	720
450	296	**.0450.296.0**	440744	1870	350	720

Lateral expansion joint Type LRR 16...
for movement in all planes with weld ends
PN 16

Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
260	457	8	290	603	0
480	457	8	224	188	0
680	457	8	185	95	0
880	457	8	158	57	0
1330	457	8	118	25	0

Lateral expansion joint with weld ends

for movement in one plane **Type LRN 16...**

for movement in all planes **Type LRK 16...**

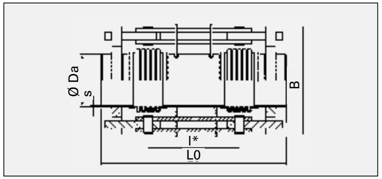
PN 16

Lateral expansion joint with weld ends

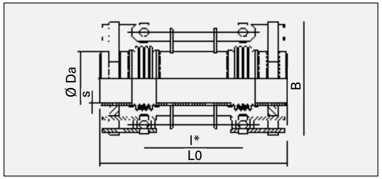
for movement in one plane **Type LRN 16...**

for movement in all planes **Type LRK 16...**

PN 16

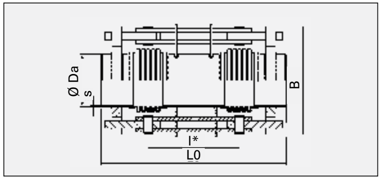


Type LRN

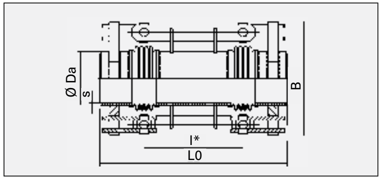


Type LRK

Nominal diameter	Nominal lateral movement absorption	Type **LRN 16 ...** **LRK 16 ...**	Order No. standard version		Overall length	LRN Weight approx.	LRK Weight approx.	Max. width approx.	Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
			LRN	**LRK**						outside-diameter	wall thickness			
DN	$2\lambda_N$	–	–	–	Lo	G	G	B	l*	Da	s	c_r	c_λ	c_p
–	mm	–	–	–	mm	kg	kg	mm	mm	mm	mm	N/bar	N/mm	N/mm bar
500	53	**.0500.053.0**	440480	440296	810	251	311	790	338	508	8	354	827	6.7
500	107	**.0500.107.0**	440481	440297	945	277	338	790	418	508	8	281	308	7.00
500	148	**.0500.148.0**	440482	440298	1095	285	351	790	568	508	8	203	164	3.70
500	203	**.0500.203.0**	440483	440299	1295	308	374	790	768	508	8	148	88	1.90
500	313	**.0500.313.0**	440484	440300	1695	361	427	790	1168	508	8	96	37	0.80
600	53	**.0600.053.0**	440485	440301	945	392	502	945	398	610	8	525	1237	9.40
600	99	**.0600.099.0**	440486	440302	1115	436	551	945	508	610	8	404	484	8.40
600	150	**.0600.150.0**	440487	440303	1365	488	603	945	758	610	8	266	214	3.60
600	202	**.0600.202.0**	440488	440304	1615	541	655	945	1008	610	8	198	120	2.00
600	305	**.0600.305.0**	440489	440305	2115	645	760	945	1508	610	8	131	53	0.90
700	54	**.0700.054.0**	440490	440306	1005	522	640	1085	403	711	10	699	1480	13.00
700	100	**.0700.100.0**	440491	440307	1180	575	698	1085	515	711	10	538	577	11.00
700	151	**.0700.151.0**	440492	440308	1430	642	765	1085	765	711	10	355	259	5.00
700	202	**.0700.202.0**	440493	440309	1680	708	831	1085	1015	711	10	265	146	2.80
700	304	**.0700.304.0**	440494	440310	2180	841	964	1085	1515	711	10	176	65	1.20
800	58	**.0800.058.0**	440495	440311	1120	768	1009	1220	460	813	10	1054	1542	13.00
800	105	**.0800.105.0**	440496	440312	1300	837	1085	1220	575	813	10	831	631	12.00
800	153	**.0800.153.0**	440497	440313	1550	921	1170	1220	825	813	10	569	302	5.80
800	211	**.0800.211.0**	440498	440314	1850	1023	1271	1220	1125	813	10	413	161	3.00
800	307	**.0800.307.0**	440499	440315	2350	1191	1440	1220	1625	813	10	283	76	1.40



Type LRN



Type LRK

Nominal diameter	Nominal lateral movement absorption	Type	Order No. standard version		Overall length	LRN Weight approx.	LRK Weight approx.
		LRN 16 ... **LRK 16 ...**	**LRN**	**LRK**			
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
900	52	**.0900.052.0**	440500	440316	1270	1161	1569
900	104	**.0900.104.0**	440501	440317	1455	1257	1676
900	157	**.0900.157.0**	440502	440318	1670	1360	1787
900	205	**.0900.205.0**	440503	440319	1920	1467	1895
900	293	**.0900.293.0**	440504	440320	2370	1660	2088
1000	51	**.1000.051.0**	440505	440321	1310	1289	1714
1000	102	**.1000.102.0**	440506	440322	1510	1407	1847
1000	154	**.1000.154.0**	440507	440323	1735	1519	1964
1000	210	**.1000.210.0**	440508	440324	2035	1656	2101
1000	303	**.1000.303.0**	440509	440325	2535	1883	2328

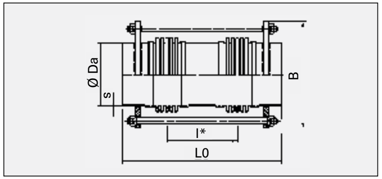
Lateral expansion joint with weld ends
for movement in one plane **Type LRN 16...**
for movement in all planes **Type LRK 16...**
PN 16

Max. width approx.	Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
		outside-diameter	wall thickness			
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
1380	535	914	10	1439	2088	9.80
1380	653	914	10	1167	814	11.00
1380	835	914	10	901	406	7.60
1380	1085	914	10	687	238	4.40
1380	1535	914	10	482	118	2.20
1490	555	1016	10	1726	2808	13.00
1490	680	1016	10	1389	1077	14.00
1490	868	1016	10	1074	539	9.90
1490	1168	1016	10	789	294	5.30
1490	1668	1016	10	546	142	2.50

Lateral expansion joint — Type LRR 25...

for movement in all planes with weld ends

PN 25



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type **LRR 25 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	50	**.0050.050.0**	440745	410	7	205
50	98	**.0050.098.0**	440746	540	8	205
50	148	**.0050.148.0**	440747	710	10	205
50	205	**.0050.205.0**	440748	910	12	205
65	51	**.0065.051.0**	440749	430	8	225
65	99	**.0065.099.0**	440750	580	9	225
65	153	**.0065.153.0**	440751	780	11	225
65	195	**.0065.195.0**	440752	940	12	225
80	52	**.0080.052.0**	440753	440	11	240
80	103	**.0080.103.0**	440754	580	13	240
80	155	**.0080.155.0**	440755	750	14	240
80	193	**.0080.193.0**	440756	890	16	240
100	50	**.0100.050.0**	440757	475	15	265
100	102	**.0100.102.0**	440758	645	17	265
100	144	**.0100.144.0**	440759	805	19	265
100	192	**.0100.192.0**	440760	990	22	265
125	51	**.0125.051.0**	440761	515	22	320
125	102	**.0125.102.0**	440762	675	25	320
125	153	**.0125.153.0**	440763	865	28	320
125	196	**.0125.196.0**	440764	1050	34	320
150	51	**.0150.051.0**	440765	545	31	380
150	102	**.0150.102.0**	440766	715	35	380
150	151	**.0150.151.0**	440767	915	40	380
150	194	**.0150.194.0**	440768	1120	49	380

Lateral expansion joint — Type LRR 25...

for movement in all planes with weld ends

PN 25

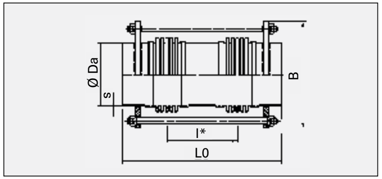
Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
156	60.3	4	3.9	24	0
286	60.3	4	2.9	7.1	0
455	60.3	4	2.2	2.8	0
655	60.3	4	1.7	1.4	0
185	76.1	4	5.5	26	0
335	76.1	4	4.1	8	0
535	76.1	4	3	3.1	0
695	76.1	4	2.5	1.9	0
176	88.9	4	6.9	41	0
316	88.9	4	5.2	13	0
486	88.9	4	4	5.4	0
626	88.9	4	3.4	3.3	0
197	114.3	4	12	55	0
367	114.3	4	9	16	0
527	114.3	4	7.1	7.7	0
712	114.3	4	5.8	4.2	0
211	139.7	4	20	69	0
371	139.7	4	15	21	0
561	139.7	4	12	8.9	0
714	139.7	4	9.7	5.2	0
221	168.3	4.5	39	88	0
391	168.3	4.5	30	26	0
591	168.3	4.5	23	11	0
764	168.3	4.5	19	6.3	0

Lateral expansion joint

Type LRR 25...

for movement in all planes with weld ends

PN 25



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type **LRR 25 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	50	**.0200.050.0**	440769	670	65	460
200	101	**.0200.101.0**	440770	870	72	460
200	155	**.0200.155.0**	440771	1140	91	460
200	195	**.0200.195.0**	440772	1340	101	460
250	51	**.0250.051.0**	440773	650	94	495
250	101	**.0250.101.0**	440774	870	115	495
250	149	**.0250.149.0**	440775	1120	136	495
250	204	**.0250.204.0**	440776	1420	160	495
300	61	**.0300.061.0**	440777	825	145	545
300	110	**.0300.110.0**	440778	1050	167	545
300	150	**.0300.150.0**	440779	1250	196	545
300	200	**.0300.200.0**	440780	1550	226	545
300	302	**.0300.302.0**	440781	2150	290	545
350	50	**.0350.050.0**	440782	790	158	615
350	100	**.0350.100.0**	440783	1000	182	615
350	145	**.0350.145.0**	440784	1200	205	615
350	190	**.0350.190.0**	440785	1450	235	615
350	291	**.0350.291.0**	440786	2000	299	615

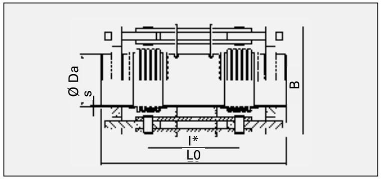
Lateral expansion joint

Type LRR 25...

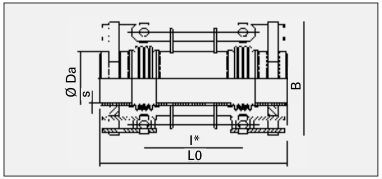
for movement in all planes with weld ends

PN 25

Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
261	219.1	6.3	70	199	0
461	219.1	6.3	53	64	0
690	219.1	6.3	40	24	0
890	219.1	6.3	34	15	0
271	273	7.1	106	264	0
450	273	7.1	79	81	0
700	273	7.1	61	34	0
1000	273	7.1	48	17	0
340	323.9	8	118	241	0
565	323.9	8	93	90	0
765	323.9	8	78	49	0
1065	323.9	8	62	26	0
1665	323.9	8	45	10	0
260	355.6	8	179	426	0
470	355.6	8	141	137	0
670	355.6	8	116	68	0
920	355.6	8	94	36	0
1470	355.6	8	68	14	0



Type LRN

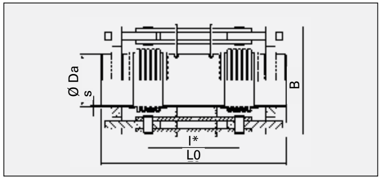


Type LRK

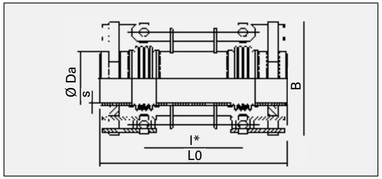
Nominal diameter	Nominal lateral movement absorption	Type	Order No. standard version		Overall length	LRN Weight approx.	LRK Weight approx.
		LRN 25 ... **LRK 25 ...**	**LRN**	**LRK**			
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
400	50	**.0400.050.0**	440510	440326	860	217	275
400	100	**.0400.100.0**	440511	440327	1110	252	310
400	153	**.0400.153.0**	440512	440328	1310	280	340
400	203	**.0400.203.0**	440513	440329	1560	313	372
400	295	**.0400.295.0**	440514	440330	2010	372	431
450	51	**.0450.051.0**	440515	440331	905	328	432
450	103	**.0450.103.0**	440516	440332	1110	370	479
450	154	**.0450.154.0**	440517	440333	1360	415	524
450	195	**.0450.195.0**	440518	440334	1560	450	559
450	297	**.0450.297.0**	440519	440335	2060	539	648
500	53	**.0500.053.0**	440520	440336	965	383	493
500	105	**.0500.105.0**	440521	440337	1220	437	549
500	150	**.0500.150.0**	440522	440338	1380	474	589
500	202	**.0500.202.0**	440523	440339	1630	521	636
500	305	**.0500.305.0**	440524	440340	2130	615	730
600	49	**.0600.049.0**	440525	440341	1065	625	850
600	98	**.0600.098.0**	440526	440342	1240	688	921
600	151	**.0600.151.0**	440527	440343	1455	754	989
600	202	**.0600.202.0**	440528	440344	1705	825	1060
600	303	**.0600.303.0**	440529	440345	2205	968	1203

Lateral expansion joint with weld ends
for movement in one plane **Type LRN 25...**
for movement in all planes **Type LRK 25...**
PN 25

Max. width approx.	Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
		outside-diameter	wall thickness			
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
680	375	406.4	8	201	707	4
680	600	406.4	8	123	212	1.90
680	775	406.4	8	94	104	1.30
680	1025	406.4	8	71	59	0.70
680	1475	406.4	8	49	28	0.40
785	378	457	8	314	882	5.10
785	530	457	8	219	286	3.80
785	780	457	8	147	130	1.70
785	980	457	8	116	82	1.10
785	1480	457	8	76	36	0.50
845	408	508	8	370	1153	6.70
845	635	508	8	229	359	3.20
845	765	508	8	188	202	2.60
845	1015	508	8	140	113	1.40
845	1515	508	8	93	50	0.60
1000	483	610	10	584	1421	5.20
1000	595	610	10	466	538	5.50
1000	778	610	10	351	256	3.80
1000	1028	610	10	263	145	2.10
1000	1528	610	10	175	64	0.90



Type LRN



Type LRK

Nominal diameter	Nominal lateral movement absorption	Type **LRN 25 ... LRK 25 ...**	Order No. standard version **LRN**	**LRK**	Overall length	LRN Weight approx.	LRK Weight approx.
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
700	51	**.0700.051.0**	440530	440346	1185	929	1321
700	103	**.0700.103.0**	440531	440347	1420	1035	1442
700	150	**.0700.150.0**	440532	440348	1670	1129	1536
700	207	**.0700.207.0**	440533	440349	1970	1242	1649
700	301	**.0700.301.0**	440534	440350	2470	1431	1838

Lateral expansion joint with weld ends
for movement in one plane **Type LRN 25...**
for movement in all planes **Type LRK 25...**
PN 25

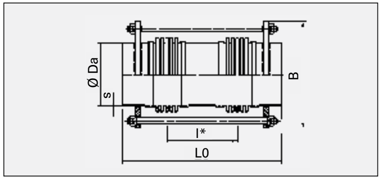
Max. width approx.	Centre-to-centre spacing of bellows	Weld ends outside-diameter	wall thickness	Adjusting force rate		
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
1150	418	711	10	1146	2029	13.00
1150	585	711	10	796	651	9.60
1150	835	711	10	547	314	4.50
1150	1135	711	10	398	168	2.40
1150	1635	711	10	273	80	1.10

Lateral expansion joint

Type LRR 40...

for movement in all planes with weld ends

PN 40



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type LRR 40 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	2λ$_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	53	**.0050.053.0**	440787	440	8	205
50	100	**.0050.100.0**	440788	640	10	205
50	146	**.0050.146.0**	440789	840	12	205
50	204	**.0050.204.0**	440790	1090	14	205
65	49	**.0065.049.0**	440791	465	12	225
65	100	**.0065.100.0**	440792	665	14	225
65	156	**.0065.156.0**	440793	915	17	225
65	200	**.0065.200.0**	440794	1115	20	225
80	51	**.0080.051.0**	440795	475	13	240
80	101	**.0080.101.0**	440796	675	16	240
80	156	**.0080.156.0**	440797	925	19	240
80	188	**.0080.188.0**	440798	1075	21	240
100	46	**.0100.046.0**	440799	590	26	325
100	96	**.0100.096.0**	440800	830	32	325
100	146	**.0100.146.0**	440801	1130	40	325
100	197	**.0100.197.0**	440802	1430	46	325
125	46	**.0125.046.0**	440803	600	32	350
125	94	**.0125.094.0**	440804	850	38	350
125	152	**.0125.152.0**	440805	1200	47	350
125	193	**.0125.193.0**	440806	1450	53	350
150	55	**.0150.055.0**	440807	730	53	405
150	96	**.0150.096.0**	440808	980	61	405
150	149	**.0150.149.0**	440809	1330	74	405
150	195	**.0150.195.0**	440810	1630	85	405

Lateral expansion joint

Type LRR 40...

for movement in all planes with weld ends

PN 40

Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	$c_λ$	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
194	60.3	4	3.5	19	0
394	60.3	4	2.4	4.6	0
594	60.3	4	1.8	2	0
844	60.3	4	1.4	1	0
198	76.1	4	6.2	33	0
398	76.1	4	4.3	8.4	0
648	76.1	4	3.1	3.2	0
848	76.1	4	2.6	1.8	0
202	88.9	4	8	38	0
402	88.9	4	5.6	9.8	0
652	88.9	4	4.1	3.7	0
802	88.9	4	3.5	2.5	0
265	114.3	4	19	63	0
465	114.3	4	13	20	0
765	114.3	4	9.6	7.8	0
1065	114.3	4	7.6	4.1	0
230	139.7	4	25	89	0
480	139.7	4	17	21	0
830	139.7	4	12	7.1	0
1080	139.7	4	10	4.2	0
314	168.3	4.5	38	81	0
564	168.3	4.5	28	25	0
914	168.3	4.5	21	9.7	0
1214	168.3	4.5	17	5.5	0

Lateral expansion joint — Type LRR 40...

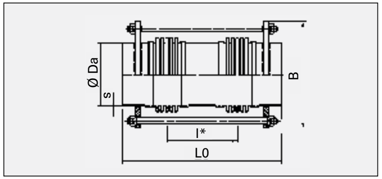
for movement in all planes with weld ends

PN 40

Lateral expansion joint — Type LRR 40...

for movement in all planes with weld ends

PN 40



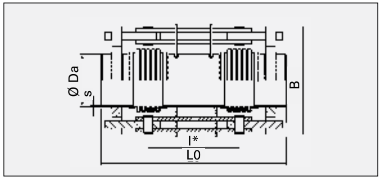
Type LRR

Nominal diameter	Nominal lateral movement absorption	Type	Order No. standard version	Overall length	Weight approx.	Max. width approx.
		LRR 40 ...				
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	54	**.0200.054.0**	440811	760	102	440
200	97	**.0200.097.0**	440812	960	115	440
200	149	**.0200.149.0**	440813	1260	135	440
200	206	**.0200.206.0**	440814	1610	159	440
250	45	**.0250.045.0**	440815	720	140	530
250	97	**.0250.097.0**	440816	970	163	530
250	151	**.0250.151.0**	440817	1320	196	530
250	206	**.0250.206.0**	440818	1670	228	530

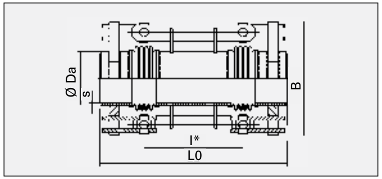
Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
300	219.1	6.3	60	182	0
500	219.1	6.3	48	67	0
800	219.1	6.3	36	26	0
1150	219.1	6.3	28	13	0
255	273	7.1	110	332	0
505	273	7.1	83	88	0
855	273	7.1	60	31	0
1205	273	7.1	48	16	0

Lateral expansion joint with weld ends

for movement in one plane **Type LRN 40...**
for movement in all planes **Type LRK 40...**
PN 40



Type LRN



Type LRK

Nominal diameter	Nominal lateral movement absorption	Type	Order No. standard version		Overall length	LRN Weight approx.	LRK Weight approx.
		LRN 40 ... **LRK 40 ...**	**LRN**	**LRK**			
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
300	52	**.0300.052.0**	440535	440351	855	194	250
300	101	**.0300.101.0**	440536	440352	1045	219	276
300	147	**.0300.147.0**	440537	440353	1295	248	305
300	194	**.0300.194.0**	440538	440354	1545	276	333
300	297	**.0300.297.0**	440539	440355	2095	339	396
350	51	**.0350.051.0**	440540	440356	915	275	380
350	106	**.0350.106.0**	440541	440357	1135	313	421
350	155	**.0350.155.0**	440542	440358	1385	352	460
350	204	**.0350.204.0**	440543	440359	1635	392	499
350	301	**.0350.301.0**	440544	440360	2135	470	577
400	50	**.0400.050.0**	440545	440361	915	319	424
400	99	**.0400.099.0**	440546	440362	1170	368	475
400	149	**.0400.149.0**	440547	440363	1370	408	516
400	198	**.0400.198.0**	440548	440364	1620	455	563
400	296	**.0400.296.0**	440549	440365	2120	548	656
450	49	**.0450.049.0**	440550	440366	945	394	502
450	107	**.0450.107.0**	440551	440367	1210	455	568
450	154	**.0450.154.0**	440552	440368	1460	505	618
450	201	**.0450.201.0**	440553	440369	1710	555	668
450	304	**.0450.304.0**	440554	440370	2260	665	778

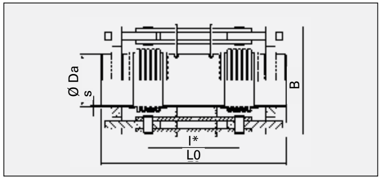
Lateral expansion joint with weld ends
for movement in one plane **Type LRN 40...**
for movement in all planes **Type LRK 40...**
PN 40

Max. width approx.	Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
		outside-diameter	wall thickness			
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
580	418	323.9	8	115	447	1.9
580	563	323.9	8	84	158	1.50
580	813	323.9	8	58	75	0.70
580	1063	323.9	8	44	43	0.40
580	1613	323.9	8	29	19	0.20
675	395	355.6	8	184	532	2.70
675	568	355.6	8	126	165	1.80
675	818	355.6	8	86	78	0.90
675	1068	355.6	8	66	46	0.50
675	1568	355.6	8	44	21	0.20
725	383	406.6	10	248	737	4.20
725	610	406.6	10	152	223	1.90
725	785	406.6	10	117	111	1.40
725	1035	406.6	10	88	63	0.80
725	1535	406.6	10	59	28	0.40
815	398	457	10	306	1052	5.40
815	605	457	10	195	286	3.30
815	855	457	10	136	141	1.60
815	1105	457	10	104	83	0.90
815	1655	457	10	69	37	0.40

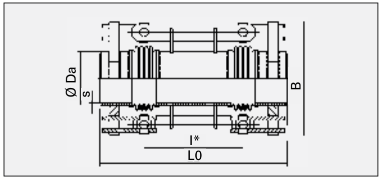
Lateral expansion joint with weld ends

for movement in one plane **Type LRN 40...**
for movement in all planes **Type LRK 40...**
PN 40

Lateral expansion joint with weld ends
for movement in one plane **Type LRN 40...**
for movement in all planes **Type LRK 40...**
PN 40



Type LRN



Type LRK

Nominal diameter	Nominal lateral movement absorption	Type **LRN 40 ...** **LRK 40 ...**	Order No. standard version **LRN**	 **LRK**	Overall length	LRN Weight approx.	LRK Weight approx.
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
500	47	**.0500.047.0**	440555	440371	1140	589	813
500	96	**.0500.096.0**	440556	440372	1405	665	897
500	146	**.0500.146.0**	440557	440373	1755	756	988
500	196	**.0500.196.0**	440558	440374	2105	847	1079
500	296	**.0500.296.0**	440559	440375	2805	1028	1260

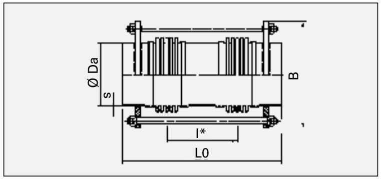
Max. width approx.	Centre-to-centre spacing of bellows	Weld ends outside-diameter	 wall thickness	Adjusting force rate		
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
890	495	508	10	392	1252	4.10
890	703	508	10	271	400	2.90
890	1053	508	10	179	175	1.30
890	1403	508	10	133	98	0.70
890	2103	508	10	88	43	0.30

Lateral expansion joint

Type LRR 63...

for movement in all planes with weld ends

PN 63



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type LRR 63 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
50	50	**.0050.050.0**	440819	540	11	205
50	96	**.0050.096.0**	440820	790	14	205
50	155	**.0050.155.0**	440821	1140	17	205
50	198	**.0050.198.0**	440822	1390	20	205
65	55	**.0065.055.0**	440823	570	17	255
65	96	**.0065.096.0**	440824	820	21	255
65	145	**.0065.145.0**	440825	1120	25	255
65	203	**.0065.203.0**	440826	1470	30	255
80	50	**.0080.050.0**	440827	590	26	300
80	98	**.0080.098.0**	440828	890	32	300
80	152	**.0080.152.0**	440829	1240	39	300
80	191	**.0080.191.0**	440830	1490	44	300
100	50	**.0100.050.0**	440831	700	45	350
100	98	**.0100.098.0**	440832	1000	55	350
100	155	**.0100.155.0**	440833	1400	67	350
100	197	**.0100.197.0**	440834	1700	76	350
125	55	**.0125.055.0**	440835	740	62	410
125	99	**.0125.099.0**	440836	1040	75	410
125	143	**.0125.143.0**	440837	1340	89	410
125	201	**.0125.201.0**	440838	1740	106	410
150	50	**.0150.050.0**	440839	750	85	385
150	98	**.0150.098.0**	440840	1050	103	385
150	153	**.0150.153.0**	440841	1450	127	385
150	195	**.0150.195.0**	440842	1750	145	385

Lateral expansion joint

Type LRR 63...

for movement in all planes with weld ends

PN 63

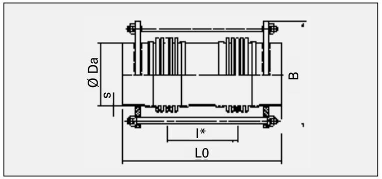
Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
260	60.3	4	3.6	28	0
510	60.3	4	2.5	7.3	0
860	60.3	4	1.7	2.6	0
1110	60.3	4	1.4	1.5	0
265	76.1	4	6.9	35	0
515	76.1	4	4.8	9.3	0
815	76.1	4	3.5	3.7	0
1165	76.1	4	2.6	1.8	0
265	88.9	4	12	44	0
565	88.9	4	8.1	9.8	0
915	88.9	4	5.8	3.8	0
1165	88.9	4	4.8	2.3	0
290	114.3	5	20	68	0
590	114.3	5	14	17	0
990	114.3	5	10	6	0
1290	114.3	5	8.2	3.6	0
318	139.7	6.3	30	73	0
618	139.7	6.3	21	20	0
918	139.7	6.3	17	8.9	0
1318	139.7	6.3	13	4.3	0
295	168.3	6.3	38	132	0
595	168.3	6.3	27	33	0
995	168.3	6.3	19	12	0
1295	168.3	6.3	16	7.1	0

Lateral expansion joint

for movement in all planes with weld ends

Type LRR 63...

PN 63



Type LRR

Nominal diameter	Nominal lateral movement absorption	Type **LRR 63 ...**	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	–	–	Lo	G	B
–	mm	–	–	mm	kg	mm
200	53	**.0200.053.0**	440843	910	150	475
200	95	**.0200.095.0**	440844	1210	177	475
200	142	**.0200.142.0**	440845	1610	213	475
200	199	**.0200.199.0**	440846	2110	257	475

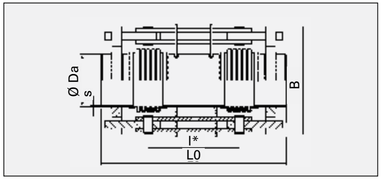
Lateral expansion joint
for movement in all planes with weld ends
Type LRR 63...
PN 63

Centre-to-centre spacing of bellows	Weld ends		Adjusting force rate		
	outside-diameter	wall thickness			
l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	N/bar	N/mm	N/mm bar
405	219.1	8	59	206	0
705	219.1	8	44	69	0
1105	219.1	8	33	28	0
1605	219.1	8	25	13	0

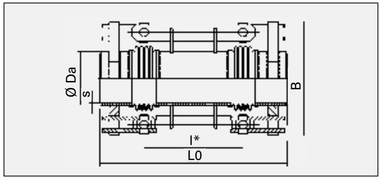
Lateral expansion joint with weld ends

for movement in one plane **Type LRN 63...**
for movement in all planes **Type LRK 63...**
PN 63

Lateral expansion joint with weld ends
for movement in one plane **Type LRN 63...**
for movement in all planes **Type LRK 63...**
PN 63



Type LRN



Type LRK

Nominal diameter	Nominal lateral movement absorption	Type **LRN 63 ...** **LRK 63 ...**	Order No. standard version **LRN**	 **LRK**	Overall length	LRN Weight approx.	LRK Weight approx.
DN	$2\lambda_N$	–	–	–	Lo	G	G
–	mm	–	–	–	mm	kg	kg
250	51	**.0250.051.0**	440560	440376	920	264	366
250	104	**.0250.104.0**	440561	440377	1215	310	414
250	153	**.0250.153.0**	440562	440378	1515	356	460
250	202	**.0250.202.0**	440563	440379	1815	402	506
300	48	**.0300.048.0**	440564	440380	950	302	407
300	100	**.0300.100.0**	440565	440381	1200	347	455
300	150	**.0300.150.0**	440566	440382	1500	399	507
300	200	**.0300.200.0**	440567	440383	1800	451	559
300	299	**.0300.299.0**	440568	440384	2400	555	664
350	49	**.0350.049.0**	440569	440385	1045	372	481
350	97	**.0350.097.0**	440570	440386	1260	420	534
350	147	**.0350.147.0**	440571	440387	1560	477	592
350	198	**.0350.198.0**	440572	440388	1860	535	649
350	299	**.0350.299.0**	440573	440389	2460	650	764
400	52	**.0400.052.0**	440574	440390	1120	547	772
400	102	**.0400.102.0**	440575	440391	1470	646	874
400	152	**.0400.152.0**	440576	440392	1870	759	987
400	196	**.0400.196.0**	440577	440393	2220	805	973
400	297	**.0400.297.0**	440578	440394	3020	1004	1142

Max. width approx.	Centre-to-centre spacing of bellows	Weld ends outside-diameter	 wall thickness	Adjusting force rate		
B	l*	Da	s	c_r	c_λ	c_p
mm	mm	mm	mm	N/bar	N/mm	N/mm bar
575	385	273	10	90	385	2
575	658	273	10	52	107	0.80
575	958	273	10	35	50	0.40
575	1258	273	10	27	29	0.20
625	425	323.9	11	142	490	2.00
625	625	323.9	11	95	146	1.30
625	925	323.9	11	63	65	0.60
625	1225	323.9	11	48	37	0.30
625	1825	323.9	11	32	17	0.10
695	448	355.6	12	168	686	2.60
695	605	355.6	12	122	239	2.00
695	905	355.6	12	80	105	0.90
695	1205	355.6	12	59	58	0.50
695	1805	355.6	12	39	26	0.20
780	510	406.4	15	244	664	2.80
780	835	406.4	15	146	201	1.20
780	1235	406.4	15	98	91	0.50
780	1585	406.4	15	76	55	0.30
780	2385	406.4	15	50	24	0.10

Type LBS

Designation

The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 10 digits

Example:
Type LBS: HYDRA lateral expansion joint for absorbing vibration, noise isolated, with lap-joint flanges

Standard version/materials:
multi-ply bellows: 1.4541
flange: P 265 GH (1.0425)
operating temperature: up to 400°C

Designation (example):

L	B	S	1	0	.	0	1	5	0	.	0	3	1	.	0

- LBS: Type
- 10: Nominal pressure (PN10)
- 0150: Nominal diameter (DN150)
- 031: Movement absorption, nominal (2δ = 31 mm)
- 0: Inner sleeve (0 = ohne, 1 = mit)

Lateral expansion joint noise-isolated with lap-joint flanges

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- order number
  -> for different materials
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]
  ____
- piping – nominal size DN
  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]
____

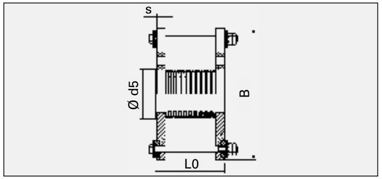
max./min. allowable temperature TS [°C]
____

test pressure PT [bar]
____

Optional:

category ______________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.



Type LBS

Nominal diameter	Vibrations in all planes for 1000 loading cycles	Vibrations in all planes for vibrations	Type LBS 06 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	Î	–	–	Lo	G	B
–	mm	mm	–	–	mm	kg	mm
50	18	0,5	**.0050.018**	459873	165	6	240
65	20	0.5	**.0065.020**	459874	180	7	260
80	21	0.5	**.0080.021**	459875	190	10	290
100	20	0.5	**.0100.020**	459876	190	11	310
125	19	0.5	**.0125.019**	459877	210	15	340
150	31	0.5	**.0150.031**	459878	265	17	365
200	32	0.5	**.0200.032**	459879	285	24	420
250	36	0.5	**.0250.036**	459880	330	39	503
300	40	0.5	**.0300.040**	459881	345	55	600
350	38	0.5	**.0350.038**	459882	360	69	650
400	31	0.5	**.0400.031**	459883	390	89	724

Lateral expansion joint — Type LBS 06...

for absorbing vibration noise-isolated with lap-joint flanges

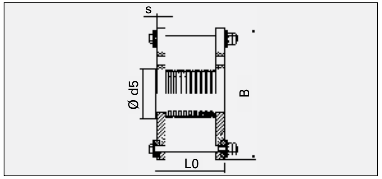
PN 06

Flange drilling EN 1092	Flange rim diameter	Flange thickness	Adjusting force rate			Natural frequency axial	Natural frequency radial
PN	d5	s	c_r	c_λ	c_p	ω_a	ω_r
–	mm	mm	N/bar	N/mm	N/mm bar	Hz	Hz
06	90	16	6	77	14	200	385
06	107	16	8.7	91	15	155	340
06	122	18	11	99	19	145	325
06	147	18	17	162	32	125	345
06	178	20	21	212	40	115	355
06	202	20	25	117	3	90	355
06	258	22	48	165	6	75	325
06	312	24	83	298	5	55	285
06	365	24	153	358	9	50	250
06	410	26	179	418	13	50	270
06	465	28	268	501	14	55	335

Lateral expansion joint — Type LBS 10...

for absorbing vibration noise-isolated with lap-joint flanges

PN 10



Type LBS

Nominal diameter	Vibrations in all planes for 1000 loading cycles	Vibrations in all planes for vibrations	Type LBS 10 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	$\hat{l}$	–	–	Lo	G	B
–	mm	mm	–	–	mm	kg	mm
50	18	0,5	**.0050.018**	459885	175	9	265
65	20	0.5	**.0065.020**	459886	200	12	285
80	21	0.5	**.0080.021**	459887	210	13	300
100	20	0.5	**.0100.020**	459888	210	15	320
125	19	0.5	**.0125.019**	459889	215	19	350
150	31	0.5	**.0150.031**	459890	285	26	385
200	32	0.5	**.0200.032**	459891	300	35	468
250	36	0.5	**.0250.036**	459892	345	54	555
300	40	0.5	**.0300.040**	459893	370	77	629
350	38	0.5	**.0350.038**	459895	380	93	689
400	31	0.5	**.0400.031**	459896	430	152	785

Lateral expansion joint — Type LBS 10...

for absorbing vibration noise-isolated with lap-joint flanges

PN 10

Flange drilling EN 1092	Flange rim diameter	Flange thickness	Adjusting force rate			Natural frequency axial	Natural frequency radial
PN	d5	s	c_r	c_λ	c_p	ω_a	ω_r
–	mm	mm	N/bar	N/mm	N/mm bar	Hz	Hz
16	92	19	5.7	77	9,4	200	385
16	107	20	8.1	136	16	160	315
16	122	20	10	146	16	150	305
16	147	22	16	236	27	125	325
16	178	22	20	364	40	115	355
16	208	24	29	191	3	90	335
10	258	24	58	266	5	75	315
10	320	26	113	339	5	55	260
10	370	28	178	532	8	45	225
10	410	28	213	620	12	40	210
10	465	37	289	1003	13	55	305

Lateral expansion joint — Type LBS 16...

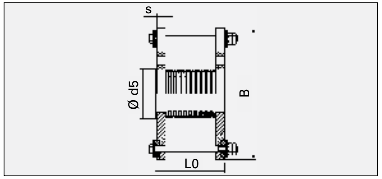
for absorbing vibration noise-isolated with lap-joint flanges

PN 16

Lateral expansion joint — Type LBS 16...

for absorbing vibration noise-isolated with lap-joint flanges

PN 16



Type LBS

Nominal diameter	Vibrations in all planes: for 1000 loading cycles	Vibrations in all planes: for vibrations	Type LBS 16 ...	Order No. standard version	Overall length	Weight approx.	Max. width approx.
DN	$2\lambda_N$	Î	–	–	Lo	G	B
–	mm	mm	–	–	mm	kg	mm
50	17	0,5	**.0050.017**	459898	185	10	265
65	22	0.5	**.0065.022**	459899	210	12	285
80	20	0.5	**.0080.020**	459900	210	13	300
100	15	0.5	**.0100.015**	459901	200	16	320
125	15	0.5	**.0125.015**	459902	210	19	350
150	32	0.5	**.0150.032**	459903	290	29	413
200	33	0.5	**.0200.033**	459904	310	47	500
250	25	0.5	**.0250.025**	459905	355	73	589
300	27	0.5	**.0300.027**	459906	385	110	680
350	25	0.5	**.0350.025**	459907	380	151	667
400	33	0.5	**.0400.033**	459908	450	193	723

Flange: drilling EN 1092	Flange: rim diameter	Flange: thickness	Adjusting force rate			Natural frequency: axial	Natural frequency: radial
PN	d5	s	c_r	c_λ	c_p	ω_a	ω_r
–	mm	mm	N/bar	N/mm	N/mm bar	Hz	Hz
16	92	19	5.5	119	11	205	360
16	107	20	7.8	130	11	140	260
16	122	20	10	178	16	145	300
16	147	22	16	402	30	135	390
16	178	22	25	573	41	130	425
16	208	24	36	220	3	90	315
16	258	26	78	421	5	70	285
16	320	32	133	499	5	85	410
16	375	37	199	741	9	70	360
16	410	32	214	1035	12	65	350
16	465	34	250	1192	11	55	275

Lateral expansion joint Type LBS 25...

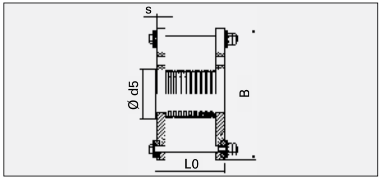
for absorbing vibration noise-isolated with lap-joint flanges

PN 25

Lateral expansion joint Type LBS 25...

for absorbing vibration noise-isolated with lap-joint flanges

PN 25



Type LBS

Nominal iameter	Vibrations in all planes		Type	Order No. standard version	Overall length	Weight approx.	Max. width approx.
	for 1000 loading cycles	for vibrations	**LBS 25 ...**				
DN	$2\lambda_N$	Î	–	–	Lo	G	B
–	mm	mm	–	–	mm	kg	mm
50	18	0,5	**.0050.018**	459909	190	10	265
65	20	0.5	**.0065.020**	459911	215	14	285
80	21	0.5	**.0080.021**	459912	215	16	300
100	20	0.5	**.0100.020**	459913	215	20	335
125	19	0.5	**.0125.019**	459914	230	30	398
150	31	0.5	**.0150.031**	459915	300	43	460
200	32	0.5	**.0200.032**	459916	325	66	544
250	36	0.5	**.0250.036**	459918	370	129	578
300	40	0.5	**.0300.040**	459919	405	164	634
350	38	0.5	**.0350.038**	459920	420	242	735

Flange			Adjusting force rate			Natural frequency	
drilling EN 1092	rim diameter	thickness				axial	radial
PN	d5	s	c_r	c_λ	c_p	ω_a	ω_r
–	mm	mm	N/bar	N/mm	N/mm bar	Hz	Hz
40	92	20	5.5	159	7.6	225	400
40	107	22	7.5	205	11	160	295
40	122	24	9.8	289	16	155	325
40	147	24	19	476	23	135	380
40	178	26	30	671	34	135	410
40	208	28	48	310	3	90	315
25	258	32	94	592	5	105	425
25	320	35	128	788	9	85	390
25	375	38	171	1344	12	75	340
25	410	42	223	1354	11	65	310

Special Ranges

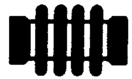
The standard ranges described in Chapter 6 are supplemented in this chapter by a series of special ranges of expansion joints and related products.

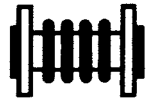
These products are primarily designed either for special applications – engine manufacturing, apparatus engineering, district heating – or for special performance data, e.g. high pressures.

Type series are available for the more frequently demanded dimension ranges; special designs outside these ranges can be supplied on request.

The table overleaf provides an overview of the special ranges.

①


②


③


① **Exhaust expansion joints with special rims**

Series:
AOK
AOU
Nominal diameters:
d_i = 20-200
Pressures:
PN1
Page:
394-397

② **Single-ply expansion joints for apparatus engineering**

Series:
AON
Nominal diameters:
DN 100-3000
Pressures:
Dependent on nominal diameter
Page:
398-409

③ **HYDRAFLON Axial expansion with PTFE liner joints**

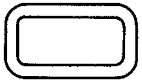
Series:
ABT
Nominal diameters:
DN 50-500
DN 50-300
Pressures:
PN10
PN25
Page:
410-419

7 | OVERVIEW SPECIAL RANGES

④

⑤

⑥



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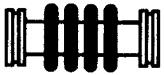

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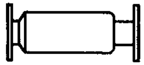

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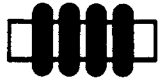


⑩

④ HYDRAMAT Axial expansion joints with automatic release mechanism

Series:
ARH
Nominal diameters:
DN 40-1000
Pressures:
PN 16 and PN 25
Page:
420-429

⑤ Pressure balanced axial expansion joints

Series:
DRD
Nominal diameters:
DN 400-1000
Pressures:
PN 25 and PN 40
Page:
430-433

⑥ Rectangular expansion joints

Series:
XOZ etc.
Nominal diameters:
Max. length of side b = 3700
Pressures:
Max. p_o = 2 bar
Page:
434-439

⑦ Axial expansion joints for vacuum technology

Series:
AVZ
Nominal diameters:
DN 16-500
Pressures:
PN 1
Page:
440

⑧ Axial expansion joints for heating and ventilating installations

Series:
Various
Nominal diameters:
DN 15-100
Pressures:
PN 6-25
Page:
441

⑨ High pressure bellows and expansion joints

Series:
Various
Nominal diameters:
DN 10-1000
Pressures:
Max. PN 400
Page:
442-443

⑩ HYDRAWELD Thin-walled, cylindrical pipes

Nominal diameters:
d_i = 40-1000
Page:
444-445

Exhaust expansion joints with special rims

Exhaust expansion joints which must be mounted directly at the engine are subjected to abnormal conditions:

- High temperatures (ϑ ≥ 400 °C)
- Temperature peaks, according to engine output
- Absorption of thermal expansion and sustained vibrations
- Compact dimensions, since available space usually restricted
- Assembly and dismantling must be rapid if the engine needs to be overhauled or repaired.

We supply special designs based on existing tool series (see table) to meet these requirements; they are tailored to specific applications and have in some cases been developed jointly with the engine manufacturers. Special tools can also be manufactured if necessary. When developing new designs, we are able to make use of our wide-ranging experience and our specially adapted testing facilities, which is an advantage with regard to both development times and costs.

Fig. 7.1 Exhaust expansion joints with special rims

The requirement for simple assembly is met by means of the special installation rims (see. Figs. 7.2 and 7.3).

The moVix connection is a snap-on fixing developed by Witzenmann; it uses a wire-pressed formed ring made of heat-resistant material to seal and secure. This ring is press-fitted together with the conical rim of the bellows by means of a V-band clamp; an unmachined pipe is a suitable mating part (Fig. 7.4).

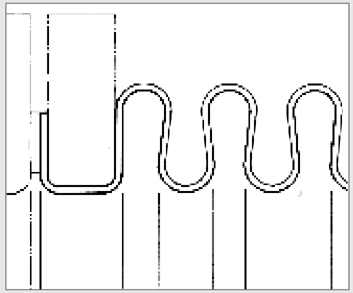


Fig. 7.3 Flange rim for split flanges
Type series AOU

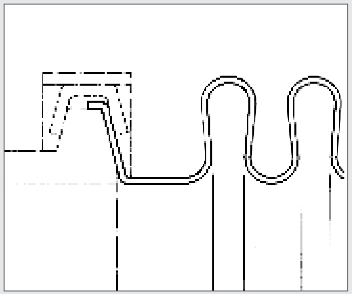


Fig. 7.2 Conical rim for V-band clamp
Type series AOK

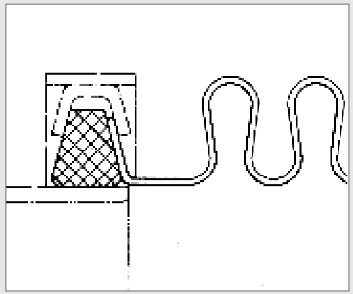
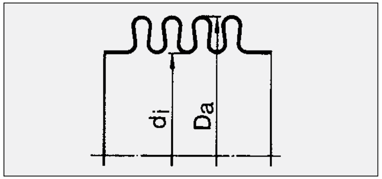


Fig. 7.4 moVix connection



Type AO …

Recommended bellows dimensions

No.	Inside diameter	Outside diameter
–	d_i	D_a
–	mm	mm
1	34	50
2	42*)	60
3	45*)	65
4	51	71
5	56	70-80
6	60	82
7	65*)	80-90
8	71	85-95
9	77	101
10	80	92-106
11	84*)	100-110
12	92	110-120
13	94	110-120
14	96	122
15	110*)	130-140
16	116	135-150
17	135*)	145-170
18	143*)	165-180
19	164	185-205
20	170	190-210
21	188	210-230
22	194	215-235
23	214	235-258
24	218	240-262
25	240*)	265-285
26	272	295-320
27	324	345-380

*) Tools available for conical rim

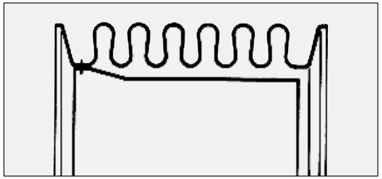


Fig. 7.6 Exhaust expansion joint with one-piece inner sleeve

Materials for sulphur-free exhaust gases (selection)

DIN No.	Designation	Upper temperature limit in °C	Remarks
1.4541	X6CrNiTi 1810	600	Austenite
1.4571	X6CrNiMoTi 17 122	600	Austenite with Mo
1.4828	X15CrNiSi 20 12	1000	Heat-resistant
1.4876	Incoloy 800H	900	(scale-resistant)
2.4856	Inconel 625	650	Temperature and
2.4610	Hastelloy C4	600[1])	corrosion-resistant

Fig. 7.5

[1]) Manufacturer´s specifications

A one-piece inner sleeve can be fitted if necessary, for example to cope with short-time temperature peaks (Fig. 7.6).

Single-ply expansion joints for apparatus engineering
The special range of single-ply expansion joints designed for apparatus engineering and container construction is highly effective in meeting the special demands of these fields:

- Thick, single-ply for welding direct to the container wall
- Good lateral rigidity, which renders axial guides in the container superfluous
- Small corrugations without circumferential seam welds for optimum overall dimensions

The design conforms to the Pressure-Tank Ordinance and has been calculated according to AD Code of Practice B13.

Fig. 7.7 Single-ply expansion joint without connection parts

Design and choice of expansion joints
The values in the table each apply to one corrugation. The required number of corrugations n_W is dependent on the required movement.

No. of corrugation n_W

(7.1) $n_W = 2\delta_{RT} / 2\delta_{WN}$

Movement, cold $2\delta_{RT}$
Movement per corrugation $2\delta_{WN}$
(see table for nominal movement)

The nominal movement, the total length and the adjusting-force rate of the multi-corrugation expansion joint are dependent on the selected number of corrugations (rounded up to integer number):

Nominal movement $2\delta_N$ in mm

(7.2) $2\delta_N = 2\delta_{WN} \cdot n_W$

(Rounded down to integer mm)

Total length L_O in mm

(7.3) $L_O = l_W \cdot n_W + 2l_B$

Length of single corrugation l_W in mm
Length of rim l_B in mm

Adjusting-force rate C_δ in N/mm

(7.4) $C_\delta = C_{\delta W} / n_W$

Adjusting-force rate of single corrugation $C_{\delta W}$ in N/mm

The rim diameter d_B can be adapted to the available connections. The dimension tables specify the permissible diameter range; the desired dimension must be indicated in the order.

It should be noted that the cylindrical section of the rim l_{BZ} must be at least 10mm long.
The transition zone must be between 4mm and $l_W/2$ long on account of the production technology used.

Prequalification, insoection tests, certificates and documentation must be agreed upon when the order is placed, for use in systems requiring inspection.

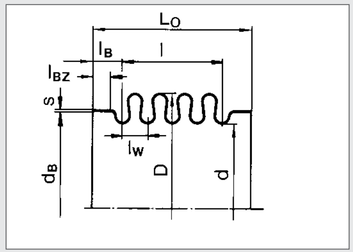


Fig. 7.8 Dimensions/designations

Type AON

Single-wall expansion joint for apparatus engineering

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 9 digits

Example:
Type AON: HYDRA single-wall expansion joint for apparatus engineering

Standard version/materials:
multi-ply bellows: 1.4541
operating temperature: up to 550°C

Designation (example):

A	O	N	1	0	.	0	1	6	4	.	0	2	0

- A O N: Type
- 1 0: Nominal pressure (PN10)
- 0 1 6 4: Inside diameter Di (from table)
- 0 2 0: Movement absorption, nominal (δ = ±10 = 20 mm)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]
  ____
- piping – nominal size DN
  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]
____

max./min. allowable temperature TS [°C]
____

test pressure PT [bar]
____

Optional:

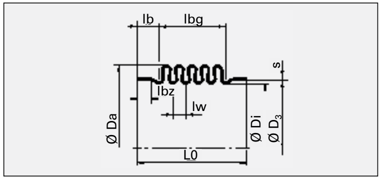
category ______________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Single-wall expansion joint — Type AON

for apparatus engineering

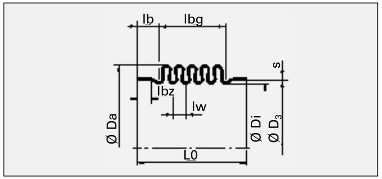
Single-wall expansion joint Type AON
for apparatus engineering



Type AON

Nominal diameter	Nominal pressure	Nominal axial movement absorption per corrugation nominal	Type AON	Weight per corrugation approx.	Bellows wall thickness	Bellows diameter inside	Bellows diameter outside
DN	PN	$2\delta_{WN}$	–	G_W	s	D_i	D_a
–	–	mm	–	kg	mm	mm	mm
100	25	1.9	**25.0110.**	0.1	1	110	145
100	50	1.3	**50.0110.**	0.2	1.5	110	146
125	20	2.5	**20.0135.**	0.2	1	135	175
125	40	1.7	**40.0135.**	0.2	1.5	135	176
150	10	4	**10.0164.**	0.2	1	164	216
150	20	2.7	**20.0164.**	0.4	1.5	164	216
150	50	1.9	**50.0164.**	0.5	2	164	215
200	6	5.8	**06.0214.**	0.4	1	214	276
200	16	4	**16.0214.**	0.6	1.5	214	278
200	32	2.8	**32.0214.**	0.7	2	214	275
250	6	7	**06.0268.**	0.5	1	268	336
250	12.5	4.4	**12.0268.**	0.8	1.5	268	334
250	25	3.4	**25.0268.**	1	2	268	336
250	63	2.2	**63.0268.**	1.5	3	268	336
300	5	8.4	**05.0318.**	0.7	1	318	392
300	10	5.6	**10.0318.**	1	1.5	318	392
300	20	4.2	**20.0318.**	1.3	2	318	393
300	50	2.8	**50.0318.**	2	3	318	393
350	4	9.6	**04.0350.**	0.8	1	350	429
350	10	6.4	**10.0350.**	1.2	1.5	350	429
350	16	4.6	**16.0350.**	1.6	2	350	428
350	50	3	**50.0350.**	2.3	3	350	426

Bellows corrugated length of one corrugation	Bellows bore diameter inside	Bellows bore diameter outside	Bellows max. no. of corrugations	Bellows effective cross-section	Axial adjusting force rate per corrugation
B	$D_{B\ min.}$	$D_{B\ max.}$	n_W	A	c_δ
mm	mm	mm	–	cm^2	N/mm
12	112	143	9	128	7400
13	112	143	7	129	20500
14	137	173	10	189	5960
15	137	173	6	190	18600
15	166	214	11	284	3370
16	166	213	8	284	11400
17	166	211	8	282	25700
17	216	274	15	471	2500
18	216	275	15	475	7900
19	216	271	16	470	19200
19	271	334	14	716	2400
20	271	331	15	712	8550
21	271	332	14	716	20000
22	271	330	15	716	60500
20	321	390	13	990	2150
21	321	389	13	990	7200
22	321	389	13	993	17300
24	321	387	13	993	52000
21	353	427	12	1192	1950
22	353	426	12	1192	6500
23	353	424	12	1188	16900
25	353	420	13	1182	54000



Type AON

Nominal diameter	Nominal pressure	Nominal axial movement absorption per corrugation nominal	Type	Weight per corrugation approx.	Bellows		
					Wall thickness	diameter	
			AON			inside	outside
DN	PN	$2\delta_{WN}$	–	G_W	s	D_i	D_a
–	–	mm	–	kg	mm	mm	mm
400	4	10	**04.0400.**	0.9	1	400	480
400	8	7.2	**08.0400.**	1.4	1.5	400	484
400	16	5.6	**16.0400.**	2	2	400	486
400	40	3.8	**40.0400.**	2.9	3	400	486
450	5	10	**05.0451.**	1	1	451	530
450	10	6.6	**10.0451.**	1.5	1.5	451	530
450	16	4.8	**16.0451.**	2	2	451	530
450	40	3.4	**40.0451.**	3.1	3	451	530
500	3.2	13.6	**03.0502.**	1.3	1	502	595
500	8	8.8	**08.0502.**	2	1.5	502	595
500	12.5	6	**12.0502.**	2.5	2	502	590
500	32	4.4	**32.0502.**	3.9	3	502	593
550	6	8.4	**06.0552.**	1.2	1	552	622
550	12.5	5.8	**12.0552.**	1.8	1.5	552	624
550	20	4.2	**20.0552.**	2.3	2	552	623
550	40	3	**40.0552.**	3.6	3	552	626
600	3.2	14.4	**03.0603.**	1.6	1	603	698
600	6	9.2	**06.0603.**	2.4	1.5	603	697
600	12.5	6.6	**12.0603.**	3.2	2	603	695
600	32	4.2	**32.0603.**	4.6	3	603	692
700	2.5	16.6	**02.0704.**	2.1	1	704	807
700	6	12.6	**06.0704.**	3.2	1.5	704	810
700	10	7.8	**10.0704.**	4	2	704	804
700	25	5.2	**25.0704.**	6.1	3	704	806

Single-wall expansion joint Type AON
for apparatus engineering

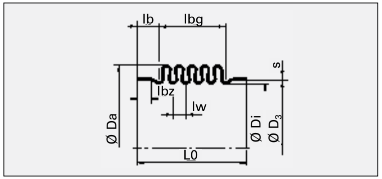
Bellows					Axial adjusting force rate per corrugation
corrugated length of one corrugation	bore diameter		max. no. of corrugations	effective cross-section	
	inside	outside			
B	$D_{B\,min.}$	$D_{B\,max.}$	n_W	A	c_δ
mm	mm	mm	–	cm^2	N/mm
22	403	478	12	1521	2100
23	403	481	11	1534	6000
24	403	482	11	1541	14100
26	403	480	11	1541	42000
24	454	528	12	1890	2350
24	454	527	12	1890	7900
25	454	526	12	1890	19800
27	454	524	12	1890	58000
24	505	593	10	2363	1600
25	505	592	10	2363	5500
26	505	586	11	2341	15800
28	505	587	11	2354	43000
25	556	620	13	2706	3800
25	556	621	13	2715	12000
26	556	619	13	2711	31300
28	556	620	13	2725	85000
26	607	696	10	3323	1800
26	607	694	10	3318	6200
27	607	691	10	3308	16400
29	607	686	10	3293	53700
27	708	805	9	4483	1600
28	708	807	9	4501	5100
29	708	800	9	4465	14800
31	708	800	9	4477	48800

Single-wall expansion joint **Type AON**

for apparatus engineering

Single-wall expansion joint Type AON

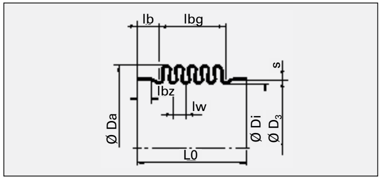
for apparatus engineering



Type AON

Nominal diameter	Nominal pressure	Nominal axial movement absorption per corrugation nominal	Type **AON**	Weight per corrugation approx.	Bellows wall thickness	Bellows diameter inside	Bellows diameter outside
DN	PN	$2\delta_{WN}$	–	G_W	s	D_i	D_a
–	–	mm	–	kg	mm	mm	mm
800	2.5	19	**02.0805.**	2.5	1	805	915
800	6	12	**06.0805.**	3.7	1.5	805	912
800	10	9.4	**10.0805.**	5	2	805	915
800	25	5.2	**25.0805.**	7	3	805	906
900	4	13	**04.0914.**	2.4	1	914	1002
900	8	9.2	**08.0914.**	3.6	1.5	914	1004
900	12.5	7	**12.0914.**	4.9	2	914	1005
900	25	4.6	**25.0914.**	7.4	3	914	1007
1000	8	10	**08.1016.**	4.3	1.5	1016	1110
1000	12.5	8	**12.1016.**	5.8	2	1016	1113
1000	25	5.4	**25.1016.**	8.8	3	1016	1115
1100	6	11.2	**06.1111.**	4.9	1.5	1111	1210
1100	12.5	8	**12.1111.**	6.4	2	1111	1208
1100	20	5.6	**20.1111.**	9.8	3	1111	1212
1200	6	11.2	**06.1211.**	5.3	1.5	1211	1310
1200	10	8.4	**10.1211.**	7.1	2	1211	1310
1200	20	5.6	**20.1211.**	10.8	3	1211	1312
1400	8	13.8	**08.1412.**	10.6	2	1412	1536
1400	12.5	10.8	**12.1412.**	17.1	3	1412	1548
1600	6	15.6	**06.1612.**	12.9	2	1612	1746
1600	12.5	12	**12.1612.**	20.7	3	1612	1758
1800	6	16	**06.1812.**	14.6	2	1812	1946
1800	12.5	11.8	**12.1812.**	22.9	3	1812	1955

Bellows corrugated length of one corrugation	Bellows bore diameter inside	Bellows bore diameter outside	Bellows max. no. of corrugations	Bellows effective cross-section	Axial adjusting force rate per corrugation
B	$D_{B\ min.}$	$D_{B\ max.}$	n_W	A	c_δ
mm	mm	mm	–	cm^2	N/mm
29	809	913	8	5809	1300
30	809	909	8	5789	5500
31	809	911	8	5809	12500
33	809	900	9	5748	56000
30	918	1000	10	7208	3100
31	918	1001	10	7223	9800
32	918	1001	10	7231	23500
34	918	1001	10	7246	78000
33	1020	1107	9	8875	9400
34	1020	1109	9	8900	21000
36	1020	1109	9	8917	70000
33	1115	1207	9	10577	9000
35	1115	1204	9	10559	23000
37	1115	1206	9	10596	73000
33	1215	1307	9	12479	9800
36	1215	1306	9	12479	23500
38	1215	1306	9	12499	78000
54	1420	1420	6	17064	13400
56	1420	1420	6	17203	36000
54	1620	1620	6	22141	12400
56	1620	1620	6	22299	33000
54	1820	1820	6	27730	13800
56	1820	1820	6	27863	39000



Type AON

Nominal diameter	Nominal pressure	Nominal axial movement absorption per corrugation nominal	Type AON	Weight per corrugation approx.	Bellows wall thickness	Bellows diameter inside	Bellows diameter outside
DN	PN	$2\delta_{WN}$	–	G_W	s	D_i	D_a
–	–	mm	–	kg	mm	mm	mm
2000	6	18	**AON 06.2012.**	17.2	2	2012	2156
2000	10	13.6	**AON 10.2012.**	27.4	3	2012	2168
2200	6	18	**AON 06.2212.**	18.9	2	2212	2356
2200	10	13.4	**AON 10.2212.**	29.8	3	2212	2366
2400	5	20	**AON 05.2412.**	22	2	2412	2568
2400	10	14	**AON 10.2412.**	33.5	3	2412	2572
2600	5	20	**AON 05.2612.**	24.1	2	2612	2770
2600	8	14	**AON 08.2612.**	36.3	3	2612	2772
2800	5	20	**AON 05.2812.**	25.4	2	2812	2966
2800	8	14	**AON 08.2812.**	39.1	3	2812	2972
3000	5	19.6	**AON 05.3012.**	26.9	2	3012	3164
3000	8	14	**AON 08.3012.**	41.9	3	3012	3172

Bellows corrugated length of one corrugation	Bellows bore diameter inside	Bellows bore diameter outside	Bellows max. no. of corrugations	Bellows effective cross-section	Axial adjusting force rate per corrugation
B	$D_{B\ min.}$	$D_{B\ max.}$	n_W	A	c_δ
mm	mm	mm	–	cm^2	N/mm
54	2020	2020	6	34110	12300
56	2020	2020	6	34307	34000
54	2220	2220	6	40972	13500
56	2220	2220	6	41151	38800
54	2420	2420	6	48695	12000
56	2420	2420	6	48774	38000
54	2620	2620	6	56874	13400
56	2620	2620	6	56917	40000
54	2820	2820	6	65552	14400
56	2820	2820	6	65688	44000
54	3020	3020	6	74894	16000
56	3020	3020	6	75088	47000

Type ABT

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 9 digits

Example:
Type ABT: HYDRA axial expansion joint with PTFE liner and swivel flanges

Standard version/materials:
multi-ply bellows: 1.4541
flange: S 235 JRG2 (1.0038)
operating temperature: up to 230°C

Designation (example):

A	B	T	1	0	.	0	1	5	0	.	0	6	0

Type — Nominal pressure (PN10) — Nominal diameter (DN150) — Movement absorption, nominal (2δ = ±30 = 60 mm)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]
  ____
- piping – nominal size DN
  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]
____

max./min. allowable temperature TS [°C]
____

test pressure PT [bar]
____

Optional:

category ______________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Axial expansion joints

with PTFE liner

Type ABT 10...

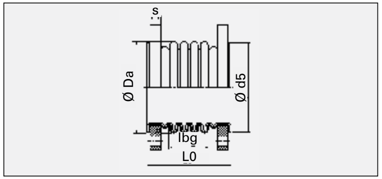
PN 10

Axial expansion joints

with PTFE liner

Type ABT 10...

PN 10



Type ABT

Nominal diameter	Nominal axial movement absorption	Type ABT 10 ...	Order No., standard version	Overall length	Weight approx.	Flange drilling EN 1092	Flange rim diameter	Flange thick-ness
DN	$2\delta_N$	–	–	Lo	G	PN	d5	s
–	mm	–	–	mm	kg	–	mm	mm
32	9	**.0032.009**	427980	145	3.9	40	70	18
32	18	**.0032.018**	427982	220	4.1	40	70	18
40	11	**.0040.011**	427985	157	4.5	40	80	18
40	22	**.0040.022**	427986	242	4.8	40	80	18
50	13	**.0050.013**	427987	179	5.7	16	92	19
50	27	**.0050.027**	427988	294	6.5	16	92	19
65	17	**.0065.017**	427989	181	6.9	16	107	20
65	32	**.0065.032**	427990	287	7.9	16	107	20
80	20	**.0080.020**	427991	185	8	16	122	20
80	35	**.0080.035**	427992	275	9	16	122	20
100	20	**.0100.020**	427994	179	10	16	147	22
100	40	**.0100.040**	427995	267	11	16	147	22
125	29	**.0125.029**	427996	221	14	16	178	22
125	50	**.0125.050**	427997	363	17	16	178	22
150	30	**.0150.030**	427998	248	18	16	208	24
150	60	**.0150.060**	427999	388	23	16	208	24
200	42	**.0200.042**	428000	246	25	10	258	24
200	78	**.0200.078**	428001	418	33	10	258	24
250	44	**.0250.044**	428002	241	32	10	320	26
250	81	**.0250.081**	428003	390	38	10	320	26

[1] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows outside diameter	Bellows corrugated length	Bellows effective cross-section	Nominal movement absorption[1] for 1000 loading cycles: angular[1]	Nominal movement absorption[1] for 1000 loading cycles: lateral[1]	Adjusting force rate axial	Adjusting force rate angular	Adjusting force rate lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/degree	N/mm
61	75	20	20	4.7	260	1.3	159
61	150	20	31	19	130	0.7	21
74	85	30.6	20	5.3	272	2.1	200
74	170	30.6	30	21	136	1	24
88	95	44.7	19	5.7	276	3.1	236
88	209	44.3	32	26	195	2.2	35
106	95	67.1	20	6	234	4	305
107	200	67.4	30	24	173	3	52
120	100	87.3	20	6.5	220	5	344
121	189	87.6	29	22	178	4.1	79
148	88	135	17	4.6	365	13	1154
148	176	135	28	18	183	6.5	144
169	120	179	20	7.9	290	14	668
172	260	181	30	29	290	14	142
204	140	261	18	7.8	560	39	1368
204	280	261	29	31	280	20	175
258	140	432	19	8.5	412	48	1684
261	310	434	30	35	335	40	286
318	120	666	17	6.1	525	95	4536
318	270	667	24	25	269	49	462

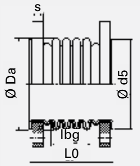
Axial expansion joints

with PTFE liner

Type ABT 10...

PN 10

Axial expansion joints
with PTFE liner
Type ABT 10...
PN 10



Type ABT

Nominal diameter	Nominal axial movement absorption	Type	Order No., standard version	Overall length	Weight approx.	Flange		
		ABT 10 ...				drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	Lo	G	PN	d5	s
–	mm	–	–	mm	kg	–	mm	mm
300	55	**.0300.055**	428004	287	40	10	370	26
300	95	**.0300.095**	428005	429	51	10	370	26
350	60	**.0350.060**	428006	296	56	10	410	28
350	92	**.0350.092**	428007	407	66	10	410	28
400	52	**.0400.052**	428008	288	74	10	465	32
400	104	**.0400.104**	428009	432	85	10	465	32
450	70	**.0450.070**	428010	329	85	10	520	32
450	130	**.0450.130**	428011	536	113	10	520	32
500	56	**.0500.056**	428012	310	104	10	570	34
500	126	**.0500.126**	428013	510	129	10	570	34
600	70	**.0600.070**	428014	334	126	10	670	36
600	126	**.0600.126**	428015	482	144	10	670	36

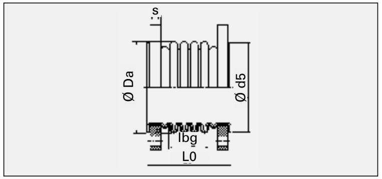
[1] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/degree	N/mm
374	165	932	17	8.9	480	121	3056
375	306	932	25	28	352	89	654
408	170	1119	17	9.1	460	139	3307
409	280	1119	23	23	378	115	1009
463	144	1449	13	5.9	713	281	9317
463	288	1449	22	23	357	141	1169
516	185	1821	15	9	548	272	5464
516	390	1813	24	35	430	214	967
571	160	2235	12	5.6	955	586	15738
571	360	2235	22	29	425	261	1385
678	185	3201	12	6.8	548	484	9723
678	333	3201	17	22	305	269	1668

Axial expansion joints
with PTFE liner

Type ABT 25...

PN 25



Type ABT

Nominal diameter	Nominal axial movement absorption	Type	Order No., standard version	Overall length	Weight approx.	Flange		
		ABT 25 ...				drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	Lo	G	PN	d5	s
–	mm	–	–	mm	kg	–	mm	mm
32	8	**.0032.008**	428016	146	4	40	70	18
32	15	**.0032.015**	428017	206	4.2	40	70	18
40	10	**.0040.010**	428018	163	4.6	40	80	18
40	17	**.0040.017**	428019	263	5.2	40	80	18
50	15	**.0050.015**	428021	201	6	40	92	20
50	24	**.0050.024**	428022	308	7.2	40	92	20
65	14	**.0065.014**	428023	197	7.7	40	107	22
65	26	**.0065.026**	428024	281	8.9	40	107	22
80	16	**.0080.016**	428027	211	10	40	122	24
80	29	**.0080.029**	428029	303	11	40	122	24
100	21	**.0100.021**	428030	217	13	40	147	24
100	35	**.0100.035**	428032	323	16	40	147	24
125	20	**.0125.020**	428033	215	19	40	178	26
125	35	**.0125.035**	428034	293	21	40	178	26
150	26	**.0150.026**	428035	256	23	40	208	28
150	47	**.0150.047**	428036	368	28	40	208	28
200	30	**.0200.030**	428037	239	36	25	258	32
200	52	**.0200.052**	428038	326	40	25	258	32
250	35	**.0250.035**	428039	268	51	25	320	35
250	61	**.0250.061**	428040	364	57	25	320	35

[1] Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

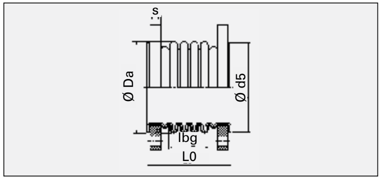
Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/degree	N/mm
61	75	19.7	17	4.2	428	2.2	269
61	135	19.7	24	14	238	1.2	45
75	90	30.8	17	5	428	3.3	280
75	190	30.5	22	18	354	2.7	51
88	114	44.3	19	7.9	357	4	212
89	220	44.2	25	24	390	4.5	64
108	105	67.2	16	5.4	660	12	748
108	189	67.2	23	18	367	6.5	125
123	115	87.8	16	5.9	740	17	884
123	207	87.8	23	19	412	9.6	154
150	120	135.2	16	6.5	616	22	1050
151	225	135	23	20	523	19	258
172	104	181	14	4.7	725	35	2225
172	182	181	20	14	415	20	415
204	140	260	15	6.8	890	62	2175
204	252	260	21	22	495	35	379
261	116	436	13	5	850	100	5110
261	203	436	19	15	486	57	951
322	128	672	13	5.1	975	179	7512
322	224	672	18	16	558	102	1398

Axial expansion joints — Type ABT 25...

with PTFE liner

PN 25

Axial expansion joints — Type ABT 25...
with PTFE liner
PN 25



Type ABT

Nominal diameter	Nominal axial movement absorption	Type	Order No., standard version	Overall length	Weight approx.	Flange		
		ABT 25 ...				drilling EN 1092	rim diameter	thick-ness
DN	$2\delta_N$	–	–	Lo	G	PN	d5	s
–	mm	–	–	mm	kg	–	mm	mm
300	40	**.0300.040**	428041	293	71	25	375	38
300	70	**.0300.070**	428042	401	80	25	375	38
350	42	**.0350.042**	428043	305	103	25	410	42
350	73	**.0350.073**	428044	416	112	25	410	42
400	44	**.0400.044**	428045	328	128	25	465	42
400	88	**.0400.088**	428046	488	146	25	465	42
450	50	**.0450.050**	428047	377	155	25	520	44
450	90	**.0450.090**	428048	541	179	25	520	44
500	48	**.0500.048**	428049	340	173	25	570	44
500	96	**.0500.096**	428050	508	201	25	570	44
600	48	**.0600.048**	428051	337	220	25	670	46
600	96	**.0600.096**	428052	501	250	25	670	46

1) Movement absorption: The movements (axial, angular, lateral) are to be regarded as alternatives, i.e. the sum of their proportions in percentages should not exceed 100%.

Bellows			Nominal movement absorption[1] for 1000 loading cycles		Adjusting force rate		
outside diameter	corrugated length	effective cross-section	angular[1]	lateral[1]	axial	angular	lateral
Da	lbg	A	$2\alpha_N$	$2\lambda_N$	c_δ	c_α	c_λ
mm	mm	cm^2	degree	mm	N/mm	Nm/degree	N/mm
377	144	932	12	5.6	1188	302	10013
377	252	932	18	17	679	173	1873
410	148	1116	12	5.5	1190	363	11394
410	259	1116	17	17	680	207	2122
464	160	1439	11	5.5	1605	635	17054
464	320	1439	18	22	803	318	2135
523	205	1831	11	7.1	1500	756	12369
523	369	1831	16	23	834	421	2126
578	168	2255	9,6	5	1673	1040	25335
578	336	2255	16	20	837	520	3167
680	164	3190	8,1	4.1	1675	1483	37910
680	328	3190	13	16	838	742	4742

Type ARH

Designation

The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 9 digits

Example:

Type ARH: HYDRA axial expansion joint with automatic release mechanism

Standard version/materials:

multi-ply bellows: 1.4541
operating temperature: up to 300°C

Designation (example):

A	R	H	1	6	.	0	1	5	0	.	1	0	0		1

Type (ARH) – Nominal pressure (PN10) (16) – Nominal diameter (DN 150) (0150) – Movement absorption, nominal (δ = ±50 = 100 mm) (100) – Inner sleeve (0 = without, 1 = with) (1)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]

  ____

- piping – nominal size DN

  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]

____

max./min. allowable temperature TS [°C]

____

test pressure PT [bar]

____

Optional:

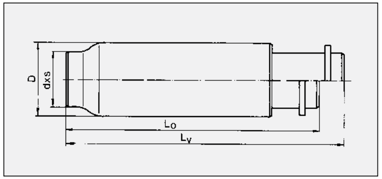
category ______________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Axial expansion joint — Type ARH 16…

with automatic release mechanism

PN 16



Type ARH

Nominal diameter	Nominal axial movement	Type ARH 16 ...	Total length Un-stressed	 Preten-sioned	Weight approx.	Weld ends Outside diameter	 Wall thick-ness	External pipe diame-ter	Effective bellows cross-section	Axial adjust-ing force rate	Shear force	Perm. tor-sional move-ment
DN	$2\delta_N$	–	Lo	Lv	G	d	s	D	A	c_δ	Fs	M_t
–	mm	–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN	kNm
50	34	**.0050.034.0**	290	307	3	60.3	2.9	106	45	60	5	0.3
50	66	**.0050.066.0**	450	483	4	60.3	2.9	106	45	30	5	0.3
50	100	**.0050.100.0**	620	670	6	60.3	2.9	106	45	45	5	0.3
65	40	**.0065.040.0**	290	310	5	76.1	2.9	120	68	60	8	0.4
65	80	**.0065.080.0**	450	490	7	76.1	2.9	120	68	30	8	0.4
65	120	**.0065.120.0**	650	710	10	76.1	2.9	120	68	45	8	0.4
80	80	**.0080.080.0**	500	540	8	88.9	3.2	135	88	115	11	0.8
80	120	**.0080.120.0**	630	690	10	88.9	3.2	135	88	40	11	0.8
80	160	**.0080.160.0**	850	930	14	88.9	3.2	135	88	60	11	0.8
100	90	**.0100.090.0**	555	600	11	114.3	3.6	161	135	120	11	1.1
100	140	**.0100.140.0**	700	770	15	114.3	3.6	161	135	40	11	1.1
100	180	**.0100.180.0**	960	1050	21	114.3	3.6	161	135	60	11	1.1
125	100	**.0125.100.0**	550	600	15	139.7	3.6	196	201	120	19	2.0
125	150	**.0125.150.0**	700	775	20	139.7	3.6	196	201	45	19	2.0
125	200	**.0125.200.0**	950	1050	29	139.7	3.6	196	201	60	19	2.0

Axial expansion joint — Type ARH 16…

with automatic release mechanism

PN 16

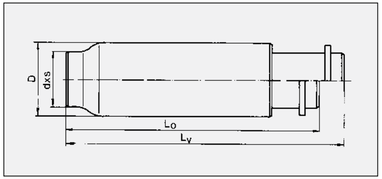
Nominal diameter	Nominal axial movement	Type ARH 16 ...	Total length Un-stressed	 Preten-sioned	Weight approx.	Weld ends Outside diameter	 Wall thick-ness	External pipe diame-ter	Effective bellows cross-section	Axial adjust-ing force rate	Ab-scher-kraft	zul. Tor-sions-mo-ment
DN	$2\delta_N$	–	Lo	Lv	G	d	s	D	A	c_δ	Fs	M_t
–	mm	–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN	kNm
150	100	**.0150.100.0**	550	600	20	168.3	4.0	224	279	120	19	2.4
150	150	**.0150.150.0**	700	775	27	168.3	4.0	224	279	50	19	2.4
150	200	**.0150.200.0**	950	1050	37	168.3	4.0	224	279	60	19	2.4
200	100	**.0200.100.0**	580	630	30	219.1	4.5	287	448	110	27	4.1
200	150	**.0200.150.0**	750	825	42	219.1	4.5	287	448	60	27	4.1
200	200	**.0200.200.0**	950	1050	57	219.1	4.5	287	448	55	27	4.1
250	100	**.0250.100.0**	580	630	42	273.0	5.0	344	684	120	40	7.0
250	150	**.0250.150.0**	750	825	57	273.0	5.0	344	684	75	40	7.0
250	200	**.0250.200.0**	950	1050	82	273.0	5.0	344	684	60	40	7.0
300	100	**.0300.100.0**	580	630	56	323.9	5.6	405	958	120	40	8.2
300	150	**.0300.150.0**	800	875	77	323.9	5.6	405	958	80	40	8.2
300	200	**.0300.200.0**	950	1050	105	323.9	5.6	405	958	60	40	8.2
350	100	**.0350.100.0**	580	630	70	355.6	5.6	437	1115	120	40	9.0
350	150	**.0350.150.0**	800	875	95	355.6	5.6	437	1115	230	40	9.0
350	200	**.0350.200.0**	950	1050	130	355.6	5.6	437	1115	60	40	9.0

See page 421 for order text.

Axial expansion joint — Type ARH 16…

with automatic release mechanism

PN 16



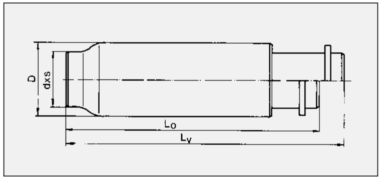
Type ARH

Nominal diameter	Nominal axial movement	Type ARH 16 ...	Total length Un-stressed	Total length Preten-sioned	Weight approx.	Weld ends Outside diameter	Weld ends Wall thick-ness	External pipe diame-ter	Effective bellows cross-section	Axial adjust-ing force rate	Shear force	Perm. tor-sional move-ment
DN	$2\delta_N$	–	Lo	Lv	G	d	s	D	A	c_δ	Fs	M_t
–	mm	–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN	kNm
400	100	**.0400.100.0**	580	630	85	406.4	6.3	487	1442	240	65	18.0
400	150	**.0400.150.0**	800	875	110	406.4	6.3	487	1442	250	65	18.0
400	200	**.0400.200.0**	1000	1100	160	406.4	6.3	487	1442	120	65	18.0
450	100	**.0450.100.0**	650	700	100	457.2	6.3	545	1821	300	71	23.0
450	150	**.0450.150.0**	800	875	140	457.2	6.3	545	1821	270	71	23.0
450	200	**.0450.200.0**	1000	1100	190	457.2	6.3	545	1821	150	71	23.0
500	100	**.0500.100.0**	650	700	120	508.0	6.3	610	2240	360	73	25.0
500	150	**.0500.150.0**	800	875	160	508.0	6.3	610	2240	240	73	25.0
500	200	**.0500.200.0**	1000	1100	220	508.0	6.3	610	2240	180	73	25.0
600	100	**.0600.100.0**	650	700	150	609.6	6.3	711	3197	560	94	39.0
600	150	**.0600.150.0**	825	900	210	609.6	6.3	711	3197	370	94	39.0
600	200	**.0600.200.0**	1000	1150	280	609.6	6.3	711	3197	280	94	39.0

Axial expansion joint Type ARH 16…
with automatic release mechanism
PN 16

Nominal diameter	Nominal axial movement	Type ARH 16 ...	Total length Un-stressed	Total length Preten-sioned	Weight approx.	Weld ends Outside diameter	Weld ends Wall thick-ness	External pipe diame-ter	Effective bellows cross-section	Axial adjust-ing force rate	Shear force	Perm. tor-sional move-ment
DN	$2\delta_N$	–	Lo	Lv	G	d	s	D	A	c_δ	Fs	M_t
–	mm	–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN	kNm
700	100	**.0700.100.0**	650	700	190	711.0	7.1	820	4318	540	98	46.0
700	150	**.0700.150.0**	875	950	260	711.0	7.1	820	4318	300	98	46.0
700	200	**.0700.200.0**	1050	1150	350	711.0	7.1	820	4318	245	98	46.0
800	100	**.0800.100.0**	700	750	240	813.0	8.0	930	5615	600	133	69.0
800	150	**.0800.150.0**	875	950	320	813.0	8.0	930	5615	380	133	69.0
800	200	**.0800.200.0**	1050	1150	430	813.0	8.0	930	5615	300	133	69.0
900	100	**.0900.100.0**	700	750	300	914.0	10.0	1050	7173	870	126	78.0
900	150	**.0900.150.0**	900	975	400	914.0	10.0	1050	7173	440	126	78.0
900	200	**.0900.200.0**	1050	1150	530	914.0	10.0	1050	7173	350	126	78.0
1000	100	**.1000.100.0**	700	750	370	1016.0	10.0	1160	8834	860	124	86.0
1000	150	**.1000.150.0**	900	975	500	1016.0	10.0	1160	8834	490	124	86.0
1000	200	**.1000.200.0**	1050	1150	660	1016.0	10.0	1160	8834	380	124	86.0

See page 421 for order text.



Type ARH

Nominal diameter	Nominal axial movement	Type ARH 25 ...	Total length Un-stressed	Total length Preten-sioned	Weight approx.	Weld ends Outside diameter	Weld ends Wall thick-ness	External pipe diame-ter	Effective bellows cross-section	Axial adjust-ing force rate	Ab-scher-kraft	Perm. tor-sional move-ment
DN	$2\delta_N$	–	Lo	Lv	G	d	s	D	A	c_δ	Fs	M_t
–	mm	–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN	kNm
50	34	**.0050.034.1**	300	317	4	60.3	2.9	106	45	80	5	0.2
50	66	**.0050.066.1**	450	483	5	60.3	2.9	106	45	40	5	0.2
50	100	**.0050.100.1**	640	690	7	60.3	2.9	106	45	70	5	0.2
65	40	**.0065.040.1**	300	320	6	76.1	2.9	120	68	90	6	0.4
65	80	**.0065.080.1**	450	490	8	76.1	2.9	120	68	45	6	0.4
65	120	**.0065.120.1**	664	725	11	76.1	2.9	120	68	65	6	0.4
80	70	**.0080.070.1**	480	515	9	88.9	3.2	135	88	160	10	0.8
80	110	**.0080.110.1**	610	665	12	88.9	3.2	135	88	65	10	0.8
80	140	**.0080.140.1**	810	880	17	88.9	3.2	135	88	80	10	0.8
100	80	**.0100.080.1**	560	600	13	114.3	3.6	161	135	200	10	0.9
100	120	**.0100.120.1**	720	780	18	114.3	3.6	161	135	70	10	0.9
100	160	**.0100.160.1**	970	1050	24	114.3	3.6	161	135	100	10	0.9
125	84	**.0125.084.1**	558	600	18	139.7	3.6	196	201	200	17	1.9
125	130	**.0125.130.1**	735	800	24	139.7	3.6	196	201	80	17	1.9
125	170	**.0125.170.1**	965	1050	34	139.7	3.6	196	201	100	17	1.9

Axial expansion joint **Type ARH 25…**

with automatic release mechanism

PN 25

Nominal diameter	Nominal axial movement $2\delta_N$ mm	Type ARH 25 ...	Total length Un-stressed	Total length Preten-sioned	Weight approx.	Weld ends Outside diameter	Weld ends Wall thick-ness	External pipe diame-ter	Effective bellows cross-section	Axial adjust-ing force rate	Shear force	Perm. tor-sional move-ment
DN		–	Lo	Lv	G	d	s	D	A	c_δ	Fs	M_t
–		–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN	kNm
150	90	**.0150.090.1**	555	600	24	168.3	4.0	224	279	200	17	2.1
150	140	**.0150.140.1**	760	830	32	168.3	4.0	224	279	90	17	2.1
150	180	**.0150.180.1**	960	1050	45	168.3	4.0	224	279	100	17	2.1
200	100	**.0200.100.1**	600	650	36	219.1	4.5	287	448	200	36	5.6
200	150	**.0200.150.1**	785	860	50	219.1	4.5	287	448	100	36	5.6
200	200	**.0200.200.1**	1000	1100	70	219.1	4.5	287	448	100	36	5.6
250	100	**.0250.100.1**	600	650	50	273.0	5.0	344	684	200	36	6.9
250	150	**.0250.150.1**	785	860	70	273.0	5.0	344	684	110	36	6.9
250	200	**.0250.200.1**	1000	1100	95	273.0	5.0	344	684	100	36	6.9
300	100	**.0300.100.1**	600	650	70	323.9	5.6	405	958	220	70	15.0
300	150	**.0300.150.1**	800	875	90	323.9	5.6	405	958	120	70	15.0
300	200	**.0300.200.1**	1000	1100	95	323.9	5.6	405	958	110	70	15.0
350	100	**.0350.100.1**	600	650	80	355.6	6.3	437	1115	200	70	16.0
350	150	**.0350.150.1**	800	875	110	355.6	6.3	437	1115	160	70	16.0
350	200	**.0350.200.1**	1000	1100	150	355.6	6.3	437	1115	100	70	16.0

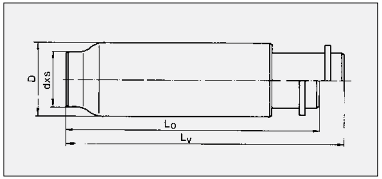
See page 421 for order text.

Axial expansion joint

Type ARH 25…

with automatic release mechanism

PN 25



Type ARH

Nominal diameter	Nominal axial movement	Type ARH 25 ...	Total length Un-stressed	Total length Preten-sioned	Weight approx.	Weld ends Outside diameter	Weld ends Wall thick-ness	External pipe diame-ter	Effective bellows cross-section	Axial adjust-ing force rate	Shear force	Perm. tor-sional move-ment
DN	$2\delta_N$	–	Lo	Lv	G	d	s	D	A	c_δ	Fs	M_t
–	mm	–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN	kNm
400	100	**.0400.100.1**	600	650	100	406.4	7.1	487	1442	300	70	18.0
400	150	**.0400.150.1**	800	875	130	406.4	7.1	487	1442	280	70	18.0
400	200	**.0400.200.1**	1000	1100	190	406.4	7.1	487	1442	150	70	18.0
450	100	**.0450.100.1**	650	700	120	457.2	8.0	545	1821	460	99	30.0
450	150	**.0450.150.1**	825	900	160	457.2	8.0	545	1821	320	99	30.0
450	200	**.0450.200.1**	1050	1150	220	457.2	8.0	545	1821	230	99	30.0
500	100	**.0500.100.1**	650	700	140	508.0	8.0	610	2240	610	131	33.0
500	150	**.0500.150.1**	825	900	190	508.0	8.0	610	2240	410	131	33.0
500	200	**.0500.200.1**	1050	1150	260	508.0	8.0	610	2240	305	131	33.0
600	100	**.0600.100.1**	650	700	180	609.6	10.0	711	3197	630	131	52.0
600	150	**.0600.150.1**	825	900	240	609.6	10.0	711	3197	500	131	52.0
600	200	**.0600.200.1**	1050	1150	340	609.6	10.0	711	3197	315	131	52.0

Axial expansion joint

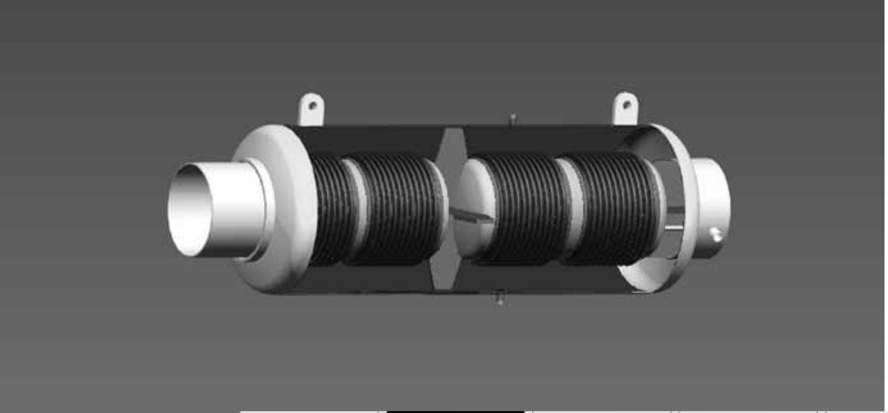
Type ARH 25…

with automatic release mechanism

PN 25

Nominal diameter	Nominal axial movement $2\delta_N$	Type ARH 25 ...	Baulänge Un-stressed	Baulänge Preten-sioned	Weight approx.	Weld ends Outside diameter	Weld ends Wall thick-ness	External pipe diame-ter	Effective bellows cross-section	Axial adjust-ing force rate	Shear force	Perm. tor-sional move-ment
DN	mm	–	Lo	Lv	G	d	s	D	A	c_δ	Fs	M_t
–		–	mm	mm	kg	mm	mm	mm	cm^2	N/mm	kN	kNm
700	100	**.0700.100.1**	700	700	220	711.0	11.0	820	4318	1230	198	95.0
700	150	**.0700.150.1**	925	1000	300	711.0	11.0	820	4318	770	198	95.0
700	200	**.0700.200.1**	1050	1150	420	711.0	11.0	820	4318	560	198	95.0
800	100	**.0800.100.1**	700	750	270	813.0	12.5	930	5615	1160	198	108.0
800	150	**.0800.150.1**	925	1000	370	813.0	12.5	930	5615	725	198	108.0
800	200	**.0800.200.1**	1100	1200	520	813.0	12.5	930	5615	580	198	108.0
900	100	**.0900.100.1**	700	750	330	914.0	14.2	1050	7173	1750	183	119.0
900	150	**.0900.150.1**	925	1000	460	914.0	14.2	1050	7173	875	183	119.0
900	200	**.0900.200.1**	1100	1200	650	914.0	14.2	1050	7173	700	183	119.0
1000	100	**.1000.100.1**	700	750	410	1016.0	14.2	1160	8834	1580	183	132.0
1000	150	**.1000.150.1**	925	1000	570	1016.0	14.2	1160	8834	900	183	132.0
1000	200	**.1000.200.1**	1100	1200	810	1016.0	14.2	1160	8834	700	183	132.0

See page 421 for order text.



Type DRD

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 9 digits

Example:
Type DRD: HYDRA pressure balanced axial expansion joint

Standard version/materials:
multi-ply bellows: 1.4541
operating temperature: up to 300°C

Designation (example):

D	R	D	2	5	.	0	4	0	0	.	4	0	0		1

- Type (DRD)
- Nominal pressure (PN25)
- Nominal diameter (DN 400)
- Movement absorption, nominal (δ = ±200 = 400 mm)
- Inner sleeve (0 = without, 1 = with)

Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]

  ____
- piping – nominal size DN

  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]

____

max./min. allowable temperature TS [°C]

____

test pressure PT [bar]

____

Optional:

category ____________________

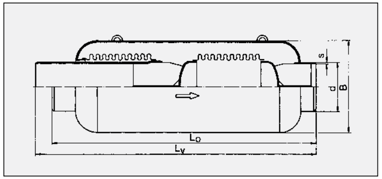
Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

Axial expansion joint

pressure balanced

Type DRD 25…

PN 25



Type DRD

PN 25

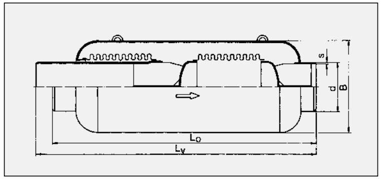
Nominal diameter	Nominal axial movement	Type **DRD 25 ...**	Total length		Weight approx.	Weld ends		Casing outside diameter	Adjusting force rate
			Un-stressed	Preten-sioned		Outside diameter	Wall thickness		
DN	$2\delta_N$	–	Lo	Lv	G	d	s	D	c_δ
–	mm	–	mm	mm	kg	mm	mm	mm	N/mm
400	400	**.0400.400.1**	2930	3130	800	406.4	7.1	609	175
500	400	**.0500.400.1**	3090	3290	1250	508.0	8.0	812	220
600	400	**.0600.400.1**	3110	3310	1600	609.6	10.0	914	285
700	400	**.0700.400.1**	3310	3510	2350	711.2	11.0	1120	350
800	400	**.0800.400.1**	3550	3750	3100	812.8	12.5	1220	370
900	400	**.0900.400.1**	3675	3875	4000	914.4	14.2	1420	460
1000	400	**.1000.400.1**	3790	3990	5000	1016.0	14.2	1520	590

Axial expansion joint

pressure balanced

Type DRD 40…

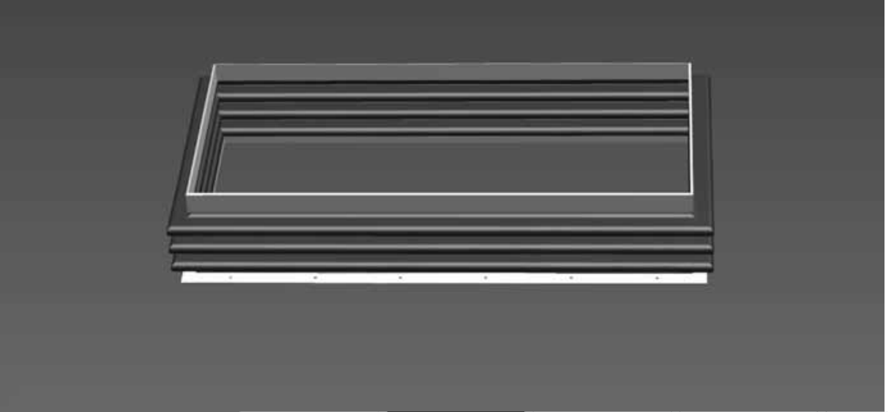
PN 40



Type DRD

PN 40

Nominal diameter	Nominal axial movement	Type **DRD 40 ...**	Total length		Weight approx.	Weld ends		Casing outside diameter	Adjusting force rate
			Un-stressed	Preten-sioned		Outside diameter	Wall thickness		
DN	$2\delta_N$	–	Lo	Lv	G	d	s	D	c_δ
–	mm	–	mm	mm	kg	mm	mm	mm	N/mm
400	350	**.0400.350.1**	3020	3195	950	406.4	10.0	609	290
500	350	**.0500.350.1**	3080	3255	1550	508.0	11.0	812	380
600	350	**.0600.350.1**	3290	3465	2150	609.6	14.2	914	495
700	350	**.0700.350.1**	3530	3705	3050	711.2	16.0	1120	650
800	350	**.0800.350.1**	3600	3775	3800	812.8	20.0	1220	800
900	350	**.0900.350.1**	3910	4085	5300	914.4	22.2	1420	870
1000	350	**.1000.350.1**	3950	4125	6100	1016.0	25.0	1520	1045



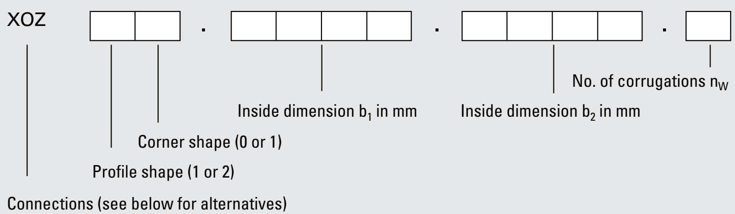
Type XOZ

Designation
The designation consists of two parts:
1. the series, defined by 3 letters
2. the nominal size, defined by 11 digits

Example:
Type XOZ: HYDRA rectangular expansion joint

Standard version/materials:
multi-ply bellows: 1.4541
operating temperature: up to 300°C

Designation (example):



Order text to Pressure Equipment Directive 97/23/EC

Please state the following with your order:

- for standard versions
  -> order number
- for different materials
  -> designation
  -> details of materials

According to the Pressure Equipment Directive 97/23/EC, the following information is required for testing and documentation:

Type of pressure equipment according to Art. 1:

- vessel volume V [l]
  ____
- piping – nominal size DN
  ____

Medium property according to Art. 9:

- group 1 – dangerous
- group 2 – all other fluids

State of medium:

- gaseous or liquid, if pD > 0.5 bar
- liquid, if pD < 0.5 bar

Design data:

max. allowable pressure PS [bar]
____

max./min. allowable temperature TS [°C]
____

test pressure PT [bar]
____

Optional:

category ______________________

Note: Tell us the dimensions that deviate from the standard dimensions and we can match the expansion joint to your specification.

7 | SPECIAL RANGES
Rectangular expansion joints

Design and choice of expansion joints
The values in the table below each apply to one corrugation. The necessary number of corrugations nw is dependent on the movement:

No. of corrugations n_W

(7.5) $$n_W = 2\delta_{RT} / 2\delta_{WN}$$

Axial movement, cold, $2\delta_{RT}$ in mm
Axial movement per corrugation $2\delta_{WN}$ in mm
(see table for nominal movements)

The nominal movement, the corrugated length and the adjusting-force rate of the multi-corrugation expansion joint are dependend on the selected number of corrugations (rounded up to an integer number):

Corrugated length / in mm

(7.6) $$l = l_W \cdot n_W$$

Length of individual corrugations l_W in mm
No. of corrugations n_W

The length of the rims or the conection parts must be taken into account when determining the total length L_O of the complete expansion joint.

Axial adjusting-force rate of one corrugation $C_{\delta W}$ in N/mm

(7.7) $$C_{\delta W} = C_{\delta E} / n_W + 2(b_1 + b_2)C_{\delta l}$$

Adjusting-force rate of four corners $C_{\delta E}$ in N/mm
Adjusting-force rate for 1 mm profile length $C_{\delta l}$ in N/mm
Length of sides b_1, b_2 in mm

Adjusting-force rate of complete expansion joint C_δ in N/mm

(7.8) $$C_\delta = C_{\delta W} / n_W$$

Connections/type series

Connection parts	Type series
None	XOZ
Flanges	XFZ
Weld ends	XRZ
Other	XSZ

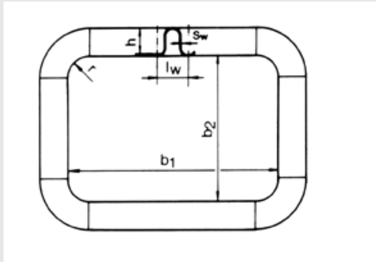
Fig. 7.9

7 | SPECIAL RANGES
angular expansion joints without connection parts Type XOZ ...
Material 1.4541 (other materials on request)

Profile file shape	Corner shape	Nominal axial move-ment per corrugation	Max. in-side dimension (in relation to profile)	Cold pressu-re	Corrugation profile			Max. no. of corru-gations	Corner inside radius	Adjusting-force rate per corrugation		Rec. angle flange acc. to DIN 1029
					Corru-gation height	Corru-gation length	Wall thick-ness			Four corners	Profile per 1mm	
–	–	$2\delta_N$	b	p_0	h	l_W	s_N	n_W	r	$c_{\delta E}$	$c_{\delta l}$	
–	–	mm	mm	bar	mm	mm	mm	_	mm	N/mm	N/mm²	
Small profile 1	Rounded corner 0	10	1000	1	50	50	1.0	7	25	1400	1.8	L 60x40
	Bevelled corner 1	8							–	1800		
Stan-dard profile 2	Rounded corner 0	20	3700	2*)	100	100	2.0	5	50	2900	0.5	L 100x65
	Bevelled corner 1	16							_	3800		

*) The permissible cold pressure p_0 is dependent on the inside dimension and must be reduced as shown in Fig. 9.35 for b > 2000.

See page 434/435 for order text.



Type XOZ

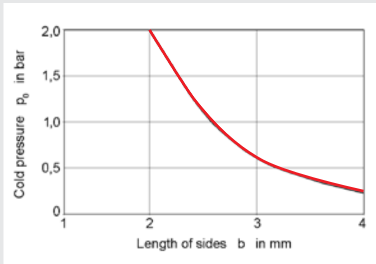


Fig. 7.10 Permissible cold pressure for profile 2

Axial expansion joints for vacuum technology
Expansion joints for vacuum systems are usually designed using single-ply bellows with relatively thin walls; their small adjusting forces and moments place only a very slight load on the connecting flanges, which is essential to ensure absolute tightness of the flange connections during operation.

The bellows can be welded to the connecting flanges without a crevice and vacuum-tight due to the use of special "rim weld seams".

High to very high leak tightness levels must be achieved; they can be verified by means of He.-leak tightness tests. The minimum leakage rate which can be demonstrated is 10^{-10} mbar·l·s^{-1}.

Flanges are used predominantly for the connections:

DN 16-50 Small flanges according to DIN 28 403
DN 63-500 Clamp flanges according to DIN 28 404

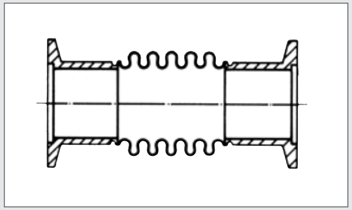


Fig. 7.11 Axial expansion joint with small flanges

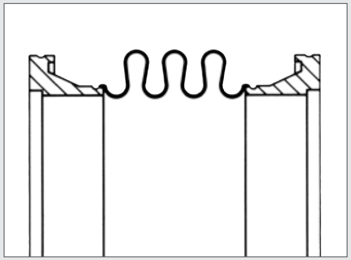


Fig. 7.12 Axial expansion joint with clamp flanges

The vacuum expansion joints can be designed on request with total lengths and movement adapted to specific applications.

Axial expansion joints for heating and ventilating installations
We have developed a series of axial expansion joints especially for the needs of heating and sanitary engineering; the different types of connection are adapted to specific assembly conditions:

- Weld ends
- Rotary or fixed flanges, drilled accordig to DIN
- Screwed nipples with pipe thread, male or female.

The connection parts are made of C-steel as standard, whilst the corrugated metal bellows are made of stainless steel 1.4541; they provide excellent corrosion resistance for reliable operation extending over several decades.
The expansion joints are designed accordingly for 10000 full stress cycles (in contrast with the standard range), as necessary in heating and ventilating installations on account of the more frequent temperature changes.
Guide sleeves are provided in some designs; they simplify flush installation, though they cannot replace slide points or anchors.
Designs with an external protective sleeve are pretensioned in the factory; assembly errors are thereby precluded to a large extent and the thermal insulation is simpler to install.

Nominal diameters: DN 15-100
Nominal pressures: PN 6-25

The exact dimensions and performance data are specified in a separate publication No. 3300 "Expansion joints for heating and ventilating installations".

Fig. 7.13 Expansion joints for heating and ventilating installations

7 | SPECIAL RANGES
for high pressure

High pressure metal bellows and expansion joints
Our standard ranges include expansion joints with nominal pressure ratings which are fully adequate under normal circumstances for pipeline construction/plant engineering and construction.

If a higher nominal pressure is necessary in individual cases, for example in heat exchangers, individually designed expansion joints can also be supplied. If the combined requirements of pressure and movement cause the technical limits to be reached when pressure is applied to the expansion joints internally, it is sometimes possible to use reinforcing rings or to apply pressure to the bellows externally (see also Chapter 8, "Special designs").

Fig. 7.14 High-pressure bellows

In addition, metal bellows, such as those used as stern seals in valves, must often be designed for high pressures, which are generally applied externally.

Available options
The graph below provides an overview of the available options with regard to multi-ply high-pressure bellows with lyre-shaped corrugations. It shows the maximum pressure values which can be achieved when the pressure is applied externally. Additional tools are necessary for some nominal diameters in the shaded area.

If the pressure is applied internally, the pressure values which are achieved are almost identical if the low movement values mean that only a few corrugations are necessary. If larger movements are involved, the permissible pressure is reduced for stability reasons.

Please consult us should you require further details.

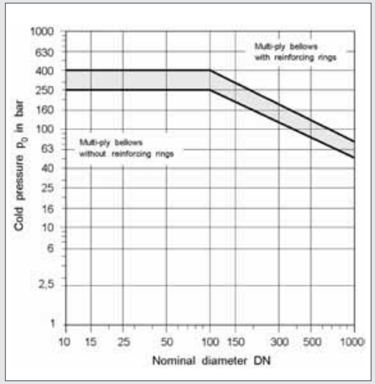


Fig. 7.15 Maximum pressure of multi-ply, metal bellows made of 1.4541 (lyre-shaped corrugations)

7 | SPECIAL RANGES
Hydraweld

HYDRAWELD thin-walled, cylindrical pipes
Thin-walled, cylindrical pipes with a longitudinal seam weld are available with any diameter; the diameters have close tolerances.

If desired, we can provide cylinders with rim diameters, beads or corrugations, or further process them to produce containers.

Fig. 7.16 Thin-walled, cylindrical pipe, with longitudinal seam weld

Available options
The table below specifies the length which can be supplied for 1.4541 and 1.4571; they also apply to materials with similar strength characteristic values. The supplied lengths may have to be reduced for materials whose charcteristic values are very different from those specified here.

Special materials can also be used in addition to the stainless steels, 1.4541 and 1.4571; almost all the stainless steels and special alloys listed in Appendix A are available.

HYDRAWELD stainless-steel pipes
with fixed diameters are available in longer sizes (up to approx. 6 m) in the diameter range DN 5 – 150.

Please consult us if you require further details.

Available lengths

Diameter Range d_i	Length, dependend on wall thickness, in mm Valid for stainless steel 1.4541 and 1.4571 Standard wall thickness s_N in mm			
mm	0.3	0.5	0.7	1.0
40 - 60	600	400	250	200
61 - 80	800	800	600	400
81 - 90	1200	800	600	400
91 - 110	1200	1200	800	800
111 - 150	1200	1200	1200	800
151 - 1000	1200	1200	1200	1200

Fig. 7.17

Special Design

Expansion joints made of special materials
Aggressive media, extreme lightness in weight, electrical conductivity and magnetic permeability are possible reasons for using either expansion joint bellows or complete expansion joints made of special materials, such as:

- Copper
- Aluminium
- Titanium
- Additional knowledge and experience in the field of welding and forming techniques are necessary to manufacture them.

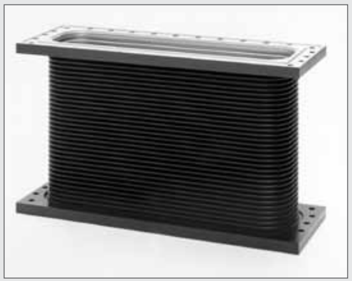


Fig. 8.1 Exp. joint as hollow conductor made of aluminium

Fig. 8.2 Pressure balanced expansion joint

Fig. 8.3 Chamber expansion joint made of titanium for the chemical industry

Fig. 8.4 Metal bellows made of copper for electrical application

Fig. 8.5 Axial expansion joint with aluminium flanges for absorbing vibrations

Fig. 8.6 Axial expansion joint made of Incoloy 825 for heat exchanger (DN 1200/PN 40)

8 | SPECIAL DESIGN

Axial expansion joints
HYDRAFLON axial expansion joints for chemical tankers (Fig. 8.7)
The special expansion joint for product- and chemical tankers combines the good flexibility and pressure reliability of multi-ply expansion joints with the excellent resistance to chemicals and seawater provided by the internal PTFE liner. Its other main characteristic – **it can be flushed, even if the pipeline is routed horizontally.**

The special HYDRAFLON axial expansion joint has a multi-ply, stainless-steel bellows with a special corrugation shape, to which support elements for the internal liner can be fitted. The internal liner is made of polytetrafluoroethylene (PTFE) and is resistant to the chemicals which must be transported. Its shallow corrugations and its smooth surface prevent the conveyed products from sticking and permit the pipe to be cleaned by flushing; there are no residue chemicals, even if the expansion joint is installed horizontally. The liner is bent around the flanges with a special, corrosion-proof coating, and also acts as a seal. The outer – likewise corrosion-proof – ply of the bellows is made of Incoloy 825, a nickel-based alloy, which is resistant to seawater and which allows the expansion joint to be used on the deck.

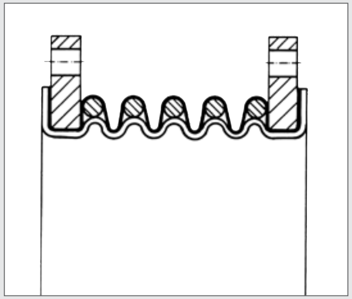


Fig. 8.7 HYDRAFLON axial expansion joint for chemical tankers

Axial expansion joints, pressure applied externally (Fig. 8.8)
The bellows of this design is arranged so that an external pressure is applied to it. This makes the design more complex, since bellows with a larger diameter and an additional, pressure proof outer casing are necessary, but on the other hand offers a number of potential, crucial advantages:

- Extremely large movement in conjunction with low adjusting forces, since the stability problems which would have to be taken into account if the pressure was applied internally are practically insignificant
- The bellows are protected from damage by the outer casing
- No residues of aggressive liquids or condensates remain in the currogations, since they can flow off
- No deposits of solids can remain in the currogations, since the currogations are not located in the line of flow
- The expansion joint and the downstream pipe can be completely drained and vented. (Note: It is normally necessary to drain the bellows corrugations of HYDRA expansion joints with small corrugations, since only a small volume of liquid can remain in the corrugations.)

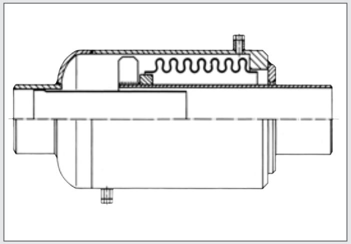


Fig. 8.8 Axial expansion joint, pressure applied externally

8 | SPECIAL DESIGN

Axial expansion joints for gas pipes under bridges (Fig. 8.9)
The axial expansion joint with which pressure is applied externally has been specially designed to withstand the dynamic stresses of bridge pipes; it meets very stringent safety requirements, as is necessary for road bridges over which large volumes of traffic flow.

Its characteristics are as follows:

- Large axial movement for compensating long pipe sections
- Any aggressive condensates only wet the bellows corrugations on the outside, and can flow off before the onset of corrosion
- The inner sleeve provides a free opening which ensures a smooth flow
- The bellows encloses a toroidal chamber which is open at one end only, and which permits a periodic leak tightness test to be performed using a suitable instrument
- The external protective sleeve prevents the bellows from being damaged in transit and during assembly, and thereby makes it more reliable
- Drain valves in the protective casing allow the pipe to be drained
- Installation is simplified by an adjustable presetting device

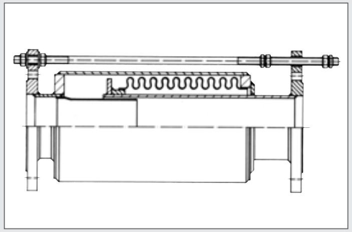


Fig. 8.9 Axial expansion joint for gas pipes under bridges

Axial expansion joint with leakage monitoring (Fig. 8.10)

If critical media (toxic, explosive, flammable) are conveyed, it may be a good idea to provide permanent leakage monitoring at the movable pipe elements, to enable any leak to be detected at an early stage.
The multi-ply bellows with spirally wound intermediate plies has a unique advantage – the patented leakage-indication facility.

Check holes in the intermediate plies, made at defined points in the rim region of the bellows, are guided into an toroidal chamber, which is also monitored for leaks. This enables any onset of damage anywhere in the inner ply to be detected in good time (see Chapter 10, “The multi-ply principle”).

Other types of leakage monitoring are possible at low operating pressures using a double-ply bellows and special connection parts (Fig. 8.11) or a chamber expansion joint (Fig. 8.12).

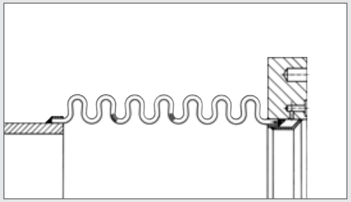


Fig. 8.10 Axial expansion joint with leakage monitoring

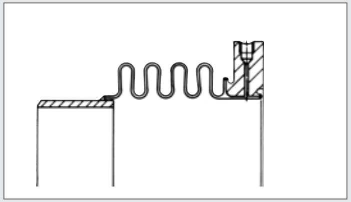


Fig. 8.11 Leakage monitoring with double-ply bellows

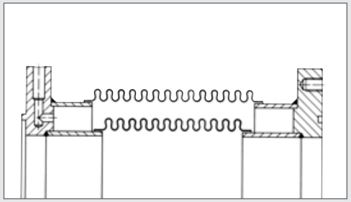


Fig. 8.12 Chamber expansion joint for leakage monitoring

8 | SPECIAL DESIGN

Chamber expansion joint (Fig. 8.13)

Heated pipes or double pipes for conveying highly viscous media or media which solidify at room temperature require chamber expansion joints to compensate thermal expansion and to ensure "force free" connections.

The chamber expansion joint with flange connection shown below is a frequently used type; the actual medium flows inside it, whilst the toroidal chamber is used for heating.

The connection for the heating fluid, e.g. steam, is provided via the flanges, frequently using metal hoses (Fig. 8.13). Weld ends can be used as connection parts as an alternative to the flanges.

Chamber expansion joints can also be used for pipes which must be cooled.

Chamber expansion joints whose toroidal chamber is fitted with a leakage indication facility can be used specifically for leak tightness testing, for example in conjunction with toxic media (Fig. 8.12).

Expansion joint with a toroidal bellows (Fig 8.14)

This type of bellows is suitable for extremely high pressures in conjunction with relatively modest movements; this corresponds to the requirements of apparatus engineering. The circumferential stresses in the bellows are reduced by the thick walls of the connection parts.

If several toroidal corrugations are necessary due to the stipulated movement, reinforcing rings must be fitted between them (Fig. 8.15).

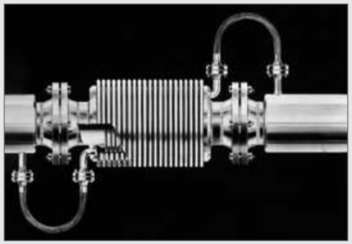


Fig. 8.13 Chamber expansion joint

Expansion joint with reinforcing rings (Fig. 8.15)

Reinforcing rings are used if the circumferential stresses become excessive as a result of high operating pressures, generally combined with large diameters, and it is no longer either technically possible or economically advisable to increase the number of plies or the thickness of the bellows wall. The reinforcing rings absorb the circumferential stresses instead, so that the wall of the bellows can remain relatively thin and flexile overall.

Axial expansion joints in the form of demounting parts (Fig. 8.16)

This expansion joint is used to create space for assembling and dismantling valves. The expansion joint is separated from the valve and compressed by means of threaded rods.

At the same time the expansion joint reduces the connecting forces and moments acting on the valve. The use of axial expansion joints is restricted by the axial reaction force. If the forces are too high, anchored demounting parts must be used.

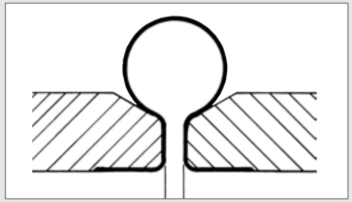


Fig. 8.14 Expansion joint with toroidal bellows

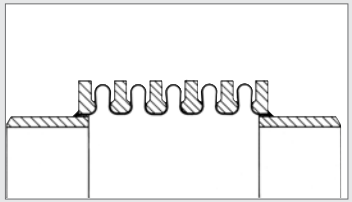


Fig. 8.15 Expansion joint with reinforcing rings

Fig. 8.16 Axial expansion joint in the form of a demounting part

8 | SPECIAL DESIGN

Expansion joints with pretensioners (Figs. 8.17 / 8.18)
Axial expansion joints can be fitted with pretensioners to simplify assembly on the building site.

The pretensioning bracket is set to a fixed pretension, with which the expansion joint is adjusted in the factory to the installation dimension; the bracket must be removed before the pipe is put into service (Fig. 8.17).

The adjustable pretensioner, which comprises threaded rods and nuts which link the connection parts of the expansion joints together, enables the installation length to be set simply and rapidly for assembly (Fig. 8.18).

Please also note our special "HYDRAMAT" range.

Pretensioners are usually only designed to absorb the adjusting forces; they cannot absorb either additional loads or the axial reaction forces.

Expansion joints with stroke limitation (Fig. 8.19)
Stoke limiters can be provided for axial expansion joints if:

- The stroke must be distributed between several different expansion joints in special cases
- Pressure tests must be performed during the construction work before the final anchors are secured in position
- The anchors are likely to fail or the pipe is likely to move excessively as a result of a breakdown

Please also note our special "HYDRAMAT" range.

Flange expansion joints with external protective sleeve (Fig. 8.20)
If damage is likely to be caused to the bellows by external factors due to the installation location, the expansion joints can be fitted with external protective sleeves. The protective sleeve can be detached from the design shown here, for example to enable the flanges to be assembled.

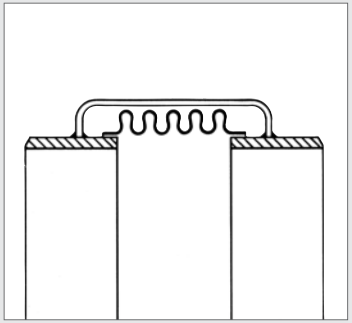


Fig. 8.17 Expansion joint with pretensioning bracket

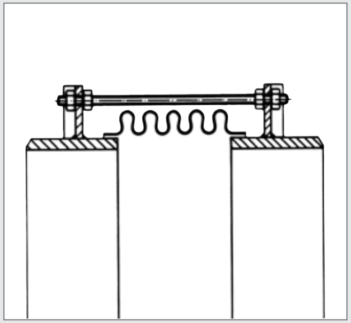


Fig. 8.18 Expansion joint pretensioning with threaded rod

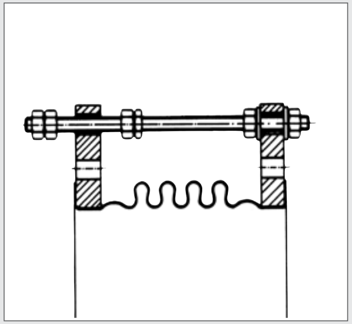


Fig. 8.19 Expansion joint with stroke limitation

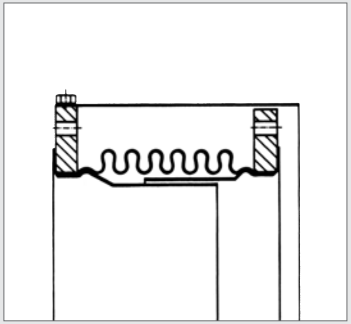


Fig. 8.20 Flange expansion joint with external protective sleeve

8 | SPECIAL DESIGN

Large expansion joint with welded sleeve (Fig. 8.21)
The axial expansion joints in the standard range with large diameters DN > 1000 are designed to achieve a short total legth with floating inner sleeves. If fixed inner sleeves are desired, the special design shown here can be supplied; it has a total length greater than that of the standard type.

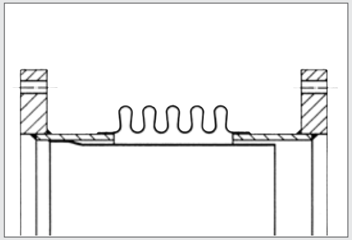


Fig. 8.21 Large expansion joint with inner sleeve

Axial expansion joint with welding neck flanges (Fig. 8.22)
The axial expansion joints in the standard range are available with either rotary flanges or smooth, fixed flanges with the same total length. The special design shown here can be supplied if welding neck flanges with a raised face are desired and the slight increase in the total length is not significant.

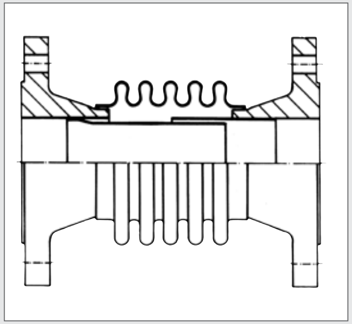


Fig. 8.22 Axial expansion joint with welding neck flanges

Universal expansion joints

Universal expansion joints in the form of centrifuge connections (Fig. 8.23)
The universal expansion joint is designed to be highly durable in the face of large, lateral vibration amplitudes, and has a lateral natural frequency which is sufficiently high in relation to the excitation frequency (speed) of the centrifuge.

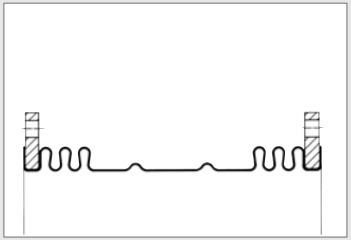


Fig. 8.23 Universal expansion joint in the form of a centrifuge connection

Universal expansion joint for a hot-air system (Fig. 8.24)
This expansion joint is designed for axial and lateral movements. Its inner sleeve is such that a large crevice cannot be produced, even in the extreme positions of the expansion joint, and that the weight of the fireproof internal liner can be borne.

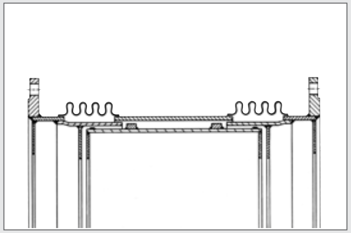


Fig. 8.24 Universal expansion joint for a hot-air system, DN 2500

8 | SPECIAL DESIGN

Hinged expansion joints

HYDRAFLON lateral expansion joint for paper machines (Fig. 8.25)
This expansion joint has been developed for connecting the head boxes of paper machines, which are required to effect a pendulum movement.
The movable section comprises a reinforced, internal PTFE liner, which is smooth and has no corrugations on the inside to prevent the conveyed material from settling. In addition to a lateral movement of up to 300 mm, it can absorb a slight angular movement of 2 to 4 deg as well as slight torsion.

Lateral expansion joint with diffuser (Fig. 8.26)
This expansion joint has been developed for connection to compressors. It combines an elastic expansion joint with a diffuser. As a "force free" connection, it is capable of compensating misalignment and absorbing vibrations.

Fig. 8.25 HYDRAFLON lateral expansion joint for paper machines

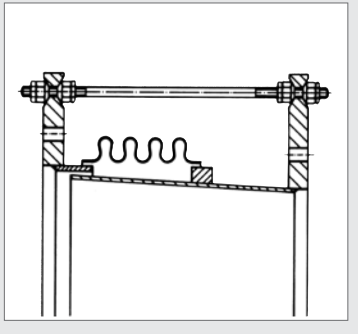


Fig. 8.26 Lateral expansion joint with diffuser

Angular expansion joint with conical sleeve (Fig. 8.27)
Inner sleeves in angular expansion joints must have a sufficient clearance to ensure flexibility. One solution is to use a one-piece, conical inner sleeve. Note: This slightly reduces the cross-section.

Angular expansion joint with internal anchoring (Fig. 8.28)
This design – in the form of a single hinge or of a gimbal hinged expansion joint – may be useful if external anchoring is not possible due to limited space.
If a reduction in the cross-section is unacceptable, the anchoring can be designed to permit an almost smooth free opening. In this case, however, a larger bellows must be used. It should be noted that the internal joint is in contact with the medium.

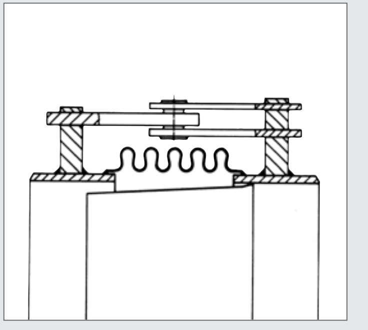


Fig. 8.27 Angular expansion joint with conical inner sleeve

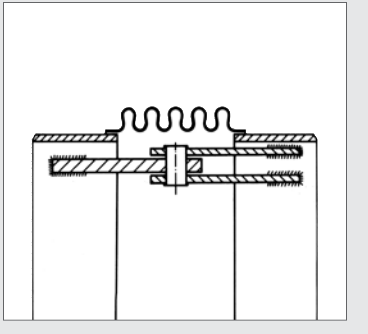


Fig. 8.28 Angular expansion joint with internal anchoring

8 | SPECIAL DESIGN

Elbow-connected pressure balanced expansion joints (Fig. 8.29)
The design and implementation of an elbow-connected pressure balanced expansion joint is dependent on specific requirements, and takes the operating conditions and the necessary movement values into account (see also Chapter 15, "Axial reaction force and pressure balanced designs"). The diagram below shows an axially and laterally flexible, elbow-connected pressure balanced lateral expansion joint.

Angular expansion joint with PTFE bearings (Fig. 8.30)
If the adjusting moments of our angular expansion joints, which are already small, are too high for your particular application, it is possible to reduce the frictional moment in the hinge points still further by using a special bearing. The PTFE compound bearing we use for this purpose has a special design which permits it to withstand high contact pressures without the plastic anti-friction coating being pushed aside. The good sliding characteristics of the bearing are thus maintained throughout the entire operating period. The bearing can withstand temperatures up to 280 °C and is absolutely maintenance-free.

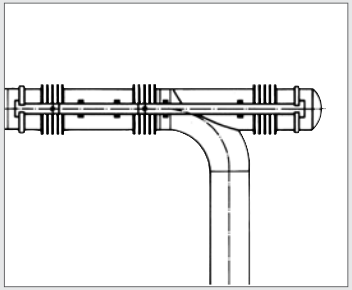


Fig. 8.29 Elbow-connected pressure balanced expansion joint

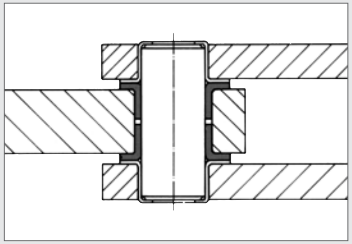


Fig. 8.30 Anchoring with special bearing

Designs with metal bellows

Oval expansion joint (Fig. 8.31)
Oval expansion joints can theoretically be manufactured with any dimensions and fitted with the necessary connection parts; it is however not advisable to use them except in cases where an element with a round cross-section cannot be employed.
Since expensive tools are necessary for each dimension, it is only economical to use an oval expansion joint if large quantities are required. The pressure reliability of an oval bellows is limited.

Shaft seal (Fig. 8.32)
A corrugated metal bellows forms part of a shaft seal on a rotating shaft. The bellows is secured pressure-tight to the body, and the slip ring is fitted onto the other side. The elasticity and springability of the bellows ensures that the sealing ring always makes full contact.

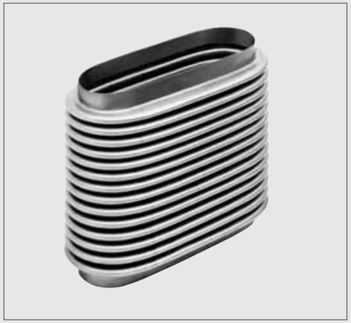


Fig. 8.31 Metal bellows with oval cross-section

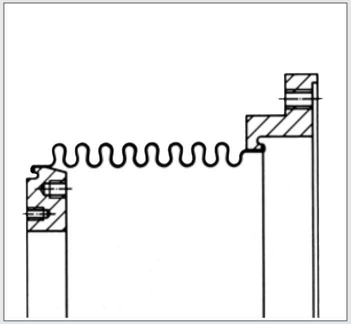


Fig. 8.32 Shaft seal

Volumetric compensation container (Fig. 8.33)
A metal bellows takes care of the temperature-related, volumetric compensation of a liquid by means of overstretching and contraction. The movement is counter to a compressed gas cushion if the liquid is under pressure.

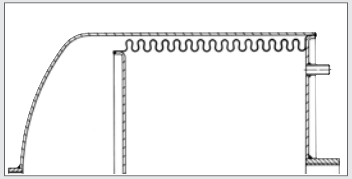


Fig. 8.33 Volumetric compensation container

Valve steam seal (Fig. 8.34)
Valves for which stringent demands are made with regard to leak tightness and freedom from maintenance are nowadays fitted with metal bellows instead of stuffing boxes for sealing the axially moved valve stem. They enable high to very high pressures to be coped with as reliable and maintenance-free as if the valves were absolutely tight.

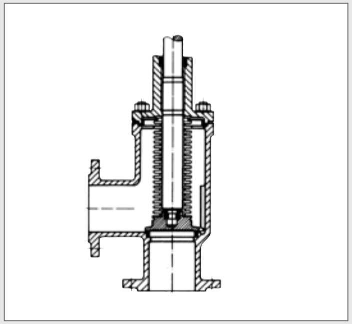


Fig. 8.34 Valve steam seal

Barometric cell (Fig. 8.35)
If the hydraulic pressure is applied to a metal bellows sealed with caps at both ends, the bellows can transfer a pressure-related force, similar to a hydraulic piston, whilst remaining absolutely tight. The diagram shows a hydraulic element used to press-fit lock gates for the Oosterschelde project.

Flexible coupling (Fig. 8.36)
Metal bellows can be used as flexible coupling elements; they transfer torsional moments within their strength and stability limits, and compensate the axial, angular and lateral misalignment of the rotating ends of the shaft.

Fig. 8.35 Barometric cell

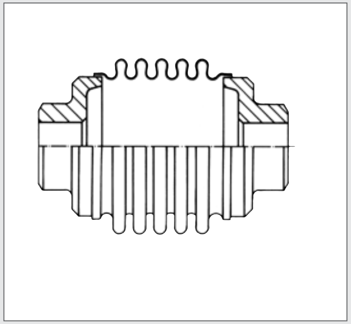


Fig. 8.36 Flexible coupling

Positioning in pipe systems

Installing expansion joints in a pipe can cause substantial changes in its behaviour; anchors and guides are subjected to different stresses, and the functions they must perform are not the same as in an umcompensated pipe system.

The general rule which must be observed when assembling expansion joints are summarized in Chapter 19, "Installation instructions".

This chapter describes the aspects which are important when sizing and implementing the anchors, guides and supports.

It also contains information on:

- The best installation positions for the tie rod
- Use of lateral expansion joints in a three-hinge system
- Installation of elbow-connected pressure balanced expansion joints
- Pretensioning alternatives

If in doubt, please make use of the advice of our specialists: wi@witzenmann.com

Anchors
All compensation systems must be limited by anchors, which have to be adequately sized if the system is to function reliably. There are four different types of anchors, each with different functions and loads.

End anchors
These are either located at the ends of a compensated pipe system or used to separate two different compensation systems (Fig. 9.1). They are generally subjected to a high load.

The following forces act on end anchors:

- Axial reaction force (axial expansion joints only)
- Adjusting force of the expansion joint or compensation system
- Frictional force between pipe and supports
- Other plant-specific forces (wind, snow, weight of pipe or medium)

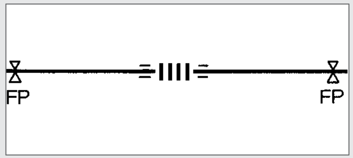


Fig 9.1 Straight pipe run with axial expansion joint and end anchors

9 | POSITIONING EXPANSION JOINT

Intermediate Anchors
These separate two expansion joints of **similar construction** which are necessary in long, straight pipe runs, and are generally only subjected to a slight load (Fig. 9.2).

The following differential forces act on intermediate anchors:

- Axial reaction force (axial expansion joints only) if different nominal diameters must be separated or if there are pressure differences (flow losses at throttles or butterfly valves). Axial expansion joints made by different manufacturers usually have different reaction-force effect, even if the nominal diameter is the same; this can result in considerable differential forces.
- Adjusting force if expansion joints of different lengths and with different adjustig rates or identical expansion joints with different movements are used. Even if the expansion joints and the movements are the same, a differential force which is 30% of the adjusting force should be assumed, since the spring rates of the expansion joints are subject to fluctuations in this region due to production and material tolerances.

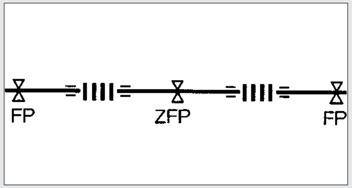


Fig. 9.2 Straight pipe run, subdivided into two compensated sections by intermediate anchors

- Frictional force between the pipe and guides. Particular attention should be paid to this point, since the frictional forces may differ substantially during operation depending on the type of support.
- Other plant-related forces, which must be taken into account when calculating the load on the anchors.

The inermediate anchor becomes an end anchor during pressure tests in a section of the pipe or if the system contains a gate valve.

Sliding anchors
These serve to guide the pipeline; they must however act as normal anchors in at least one direction, e.g. if universal expansion joints are used (Fig. 9.3). The same forces act on sliding anchors as on end anchors. It should be noted in addition that a large frictional force is generated at the sliding anchor due to the high anchor force which is active there. This frictional force must also be taken into account when sizing the end anchor FP1.

Elbow anchors
These separate two identical compensation systems at the crown of a pipe elbow.
This type of anchor is a mixture of an end anchor and an intermediate anchor. The same forces must consequently be taken into account as for end anchors, in addition to the differential forces which occur with the intermediate anchors if the pipe elbows are too small. The redirection of the flow in the pipe elbow results in a centrifugal force, which must likewise be absorbed by the elbow anchor if an axial compensation system is used. This force is however usually negligible.
The individual force components must be added together geometrically, in order to obtain the magnitude and direction of the resulting anchor force F_{res}.

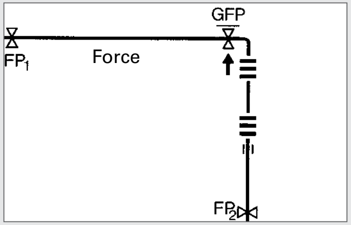


Fig. 9.3 Offset pipeline with universal expansion joint and one sliding anchor

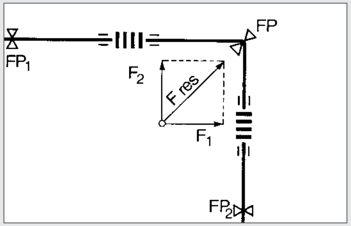


Fig. 9.4 Offset system with axial expansion joints and elbow anchor

9 | POSITIONING EXPANSION JOINT

Anchor forces

Axial reaction force
Chapter 12, "Axial reaction force and pressure balenced designs" describes the generation and effect of the reaction force in detail; the calculation formula consequently suffices at this point.

Axial reaction force Fp in kN
(axial compensation only)

(9.1) $$F_p = 0.01A \cdot p$$

Effective cross-section A in cm^2 (see dimension tables for axial expansion joints)
Pressure p in bar (take maximum pressure, e.g. test pressure)

If the internal pressure is greater than the external pressure, the expansion joint will be elongated by the reaction force without anchors, whilst if the external pressure is greater than the internal pressure, it will be compressed.

If pressure tests are performed section by section during construction of an extensive pipe system, and if the strong end anchors are not locked in position, axial expansion joints must be protected by means of suitable stroke limiters (see special "HYDRAMAT" range, for example), or alternatively the intermediate anchors must be made correspondingly stronger.

Adjusting force of the compensation system
The axial adjusting-force rate c_δ is specified in the dimension tables for **axial expansion joints.** The adjusting force is calculated as follows:

Axial adjusting force F_δ in kN

(9.2) $$F_\delta = 0.001c_\delta \cdot \delta$$

Axial adjusting-force rate c_δ in N/mm (see dimension tables for axial expansion joints)
Half total movement δ in mm (with 50% pretension)

In **hinge systems**, the adjusting forces are more complicated to calculate than for axial expansion joints. Contains detailed instructions on how to calculate the forces and moments.

Frictional force between pipe and support
The entire frictional force of the pipe section between the compensation system and the anchor, i.e. the sum of the frictional forces of all supports, acts on each anchor.

Frictional force F_R in kN

(9.3) $$F_R = \sum F_L \cdot K_L$$

Support load F_L in kN
Resistance coefficient of supports K_L
Empirical values for K_L:

Steel/steel supports:	0.2 – 0.5
Steel/PTFE supports:	0.1 – 0.2
Roller supports:	0.05 – 0.1

It must be remembered that the frictional force acts on an anchor in alternating directions – as a reaction force when the pipe is heated up and as a tensile force when it is cooled down.

The distribution of the frictional-force components acting on the two anchors can be altered by changing the arragement of the compensation system along the pipe section between these anchors. If, for example, the compensation system is positioned directly at an anchor, this anchor (FP1) must not absorb any frictional force; the second anchor (FP2) on the other hand must absorb the entire frictional force of this section (Fig. 9.5).

If the compensation system is positioned centrally between both anchors, each anchor must absorb half the frictional force of the complete section (Fig. 9.6).

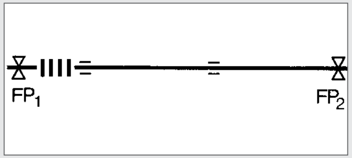


Fig. 9.5 Asymmetrical arrangement of the expansion joint. Frictional force acting on one anchor

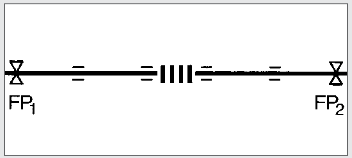


Fig. 9.6 Symmetrical arrangement of the expansion joint. Frictional force distributed uniformly

9 | POSITIONING EXPANSION JOINT

Centrifugal force
This is only released at the elbow anchors of axially compensated pipes, and is generally negligible (Fig. 9.7). A significant force is only generated by heavy media with a high flow velocity.

Centrifugal force F_Z in kN

(9.4) $$F_Z = \frac{A \cdot \varrho \cdot v^2 \cdot \sin\beta}{10.000}$$

Effective cross-section A in cm² (see dimension tables for axial expansion joints)
Density of medium in ϱ g/cm³
Flow velocity v in m/sec
Angle of pipe elbow β in deg

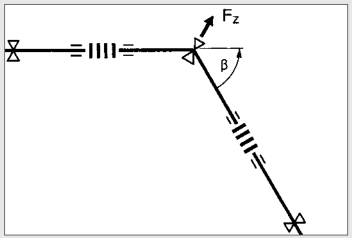


Fig. 9.7 Centrifugal force at the elbow anchor

Other plant-related forces
In addition to the forces generated as a direct result of the manner in which the expansion joints are installed, the anchor sizing must also take into account those forces produced by the system or the pipeline route, or by additional loads:

- Weight of pipe, medium and insulation
- Weight of dust deposits both inside and outside
- Weight of condensate
- Wind and snow loads
- Forces due to mass acceleration in event of an earthquake
- Forces due to pipe deformation as a result of inadequate compensation

If pipes used for gaseous media are subjected to a water pressure test, the weight of the water must be taken into account additionally.

9 | POSITIONING EXPANSION JOINT

Guides

Particular attention must be paid to the pipe guides in the region of expansion joints or compensation systems; the differing requirements of the compensation systems must be taken into account.

Guides for axial compensation

The conditions dictated by the plant must always be taken into consideration when sizing the supports and calculating the distances between the supports. The following rules must also be observed if axial expansion joints are used:

- The first guide after the axial expansion joint must be no more than 3 x DN away from the expansion joint, i.e. $L_1 \approx 3 \cdot DN$ (Fig. 9.8)
- The distance between the first and second supports after the expansion joint must be approximately half the normal distance between supports, i.e. $L_2 \approx 0.5 \cdot L_F$ (Fig. 9.9)
- The normal distance between supports L_F may have to be reduced if there is a risk of the pipe buckling (Fig. 9.10)

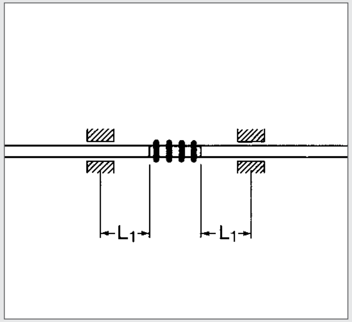


Fig. 9.8 Guide support installed directly at axial expansion joint

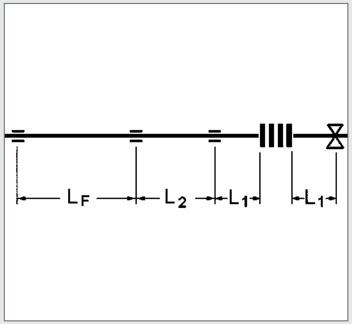


Fig. 9.9 Guide installed in pipe

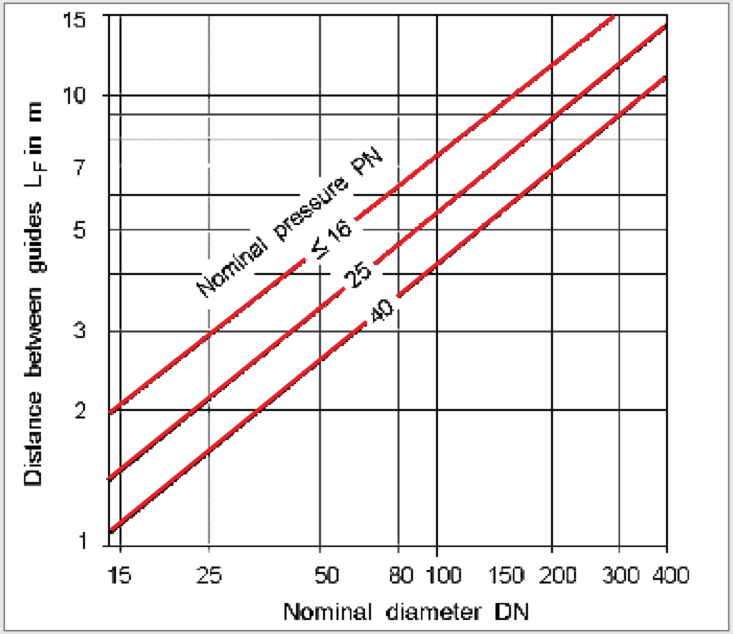


Fig. 9.10 Distances between pipe guides for axial compensated pipe systems (approx. values)

Guides for lateral compensation or double-hinge systems
With lateral compensation systems there is always a “residual elongation” which must be absorbed by bending the pipe.
This residual elongation is made up of two components:

- Thermal expansion in the uncompensated pipe section (with expansion joint)
- Height of the bend derived from the circular movement of the lateral expansion joint or the two angular expansion joints (Fig. 9.11)

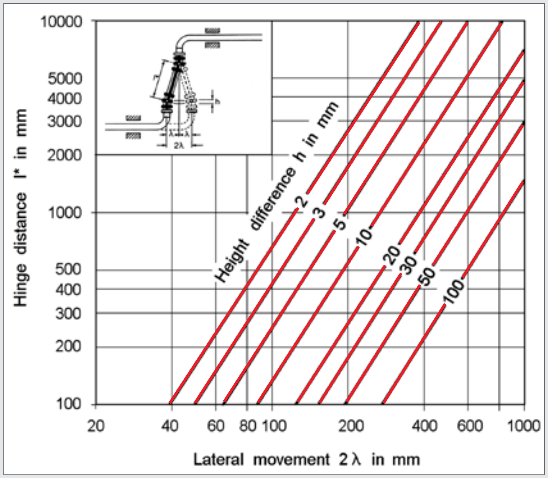


Fig. 9.11 Height difference of the hinge point of a double-hinge system with lateral movement

9 | POSITIONING EXPANSION JOINT

Height difference h in mm

(9.5) $$h = l^* - \sqrt{l^{*2} - \lambda^2}$$

Hinge distance l^* in mm
Half lateral movement λ in mm

Sufficient freedom of movement must therefore be permitted at one end of the expansion joint of the double-hinge system, or reactive forces will occur (Fig. 9.12).

Guide 3 must have sufficient clearance not to impede the residual elongation. It is in other words only a lateral guide. In vertical systems the lateral guide may be dispensed with if there are no lateral forces and if vibrations are not possible. Guides 2 and 4 must be able to absorb the bending forces of the pipe.

If the long intemediate pipes are installed in horizontal systems, they must be supported in order to prevent excessive lateral forces from acting on the expansion joint. (Fig. 9.13).

The slip plane of the supports must always be perpendicular to the pivots of the expansion joints.

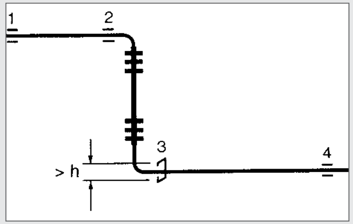


Fig. 9.12 Vertical, double-hinge system

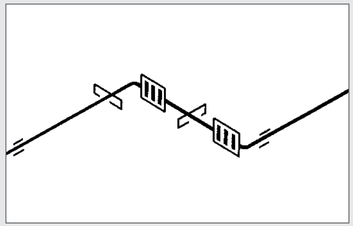


Fig. 9.13 Horizontal hinge system on two-way glide guides

9 | POSITIONING EXPANSION JOINT

Flexible suspensions or supports must be provided for vertical systems or systems which are flexible on all planes and for heavy loads (Figs. 9.14 and 9.15).
It should be noted that bending the pipe causes additional forces on the hinge parts of the expansion joint derived from the residual elongations of the pipe system. For vacuum service or abnormal pretensioning of the expansion joints, the additional bending forces placed on hinge parts may be so heavy that reinforcement is necessary. In this case the additional on the expansion joints forces must be specified in inquiries and orders.

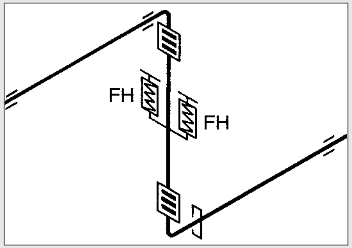


Fig. 9.15 Vertical double-hinge system with suspended intermediate pipe

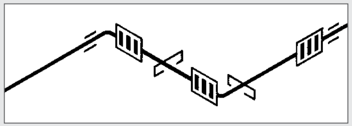


Fig. 9.16 Plane, three-hinge system with both intermediate pipes supported

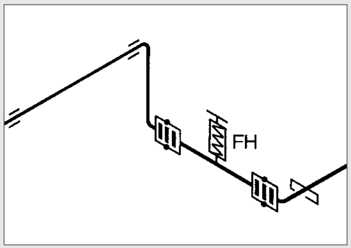


Fig. 9.14 Double-hinge system flexible on all planes with suspended intermediate pipe

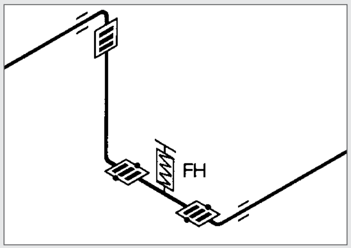


Fig. 9.17 Three-hinge system with spring hanger for suspending intermediate pipe

Guides for three-hinge systems
The loads placed on the guides of three-hinge systems are only slightly greater than those placed on standard pipe guides. The only additional loads are the adjusting forces of the system, which are however usually small. Special attention should be paid to absorption of the weight of the pipe sections between the angular expansion joints. These sections are often long and their weight can place an excessive load on the expansion joints.

The examples below demonstrate load removal by means of supports and flexible suspensions.

If a plane three-hinge system is installed at a slope angle α (Fig. 9.19), it is important to ensure that the pin axes are **always** parallel to one another and perpendicular to the support level, i.e. the axes of the expansion joints must be inclined by the angle a when they are installed.

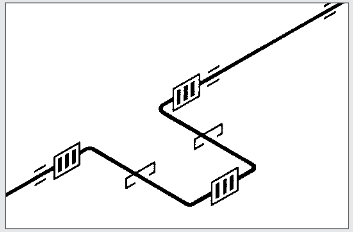


Fig. 9.18 Three hinges in U-configuration with pipe legs supported at centre of gravity

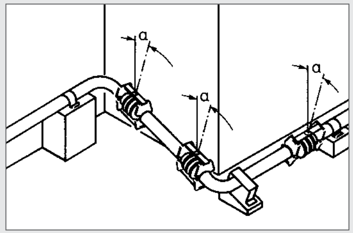


Fig. 9.19 Inclined three-hinge system

9 | POSITIONING EXPANSION JOINT

Installation instructions

Anchor positions for lateral expansion joints

Almost all lateral expansion joints have two tie rods, which give them additional angular flexibility in one plane (Fig. 9.20). The same applies to lateral expansion joints flexible on all planes. Lateral expansion joints cannot be offset in the second plane, since the anchoring functions like a parellelogram in this plane (Fig.9.21). As mentioned earlier in the "Guides" section of this chapter, there is always an uncompensated movement component, which must be absorbed by bending the pipe, when lateral expansion joints (double hinges) are used. The pipe can be bent in different ways depending on the position of the anchor.

Deflection transversal to anchor plane

The pipe is bent in approximately the manner of a beam clamped at one end (Figs. 9.22 and 9.23), since the small adjusting moment of the expansion joint is insignificant. The free bending length can thus be kept relatively short and the additional loads on the expansion joint remain small.

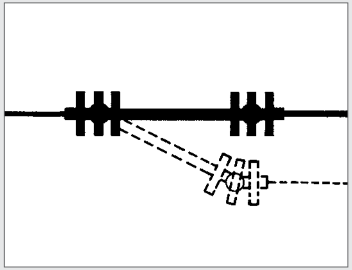


Fig. 9.20 Lateral expansion joint, flexible on all planes. Deflection transversal to anchor plane

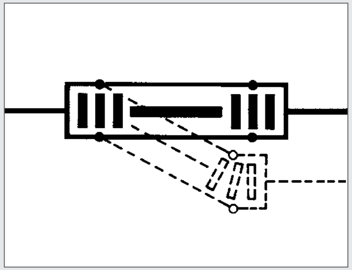
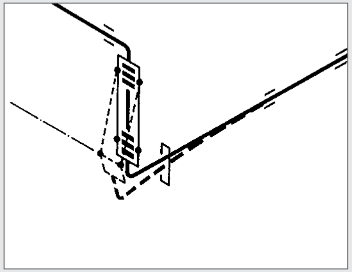


Fig. 9.21 Lateral expansion joint, flexible on all planes. Deflection in anchor plane



Fi. 9.22

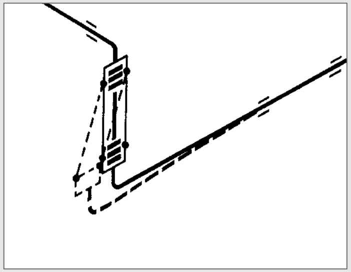


Fig. 924

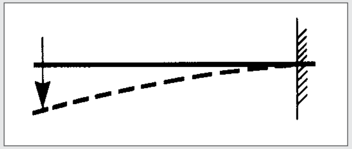


Fig. 9.23

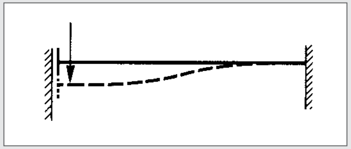


Fig. 9.25

Deflection in anchor plane

The pipe is bent in approximately the manner of a beam clamped at both ends, since the anchoring transfers a significant moment (Figs. 9.24 and 9.25). The S-bend in the pipe which results necessitates a much greater free length than in the first example; in addition, much greater moments and forces are generated, and may place an excessive load on the anchoring of the expansion joint.

If necessary, the load-bearing capacity of the anchoring must be checked on the basis of the additional forces and moments.

9 | POSITIONING EXPANSION JOINT

Angular configuration of two lateral expansion joints

Two short, lateral expansion joints are often arranged diagonally to cope with small, lateral movements on all planes or with vibrations at machine connections (Fig. 9.26).
In this case it is important to ensure that the pairs of tie rods belonging to the two expansion joints are offset 90° in relation to one another. This prevents the connecting pipe bend from rocking excessively, which would cause the expansion joints to fail prematurely.

Combination of lateral and angular expansion joints in a three-hinge system

Since one lateral expansion joint has the same kinematic characteristics as two angular expansion joints with an intermediate pipe, it is also possible to construct a three-hinge system with one lateral expansion joint and one angular expansion joint.

If the hinge system is installed in a confined space, especially if it is a 3 - dimensional system, it may be cheaper to use a combination of angular and lateral expansion joints. Purely angular systems are usually cheaper if large hinge distances are desired (greater than 5 x DN).
The anchor of the lateral expansion joint must be arranged in the system so that they can be offset in the direction of the angular joints (Figs. 9.27 and 9.28).
The lateral expansion joint functions like a parallelogram with regard to transversal movements in a 3 - dimensional system.

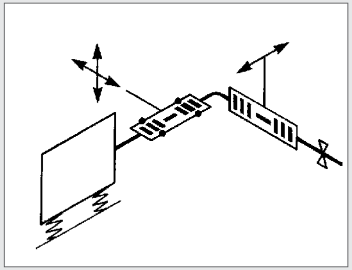


Fig. 9.26 Lateral expansion joint in an angular configuration at a vibrating aggregate

Only lateral expansion joints with hinge pins located exactly above the centre of the bellows should be used. If the lateral expansion joints have tie rods, or if they have hinges located away from the centre of the bellows, it is considerably more difficult to calculate the bending angles, the forces and moments and the stability of the system.
This pipe system must always be examined by the expansion joint manufacturer to ensure that it can function properly, even if no problems are apparent after the initial, rough calculations.

Lateral expansion joints with more than two tie rods cannot be used in a three-hinge system.

Installing elbow-connected pressure balanced expansion joints

Elbow-connected pressure balanced expansion joints are anchored expansion joints in which the axial reaction force produced by the internal pressure is not released.

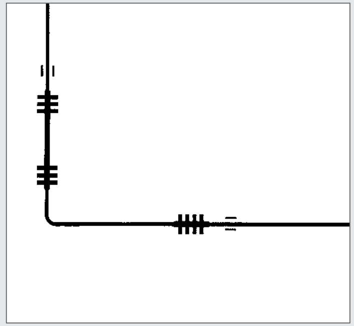


Fig. 9.27 Plane three-hinge system with lateral and angular expansion joints

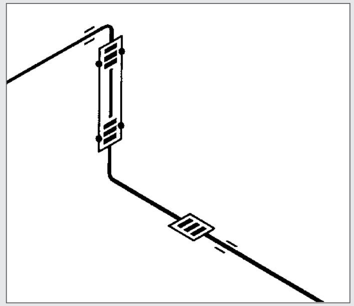


Fig. 9.28 3 - dimensional, three-hinge system with lateral and angular expansion joints

9 | POSITIONING EXPANSION JOINT

Installing elbow-connected pressure balanced expansion joints
Elbow-connected pressure balanced expansion joints are anchored expansion joints in which the axial reaction force produced by the internal pressure is not released.

Axial and lateral movements can be absorbed simultaneosly. An additional, angular flexibility on all planes can be achieved using special designs (see also Chapter 12, “Axial reaction force and pressure balanced designs”).

A further advantage of this construction type is its compact dimensions. These enable complex movement problems to be solved in confined spaces, which also has the advantage of small connecting forces. The principle apllications should now be apparent, namely connections for pumps, compressors and turbines in restricted spaces.

Elbow-connected pressure balanced expansion joints are normally designed specially to suit particular operating and installation conditions. The examples described below demonstrate the special advantages of this construction type and indicate points which should be noted when it is installed.

If **elbow-connected pressure balanced expansion joints** are used for **pump connections** (Fig. 9.29), it is possible firstly to achieve a low-stress machine connection, which is flexible on all planes and requires little space, and secondly to decouple vibrations with small, movable masses.

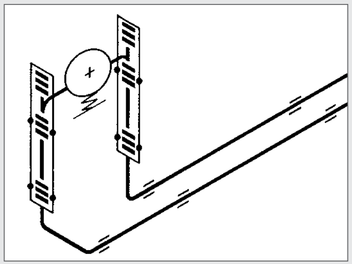


Fig. 9.29 Elbow-connected pressure balanced expansion joint used for pump connections

An **elbow-connection pressure balanced expansion joint installed between a turbine and a condenser** can provide a connection which requires only a relatively small vertical distance (Fig. 9.30).

The connection on the turbine side can also be made with a rectangular crosssection.

A pressure balanced expansion joint can be used in long pipe sections to absorb larger movements (Fig. 9.31).

The movement is effected by means of an extremely small pipe offset. Unlike with the three-hinge system, there is no lateral deflection which needs to be considered; a small clearance may be left merely in the guides directly at the expansion joints for the thermal expansion resulting from the distance between the axes of the two pipe runs, in order to relieve the load on the bellows.

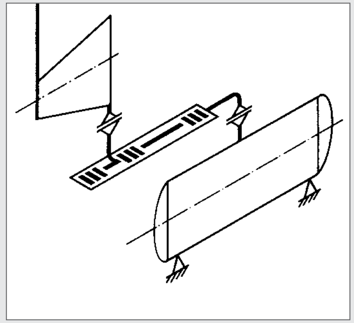


Fig. 9.30 Elbow-connected presure balanced expansion joint between turbine and condenser

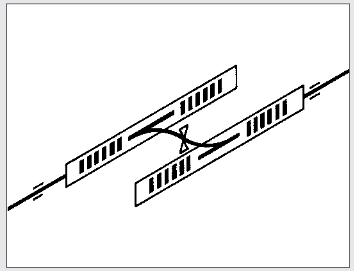


Fig. 9.31 Elbow-connected pressure balanced expansion joint in a long pipe section for absorbing large movements

Presetting
Presetting is necessary in order to exploit the full movement capability of an expansion joint. Each expansion joint can effect movements of an identical magnitude in both directions from the neutral position. The optimum presetting value is consequently 50% of the total movement.

The pretension as a proportion of the pipe expansion corresponds to the pretension of the expansion joint itself in the case of axial expansion joints, lateral expansion joints and angular expansion joints in a double-hinge system.

In three-hings systems with angular expansion joints this is usually the case as well; in unfavourably designed systems, however, the pipe pretension should be calculated with particular care, since it is no longer necessaryly proportional to the angular deflection of the individual angular expansion joints.

Since it is difficult to pretension an expansion joint directly when it is assembled, it is advisable to assemble the expansion joints in their neutral positions and to pretension the complete pipe run later on, either by displacing them before securing the anchors or afterwards using an adapter which has been cut out.

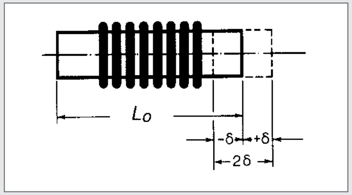


Fig. 9.32 Axial expansion joint with total length L_o (neutral position)

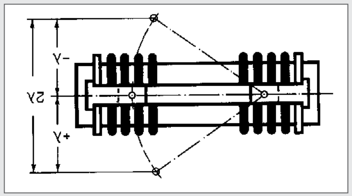


Fig. 9.33 Lateral expansion joint

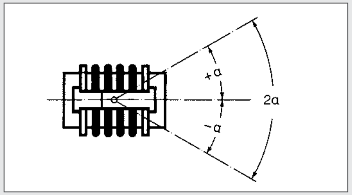


Fig. 9.34 Angular expansion joint

Axial expansion joints
The expansion joint is welded at one end to the pipe (1). This section of the pipe has already been secured, so that the expansion joint can be pretensioned subsequently without it being displaced.
The pipe section to be connected is lying loose in the guides (3).
The pipe section to be connected is then advanced up to the point of contact (4) and welded to the expansion joint (5).

After welding the loose pipe, it is pulled away from the expansion joint in an axial direction, using a wrench or other suitable device, by the magnitude of the pretension value (6).

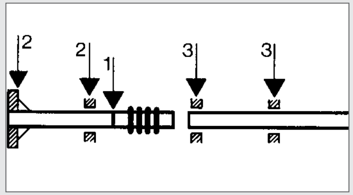


Fig. 9.35

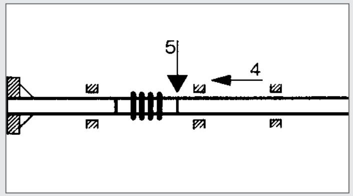


Fig. 9.36

Care must be taken to ensure that the expansion joint is not overextended (7). This section of the pipe must then also be secured, so that the expansion joint no longer draws the pipe towards it when released by the pretensioner (8). (Fig. 9.37)

9 | POSITIONING EXPANSION JOINT

If axial expansion joints are used, it is also possible to order them already pretensioned; this ensures that they are always pretensioned to the correct value on the building site.
It is of course also possible to dispense with pretensioning if the movements are so minimal that the permissible deflection of the expansion joint in one direction from the neutral position is not exceeded.

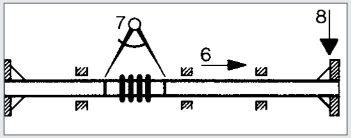


Fig. 9.37

Lateral expansion joints
The end anchors are secured at both ends (1). The expansion joint is welded in at a neutral position (2).
The pipe to be connected is spaced at a distance corresponding to the pretension value V (3). This must be ensured by means of a movable adapter or by cutting out a pipe section with the length V. (Fig. 9.38)

The expansion joint is pulled (or pushed) away from its neutral position by the pretension value (4), then connected rigidly to the pipe run (5).

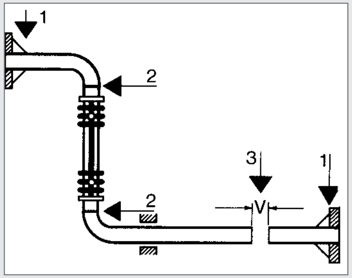


Fig. 9.38

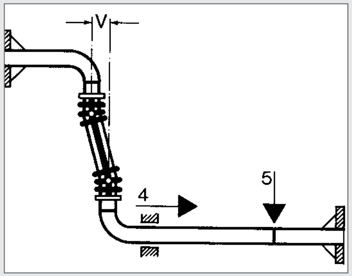


Fig. 9.39

This is possible manually if the expansion joint is lightweight; otherwise a suitable tool can be used. (Fig. 9.39)

Angular expansion joints
The end anchors are secured at both ends (1). The angular expansion joints are welded or flanged in in their neutral position, i.e. perpendicular to the incoming pipe runs (2). The pipes to be connected are spaced at a distance corresponding to the pretension values, or alternatively a pipe section corresponding to the pretensionvalue can be cut out (3). (Fig. 9.40)

The expansion joints, which are already operating jointly, must then be pulled (or pushed) away from their neutral position by the pretensioning value (4) and rigidly connected to the pipe runs (5).
This is possible manually if the expansion joints are lightweight; otherwise a suitable tool can be used. (Fig. 9.41)

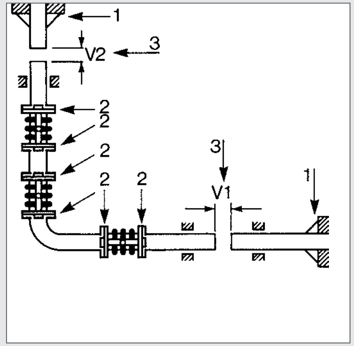


Fig. 9.40

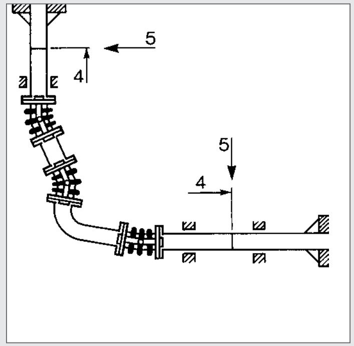
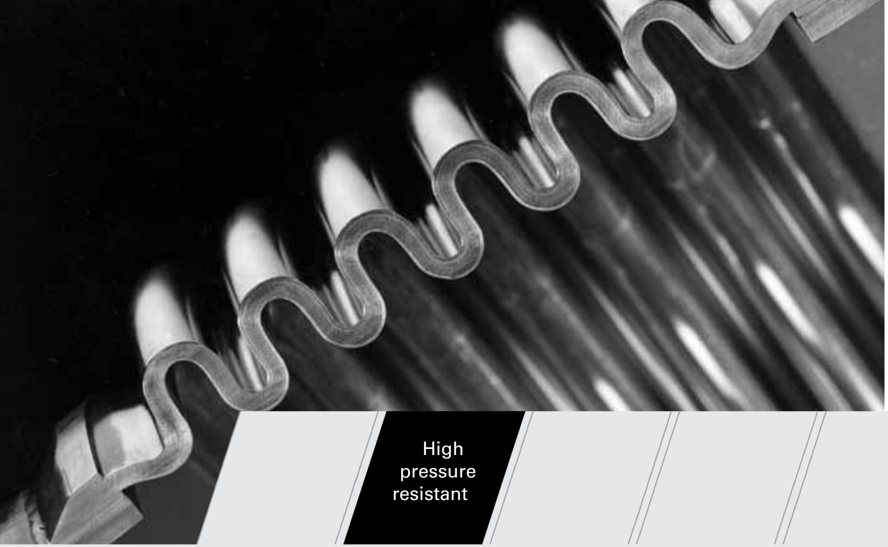


Fig. 9.41



Technical characteristics

The "multi-ply" principle is based on the idea of subdividing the pressure-bearing wall into a large number of thinner, individual plies, and thereby considerably increasing the flexibility, which is the most important characteristic of an expansion joint (cf. wire rope as opposed to steel rod).

Physical interrelationship

It becomes apparent merely by considering a simple flexural bar that if the bending and all other dimensions remain the same whilst the beam height is halved, the bending stress is likewise halved and the adjusting force of the double-ply flexural bar is reduced to just one quarter of its original value.

The principle is similar for the corrugations of a metal bellows. The interrelationships shown below (Fig. 10.2) demonstrate how the flexibility, pressure reliability and adjusting force are dependent on the most important geometrical parameters of the corrugation in an initial approximation (see, also Chapter 11, "Bellows design").

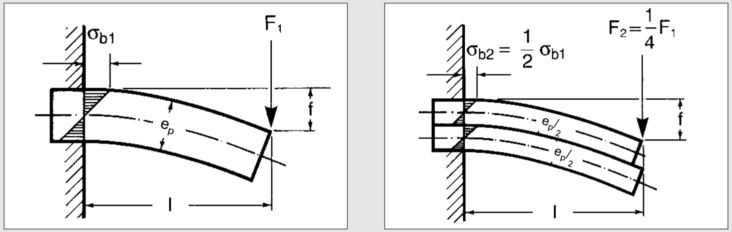


Fig. 10.1 Single and double-ply flexural bars with stress profiles

Pressure:

(10.1) $$p \sim n_p \left(\frac{e_p}{w}\right)^2$$

Axial movement:

(10.2) $$x \sim \frac{w^2}{e_p}$$

Axial adjusting-force rate:

(10.3) $$k \sim n_p \left(\frac{e_p}{w}\right)^3$$

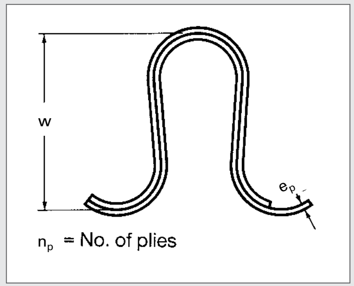


Fig. 10.2 Physical interrelationships of a bellows corrugation (approximation)

10 | THE MULTI-PLY PRINCIPLE

The relationships take into account the number of plies; this reveals the positive effect of a large number of plies in view of the aim of a high pressure reliability combined with good flexibility; **whilst increasing the number of plies causes the pressure reliability to be increased likewise in linear fashion, the flexibility remains unaffected.** Although these relationships are much more complex and less easy to formulate in reality, the potential for adapting the multi-ply expansion joint optimally to specific operation conditions is readily apparent.

Bellows structure
The multi-ply bellows is made using a multi-ply cylinder package.
The multi-ply cylinder package is turned into a multi-ply bellows by pressing out toroidal corrugations (Fig. 10.3). The plastic stretching of the material which occurs during this process is also a reliable test of the quality of the longitudinal seam of the cylinder.

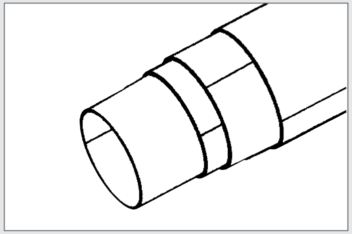


Fig. 10.3 Wound cylinder package

The individual tight cylinders may be made of different materials if desired; this opens up various economic possibilities, for example, of countering corrosion.

Material quality
Using cold-rolled strip material in only a few thicknessess – it is usually the number of plies which is varied – enables the material to be procured in large quantities, in order to influence positively the characteristics of the raw material which are particularly important for manufactering bellows, such as dimensional tolerances, surface quality, strength characteristic values and formability. The desired characteristics and data are laid down in our order and inspection certificate according to EN 10204-3.1/3.2 from the TÜV.

The most important materials are permanently available in stock.

Technical characteristics
A number of **highly positive** expansion joint **characteristics** result from structuring the bellows with a large number of individual plies:

- Ability to cope with high pressure combined with excellent flexibility
- Large movemen combined with small total lengths and a guaranteed number of stress cycles (normally 1000)
- Small adjusting forces in relation to other designs
- Small bellows outside diameters and consequently small effective cross-sections for reduced loads on anchors
- High bursting pressures – at least 3 times the nominal pressure

10 | THE MULTI-PLY PRINCIPLE

Benefits and safety of multi-ply expansion joints

Economic benefits
The large movements of the multi-ply HYDRA expansion joints means that only a **few expansion joints are necessary** to compensate the movements which occur, such as thermal expansion, and that the costs are reduced accordingly (fewer inspection shaft constructions are required, for example).
The more compact dimensions of the multi-ply bellows result in shorter total lengths of the expansion joints and in reduced protrusion of the anchoring of hinged expansion joints as well as small outside diameters of any outer protective sleeves which may be necessary. This again results in **cost savings** with regard to the shaft constructions, since these constructions can manage with much smaller dimensions.
The smaller adjusting forces of the multi-ply HYDRA expansion joint reduce the expenditure for anchors, and thus allow effective, **economical compensation in a small place**, e.g. hinge systems with very short leg lengsts.
If they are planned correctly and installed in accordance with instructions, multi-ply HYDRA expansion joints shield machine connections from forces and moments and dampen vibrations; they thus help to maintain trouble-free operation and **reduce repair costs.**
A number of different bellows materials can be used to counter the risk of corrosion, providing they are sufficiently formable – **the most economical method is to manufacture only the ply which is in contact with the aggressive medium using the corrosion-resistant material, which is generally extremely expensive**, and to make the remaining plies using the stainless steel 1.4541 employed as standard. It is however essential to ensure that the different bellows materials can be welded to one another and to the connection parts, or alternatively that lap-joint flanges can be used.

Safety principle
In addition to the safety which the expansion joint user is guaranteed by the reliable design and conscientious manufacturing, the multi-ply HYDRA expansion joints offer a notable advantage with regard to safety, namely the **check hole for indicating leaks** (Fig. 10.4).

If the ply of the multi-ply expansion joint which is in contact with the medium develops a leak, for example as a result of corrosion, a weak stream of the conveyed medium is choked out of the expansion joint through the seperate cylinders; the onset of damage is indicated by a slight leak at the “check holes” in the bellows neck (covered by rings). The pressure reliability and operation of the expansion joint are maintained in such cases for a lengthy period of time (weeks or months). It is therefore not necessary to replace it immediately; this can be left until a later date which is more convenient to the operator. A replacement expansion joint can be procured within the normal delivery period without the need for any special measures.
There is no need to store spare expansion joints.

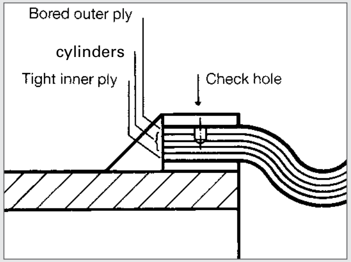


Fig. 10.4 Weld seam and check hole

10 | THE MULTI-PLY PRINCIPLE

On the basis of our many years of experience, we can state that spontaneous bursting of HYDRA multi-ply bellows is not possible under any circumstances.

Permanent leakage monitoring
When used in plants with toxic, flammable, explosive or other critical media, multi-ply HYDRA expansion joints can be monitored permanently for leaks without any risk of the critical medium escaping if damage occurs.
The check hole is guided into a closed, toroidal chamber, to which a pressure measurement instrument is connected (Fig. 10.5). The instrument outputs an alarm if the pressure rises, so that any onset of damage to the inner ply is indicated at absolutely no risk. Even large pipe systems, such as gas networks, can be monitored completely, reliably and economically by this method.

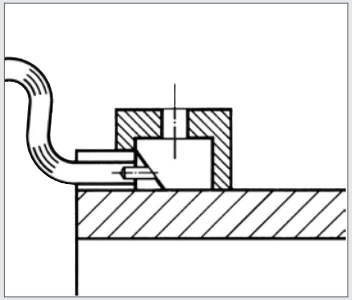


Fig. 10.5 Patented leakage-monitoring system

Noise proofing
Multi-ply bellows have a movement hysteresis due to mutual effect of the plies on one another and to the effect of friction.

The dampling which results from energy consumption has an extremely positive effect as regards isolation against structure-borne noise. Multiply bellows can reduce this noise by up to 20dB in the same way as rubber elements.

The outstanding characteristics of multi-ply HYDRA expansion joints have for many years made them the best, if not the only, answer for many practical applications, especially when high pressures are involved.

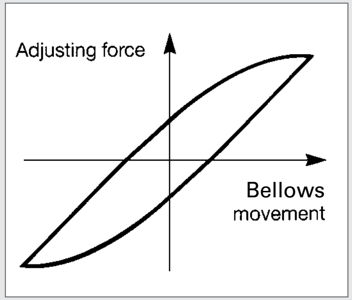


Fig. 10.6 Hysteresis loop due to over elastic alternating stresses

Bellows Design

The problem
A corrugated metal bellows must meet two contradictory demands – namely pressure reliability on one hand and flexibility with regard to relatively large, alternating movements on the other hand – giving almost equal priority to both.

This is a major difference – also as far as the calculations are concerned – between the metal bellows and other pressure-bearing components, such as vessels and pipes, where pressure reliability is essential, whilst other, alternating loads which are imposed on them generally play a subordinate role and are only calculated approximately as addition loads.

But the aim when designing an expansion joint bellows is to establish the shape and size which allow the two demands to be met optimally in both technical and economic terms.

According to the latest state of the art – which is based on several decades of experience – the construction principle of double and multi-ply expansion joints provides the best basis for achieving an optimised system.

On the other hand, using several plies further complicates the already difficult calculation of the lyre-shaped bellows corrugation, which has the shape of a doubly-curved shell. A reliable method of designing and sizing expansion joints is however indispensable, since the safety of the plant and the operating personnel may depend on it.

So we have developed an independent calculation method. This calculation method is basically founded on EN 13445-3 and EN 14917 and was complemented by supplements of operational experience and test results.

The method was examined by an independent third party inspection agency (TÜV); an equivalent complete safety level in the sense of directive 97/23/EG was demonstrated.

The theoretical basis
This calculation method applied in standards (EN 13445, EN 14917,...) and rules (EJMA, ASME,...) is founded on the calculation method which was developed by Anderson for the Atomic Energy Commission, USA and published in the year 1964/65.

This method takes a flat, non-curved plate strip with a height w, corresponding to the height of the corrugations, as a simplified, substitute model for a bellows half-corrugation (Fig. 11.1). The equations required to calculate this substitute model are set up, and then corrected with factors which take into account the effect of the real shell shape of the bellows corrugation.

Anderson provides the correction factors in the form of a graph; they have been determined analytically by means of shell equations and take the laws of similarity into account. The method provides clear equations in line with the simplified, yet elegant, formulation (Fig. 11.1).

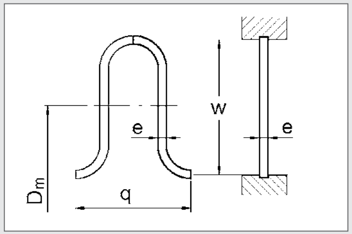


Fig. 11.1 Bellows corrugation and substitute model for Anderson's calculation

The equations can principally be used as the basic equations for calculating the bellows, though strictly speaking they only apply to single-ply bellows with U-shaped corrugations (parallel flanks) and with a constant wall thickness over the entire corrugation; bellows with more than one ply can be calculated approximately using these equations, providing the number of plies is not too high (between 2 and 4) and the overall wall thickness is small in relation to the given corrugation height.

The Witzenmann method

The essential completions and extensions of the calculation method acc. to EN 13445 introduced by us are:

- Repeal of the limit of 5 plies by introducing a correction factor
- Modification of the fatigue life curve evaluated on tests
- Determination of working spring rate considering the real material behaviour as well as other effects such as friction
- Modification of the formula for column instability considering the influence of movement

11 | BELLOWS DESIGN

Service life

Based on test results and considering the correction factor a fatigue curve specific to the manufacturer was established. The determination of this particular curve followed EN 13445-3 and EN 14917. Based on the best fit curve a service-life curve is determined, which covers at least 98 % of the test results. It is called "design-curve" and is the basics for the expansion joint design (Fig. 11.2).

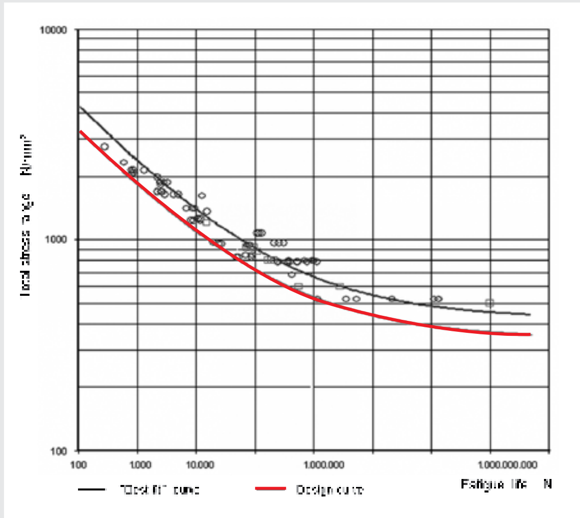


Fig. 11.2

Stability
The performance of a bellows (pressure resistance, fatigue life) can be decreased considerably by instability. Therefor a reliable calculation of the critical internal pressure is very important. There are to kinds of instability:

Column instability, which only applies to bellows with internal pressure, is defined as a strong lateral shift of the bellows median line and occurs at bellows with a relative great ratio of length and diameter.

To determine the critical pressure we have considered both the static pressure and the effect of movement.

Inplane instability – also called local instability – occurs at relative small ratio of length and diameter and is defined as slipping or twisting the plane of one or several corrugations against the straight axis of the bellows.

Fig. 11.3

Fig. 11.4

11 | BELLOWS DESIGN

Working spring rate of bellows
The spring rate of a bellows, which depends on the geometry (in particular wall thickness and convolution height) and the material of the bellows, is required for the determination of several properties of the bellows and is no clear, linear order.

The stiffness of a bellows can be calculated within the elastic range with sufficient accuracy (see EN 13445-3). It is valid only for small axial movements and deviates from the linear course (plastic range, line BC) when the axial movement increases.
With great efforts is possible to determine the real working spring rate by measurement.

That's why we formulated an equation for the working spring rate by the analysis of internal measurings in combination with theoretical models.

With this equation it is possible – in accordance with the results of measurement – to calculate the working spring rate in relation to the axial movement.

All supplementary influences such as pressure, friction or plastic deforming were taken into account in this equation.

It is recommended for the practical use to apply the real adjusting force rate (AC) for the calculation of forces and moments.

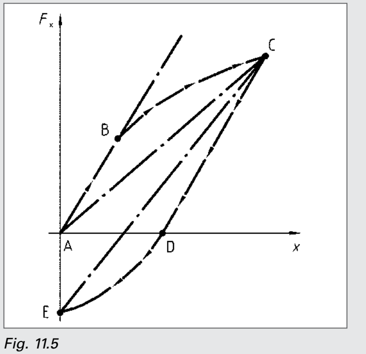


Fig. 11.5

Axial reaction force

A longitudinal force with the magnitude $F_L = a \cdot p$ generally prevails in a pressurized pipeline, where a represents the pipe cross-section and p the pressure difference (internal/external). The reaction force is generated by the axial pressure components, which act on a projected cross-section at the end of a pipe section (Fig. 12.1).

Axial expansion joints
If a flexible, non-anchored, axial expansion joint is used, the reaction force is released, i.e. there is no rection in the pipeline in the form of a longitudinal force; the reaction force must be absorbed at both ends of the pipe section by means of anchors.

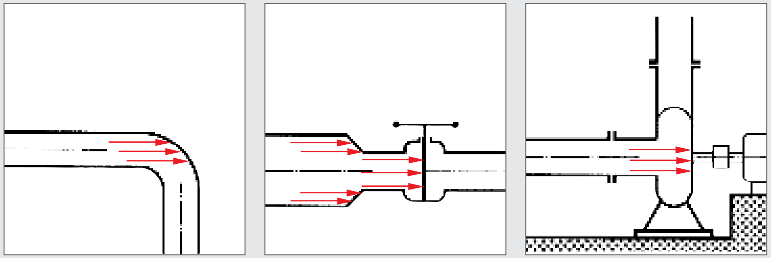


Fig 12.1 Pipe bend — Gate valve — Pump

Since the axial expansion joint normally has a mean bellows diameter which is greater than the inside diameter of the pipe, the force which must be taken into account when designing the anchors is slightly higher (Fig. 12.2).

Axial reaction force

$$F_p = A \cdot p \qquad (12.1)$$

A = effective bellows cross-section
p = gauge pressure

The axial reaction force is obtained in kN, if A is specified in cm^2 and p in kN/cm^2 ($1kN/cm^2 = 100$ bar; see Chapter 4, "Compensation types", Fig. 4.6). The effective bellows cross-section specified in the dimension tables for the axial expansion joints can be well approximated with the aid of the mean bellows diameter.

Effective bellows cross-section

$$A = \frac{\pi}{4} d_m^2 \qquad (12.2)$$

Mean bellows diameter

$$d_m = \frac{1}{2}(d_i + d_a) \qquad (12.3)$$

The maximum gauge pressure which occurs must be taken when designing the anchors (usually the test pressure)

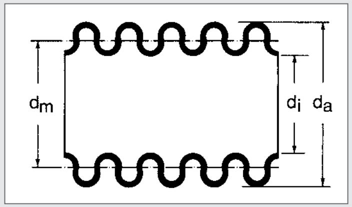


Fig. 12.2 Diameter at bellows

12 | AXIAL REACTION FORCE
AND PRESSURE BALANCED DESIGNS

A force part is derived from the difference between the cross-sections of the bellows and the pipe $\Delta A = A - a$; it is guided through the pipe as a longitudinal reaction force from the expansion joint to the anchor (Fig. 12.3).

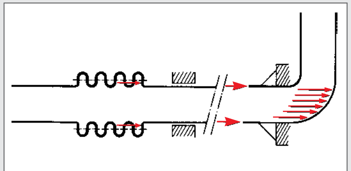


Fig. 12.3 Axial reaction force with axial compensation

Anchored expansion joints

Expansion joints are fitted with anchors in the form of spherically supported tie rods or hinged sections, in order to guide the longitudinal force via the expansion joint from one pipe connection to the next. As far as the axial reaction force and the longitudinal force are concerned, a pipe with a hinged expansion joint behaves in the same manner as a continuous pipe; no additional load is placed on the anchors or guides by the axial reaction force.

Pipe connection load

The reaction force acts on machines and aggregates via the pipe connectors; different pipe connections loads result according to the type of pipe connection. **No other loads are considered here!**

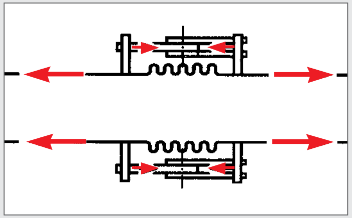


Fig. 12.4 Longitudinal force at the angular expansion joint

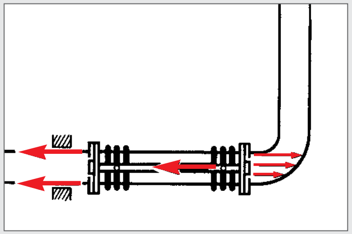


Fig. 12.5 Longitudinal force at the lateral expansion joint

Rigid pipe connection (Fig. 12.6)

- Longitudinal force equal to reaction force pulls at pipe connection (with internal gauge pressure
- No load on foundation

Connection with hinged expansion joint or pressure balanced expansion joint (Fig. 12.7)

- Longitudinal force equal to reaction force pulls at pipe connection (with internal gauge pressure)
- No load on foundation

Connection with axial expansion joint (Fig. 12.8)

- Pipe connection practically force free
- Reaction force absorbed by supports

$$Q_A = Q_B = F_p/2 \qquad F_A = -F_B = F_p \frac{h}{c} \tag{12.4}$$

The problem which results when flexibly supported aggregates must be connected via axial expansion joints is apparent – the aggregate is tilted due to the dynamic effect (see Chapter 13).

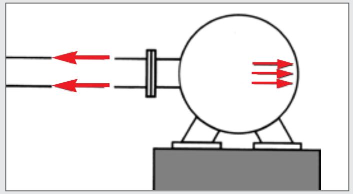


Fig. 12.6 Axial force at an aggregate with a rigid pipe connection

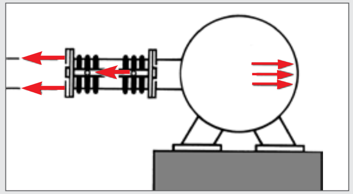


Fig. 12.7 Axial force at an aggregate with a lateral expansion joint

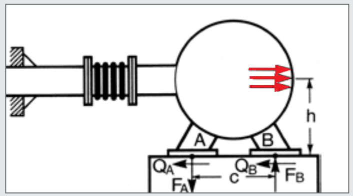


Fig. 12.8 Axial force at an agregate with an axial expansion joint

12 | AXIAL REACTION FORCE
AND PRESSURE BALANCED DESIGNS

Pressure balanced designs

Since higher operating pressures and larger diameters can cause the axial reaction force to reach a level which makes it either uneconomical or impossible to size the anchors, anchored expansion joints (either angular or lateral expansion joints) are normally used to absorb the thermal expansion; they always require the pipeline to be rerouted however, since their design does not permit axial movement.

If it is undesirable to reroute the pipeline, or if it is impossible for reasons of space, **straight-section tie rods** or **pressure balanced, axial expansion joints** can be used instead, depending on the plant-specific circumstances.

Pressure balanced, axial expansion joints are relatively complex constructions, which should only be used if other, more economical alternatives are not viable. One possible reason for using them might be that they are designed to absorb additional, lateral movements, e.g. vibrations.

The **elbow-connected pressure balanced expansion joint** is a versatile variant of the pressure balanced design; in contrast with the designs described above, it requires the pipeline to be rerouted, but in exchange provides flexibility on all planes.

Straight-section tie rods

Containers which must be connected together by a straight pipe – often at great heights – cannot absorb any significant axial reaction forces. An axial expansion joint and a straight-section tie rod which is adequately sized to cope with the reaction force may be the best answer (Fig. 12.9). The tie rods are almost always fixed and fitted by the customer. The full benefit is only obtained from the straight-section tie rod if the tie rods are located outside the insulation, in other words if they remain "cold", and if they are fitted in the centre of the container.

If differences in height must be compensated at the same time, hinge-supported anchors and axial expansion joints which are adequately sized to cope with the total movement are necessary.

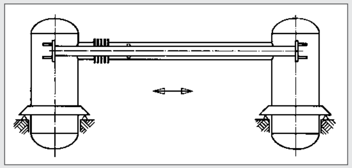


Fig. 12.9 Two container connected together by a straight-section tire rod

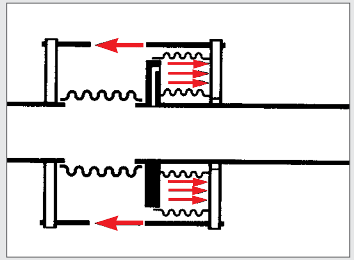


Fig. 12.10 Pressure balanced axial expansion joint. Toroidal-chamber priciple

Pressure balanced axial expansion joints

These designs compensate the axial reaction force by means of an additional pressure chamber, which can be either circular or toroidal and which is connected to the two diverging ends of the working bellows in opposite directions (Figs. 12.10 to 12.13).

- Reaction force compensated via **toroidal chamber** with cross-section corresponding to effective cross-section A of working bellows
- Three bellows necessary
- No redirection of flow

- Reaction force compensated via a **circular pressure chamber**
- Two identical bellows – in this case with pressure applied externally – permit full compensation of reaction force
- Flow redirected

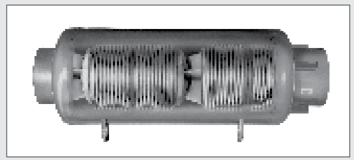


Fig. 12.11 Pressure balanced axial expansion joint. Pressure-chamber principle

Other designs based on the same principle are also possible, and have been implemented in numerous cases; in the final analysis, the design is dictated by the requirements of a specific application. Our multi-ply bellows designs with their low adjusting forces have proved extremely useful, since either one or two additional bellows must now be moved as compared with a normal axial expansion joint. The axial adjusting force cannot be compensated in the manner of the reaction force, but remains as a load on the anchors.

Elbow-connected pressure balanced expansion joints

This design exploits a rerouted pipeline by incorporating the expansion joint exactly at the “elbow”. The axial reaction force is then compensated by means of an additional bellows, which is located outside the actual pipe and acts as a piston, thereby transferring its counter-force to the pipe to be connected via tie rods (Fig. 12.14).

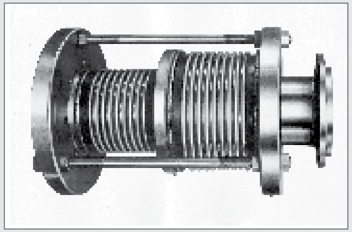


Fig. 12.12 Pressure balanced axial expansion joint, toroidal-chamber principle, for chemical plant

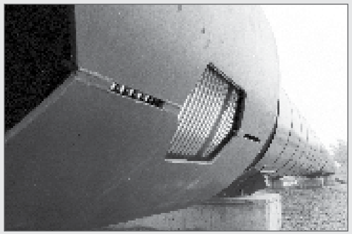


Fig. 12.13 Pressure balanced axial expansion joint, toroidal-chamber principle, in district-heating pipe system DN 1000

12 | AXIAL REACTION FORCE
AND PRESSURE BALANCED DESIGNS

The simplest type is the **elbow-connected pressure balanced axial expansion joint** with slight lateral flexibility. (Fig. 12.14)

One example of how this design can be used in practice is to **link containers** if only small vertical movements are involved, or – if the vertical movement caused by the time gap is sufficiently small. (Fig. 12.15)

Otherwise designs with greater lateral flexibility, provided by **two working bellows**, must be used instead. (Fig. 12.16).

Elbow-connected pressure balanced lateral expansion joints can also be used in 3-dimensional systems if they are fitted with **gimbal hinged expansion joints** for flexibility on all planes.

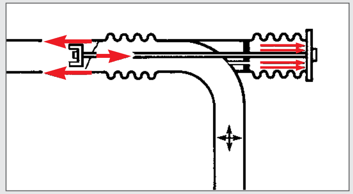


Fig. 12.14 Elbow-connected pressure balanced expansion joint (principle)

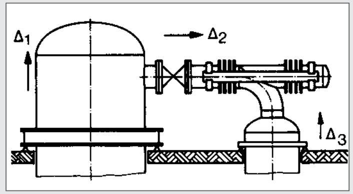


Fig. 12.15 Elbow-connected pressure balanced axial expansion joint used to link containers

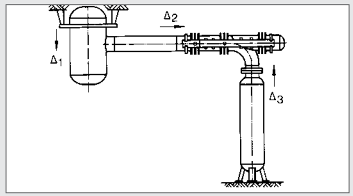
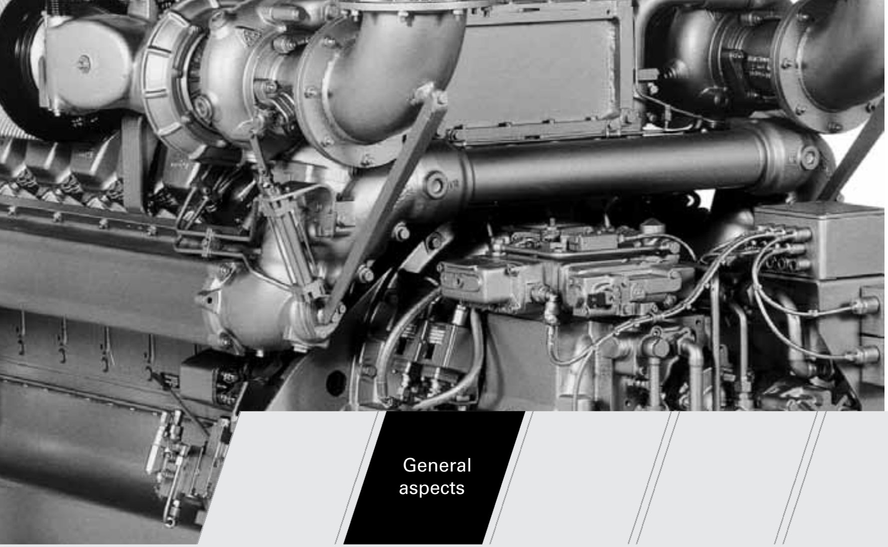


Fig. 12.16 Elbow-connected pressure balanced lateral expansion joint



General aspects

Hydrodynamic machines, piston engines and similar aggregates generate vibrations with differing frequencies and amplitudes according to their construction type as a result of the rotating or to-and-fro movement of their masses.

The pipes connected to them are consequently also made to vibrate, which can lead to material fatigue and damage; damage is inevitable if the resonance occurs in the connecting pipes. High-frequency vibrations moreover have an unpleasant side-effect in the form of noise, whilst low-frequency vibrations can be passed on via the foundations and the ground and cause damage in neighbouring constructions.

The aggregates are flexibly supported and their connecting pipes decoupled by means of flexible pipe elements, in order to prevent vibration damage and noise propagation. Metal hoses and expansion joints are used for this purpose.

The most important criteria which should be considered when selecting the best flexible element are as follows:

- **Dimensions of pipe connectors**
  Drilling template of flanges
  Diameter and thickness of weld ends
  Bolting (types and dimensions)
  Special connections

- **Operating data**
  Pressure
  Temperature
  Flow velocity
  Medium (possible impurities)

- **Permissible forces and moments**
  Acting on the pipe connection
  Acting on the entire aggregate (stability)

- **Thermal expansion, if this must also be absorbed**

- **Vibrations** (sustained vibrations)
  Direction
  Amplitude
  Frequency

- **Space available for installing flexible elements**

- **Anchors and guides for the outgoing pipes** (feasible alternatives)

13 | VIBRATIONS AND NOISE

The **connections** used for the vibration elements normally take the form of flanges according to DIN 2501 or equivalent standards; special flange designs are often necessary for engines due to the lack of space available.

The nominal pressure of the flexible pipe element can be determined from the **operating data** (pressure and temperature), taking the reduction factor into acount; this data also effects the choice of materials for the corrugated section and for the connection parts (see Chapter 5, "Selecting an expansion joint").

The operating pressure is used additionally to calculate the **axial reaction force**, which acts as a longitudinal force in all pressurized pipes, but which is released if an axial expansion joint is used, thereby placing a direct load both on the next support and on the aggregate (Fig. 13.1). This topic is discussed in more detail in Chapter 12, "Axial reaction force and pressure balanced designs".

It should be noted that the axial reaction force which is released acts on the interior wall of the body which is opposite the pipe connector (Fig. 13.2), and that the flexibly supported aggregate may be tilted or displaced excessively, depending on the magnitude of the force. The position of the pipe connector is also important in addition to the weight of the machine and the elastic parameters of the support, since it determines the direction of the force and thus also its permissible magnitude.

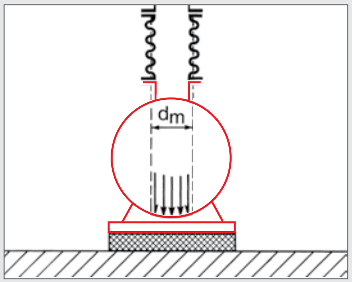


Fig. 13.1 Axial reaction force acting vertically on an aggregate

Practically no load is placed on the pipe connector by the reaction force if axial expansion joints are used.

If lateral forces occur, the permissible **connector loads** should always be checked, especially if lateral expansion joints – which can only move in lateral direction due to their anchoring – are to be installed. HYDRA lateral expansion joints with multi-ply bellows have relatively small lateral adjusting-force rates; these rates may nevertheless be to high for types designed for high operating pressures, due to the frictional-force part, or for types where the total length is too short, especially if thermal expansion must also be absorbed.

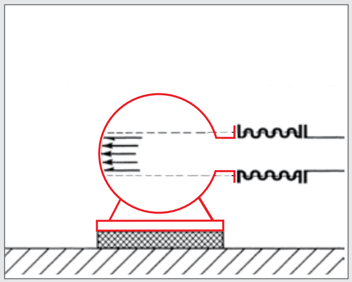


Fig. 13.2 Axial reaction force acting horizontally on an aggregate

The medium which is conveyed also has an influence on the choice of materials if it is aggressive or contains aggressive components (see Chapter 5, "Selecting an expansion joint").

Significant vibrations with amplitudes of 0.1 – 0.5 mm are generated primarily at piston engines due to the to-and-fro movement of their masses. Turbines, centrifugal pumps and turbo-compressors usually only generate vibrations with very small amplitudes – often in the audible frequency range – which are due to unbalance or to pressure differences at the blades.

In all machines the highest amplitudes are thus encountered in a plane which is perpendicular to the pivot. The requirements which must be met by the flexible elements, and on which the choice must be based, can therefore differ considerably according to the position of the pipe connections.

In addition to the vibration values during continuous operation, which necessitate highly durable elements, moment amplitudes which are often up to five times as high are likely during start-up, especially if the machine must pass through a critical speed range. These wider limit stops can generally be ignored when designing the flexible elements, since they are only allowed to occur for extremely short periods in the interests of gentle machine operation.

The first natural frequencies of the flexible elements should be higher than the excitation frequencies of the machine and sufficiently far away from them.

The elements used for **noise isolation**, on the other hand, must have natural frequencies which are lower than the noise frequency, which is almost bound to be the case; these elements can only provide insulation against structure-borne noise. Any noise which is conveyed in the medium (e.g. water) is not normally dampened to any significant extent by flexible connecting elements.

Braided HYDRA metal hoses and multi-ply HYDRA expansion joints, with their special design principle, have a noise isolating effect, which has been verified by means of tests. The multi-ply HYDRA axial expansion joints, for example, can provide insulation against structure-borne noise up to 20dB. They are thus far superior to single-ply designs.

Impulse pressures in the medium, which may also form the pipes or cause them to vibrate, cannot be eliminated using flexible elements; viscous dampers must be used instead.

Flexible elements for absorbing vibrations

Every all-metal, flexible pipe element we supply for connecting to vibrating aggregates is pressure and temperature-resistant and absolutely leak tight; our elements do not age, and if chosen and fitted correctly have a practically unlimited service life.

Different types of flexible elements can be used, depending on specific requirements (Figs. 13.3 and 13.4). The table below lists the various possible designs and outlines the applications to which they are best suited for (Fig. 13.5). Deviations from the specified approx. values are possible on the case-to-case basis.

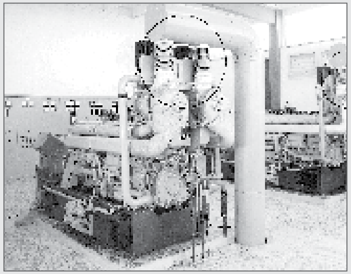


Fig. 13.3 Axial expansion joints used at the turbochangers of diesel engines

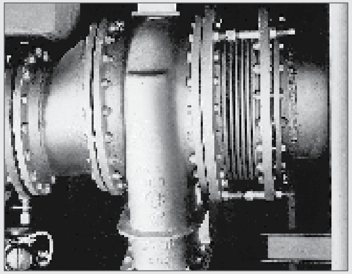
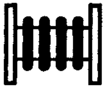
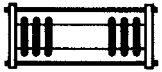
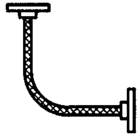


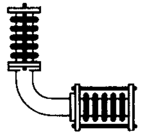
Fig. 13.4 Axial expansion joints used at pumps.

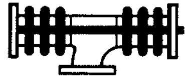
① 

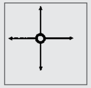
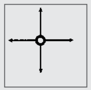
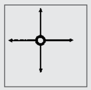
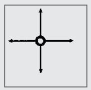
② 

③ 

④ 

⑤ 

⑥ 

Number.	Flexible element	Approx. values Movement		Nominal diameters DN	Pressure rating PN (max)
①	Axial expansion joint		All planes	15 - 100 150 - 1000 ≥ 1000	≤ 2.5 ≤ 1 Pressureless
②	Lateral expansion joints with braided anchor		Noise in all directions in circular plane	15 - 40	25
③	Lateral expansion joints with flexibly supported, tie rods (wire pressed form ring)		Noise in all directions in circular plane	50 - 500	25
④	Metal hose with 90° bend (See hand book No. 301 Metal hoses)		All planes	≤ 100	25
⑤	Lateral expansion joints with tie rods in 90° angular configuration		All planes	50 - 500	63
⑥	Elbow-connected pressure balanced expansion joint (Special design on request)		All planes	50 - 500	63

Values higher than the approx. values are also possible

Fig. 13.5

Axial expansion joints
The most economical element with the simplest design is the axial expansion joint; it can be used whenever the aggregate is able to withstand the axial reaction force specified in the table below for a common range (Fig. 13.6).

Axial reaction force in kN*

Nominal pressure PN	50	65	80	100	125	150	200
1	450	700	900	1350	2000	2800	4500
2.5	1100	1700	2200	3800	5000	7000	11200
6	2700	4100	5300	8100	12100	16750	66900
10	4500	6800	8800	13500	20100	27900	44800

Fig. 13.6

* Values for larger dimensions and higher pressures are specified in the graph (Fig. 4.3) in Chapter 4, "Compensation types".

Vibration amplitude
The permissible vibration amplitude can be calculated from the axial movement:

Axial vibration amplitude

(13.1) $$\hat{a}_\delta = 0.03 \cdot 2\delta$$

Axial movement at temperature 2δ in mm ($2\delta = K_{\Delta\vartheta} \cdot 2\delta_N$)

Lateral vibration amplitude
(one bellows)

(13.2) $$\hat{a}_\lambda = 0.01 \frac{l}{D} \cdot 2\delta$$

Corrugated length of bellows l in mm
Outside diameter of bellows D in mm

The equations yield the maximum values for vibrations in one direction; proportional values are permissible for vibrations on all planes.

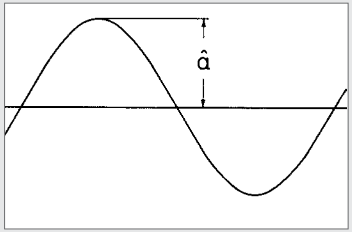


Fig. 13.7 Sinusoidal vibration

Thermal expansion
If thermal expansion must be absorbed in addition, the permissible values can be calculated in the usual way (see Chapter 5, "Selecting an expansion joint"), i.e. sustained vibrations need not be taken into account. This also applies to lateral movement, which can be calculated for axial expansion joints with single bellows according to the equation below:

Equivalent lateral movement

(13.3) $$2\lambda = 2\delta \cdot \frac{1}{3} \cdot \frac{l}{D}$$

Lateral adjusting-force rate

(13.3) $$c\lambda = 1.5\, c_\delta \left(\frac{l}{D}\right)^2$$

Axial adjusting-force rate taken from dimension tables for axial expansion joints c_δ in N/mm.

The likely pipe connection load can be determined on the basis of the adjusting-force rate (see Chapter 9, "Positioning an expansion joint").

Guides and anchors
The diverting pipes of vibrating aggregates, which are decoupled by means of axial expansion joints, must be supported directly downstream of the expansion joint, whereby it is important for the fixture to be indipendent of the vibrating foundation. A support in the form of a fixed or sliding anchor must be sized so that it is capable of absorbing the axial reaction force in addition to the adjusting forces (Fig. 13.8). A sliding anchor should be used if lateral thermal expansions must be absorbed at the same time (Fig. 13.9).

13 | VIBRATIONS AND NOISE

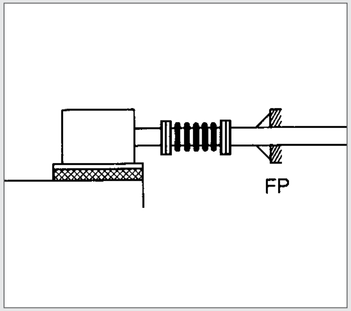


Fig. 13.8 Axial expansion joint at a vibrating aggregate. Anchor

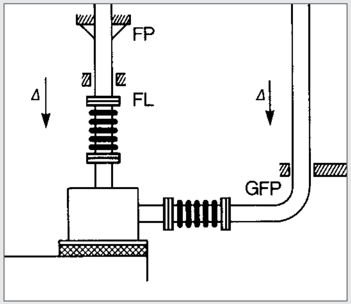


Fig. 13.9 Axial expansion joints at a vibrating aggregate. Guides and anchors

Natural frequencies

The natural frequencies in the axial and radial directions are specified for the standard range of "axial expansion joints for low pressure". They only apply if the expansion joints are used for gaseous media. If other axial expansion joints are to be used to absorb vibrations, the calculation of the natural frequency must take into account whether a gas or liquid is to pass through the expansion joint, since this frequency also depends on the conveyed medium. We can calculate the natural frequencies for you on request.

Inner sleeve

The standard design of inner sleeves are not suitable for the use in vibrating expansion joints, since they impede the lateral movement. If inner sleeves are necessary, e.g. in conjunction with high flow velocities (see Chapter 5, "Selecting an expansion joint") or abrasive impurities in the fowing medium, specially designed expansion joints can be supplied with one-piece, inner sleeves with a reduced diameter.

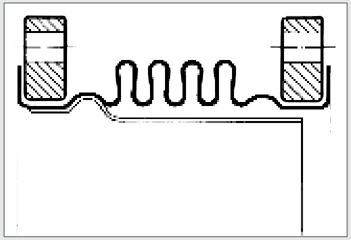


Fig. 13.10 Axial expansion joint with one-piece, inner sleeve with reduced diameter

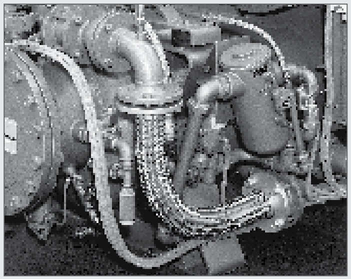


Fig. 13.11 Metal hose in 90° bend at a screw-type compressor

Metal hoses

If the normal diameters are sufficiently small at high pressures, i.e. up to approx. DN 100, braided metal hoses, where the braid absorbs the reaction forces, provide a potential means of absorbing vibrations. If they are integrated in a 90° bend, they can absorb vibrations on all planes whilst producing only small adjusting forces (Fig. 13.11).

Lateral expansion joints

Lateral expansion joints are used at vibrating aggregates if the operating pressures are so high that an axial expansion joint can no longer be used due to the axial reaction force and a metal hose is no longer suitable on account of the specified connection diameter or other parameters.

If the vibrations only occur in one plane, perpendicular to the axis of the pipe connector, a single expansion joint is sufficient, providing it is flexible in all directions in this plane. A design with spherically supported tie rods is suitable (Figs. 13.12 and 13.13).

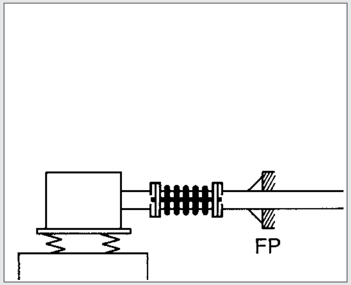


Fig. 13.12 Lateral expansion joint at a vibrating aggregate

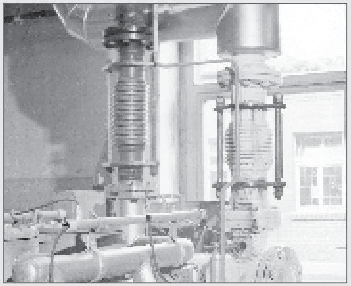


Fig. 13.13 Lateral expansion joints with tie rods at vibrating aggregates

If 3-dimensional movements occur in all directions, a second expansion joint must be installed perpendicular to the first. The additional expansion joint should be either an angular expansion joint (Fig. 13.14) or a lateral expansion joint (Fig. 13.15), depending on the magnitude of the vibration amplitudes and on any thermal expansion which must be absorbed. If an angular expansion joint is used, it must be installed so that it can work together with the lateral expansion joint, i.e.the pipe bend must be able to effect rocking movements, and the lateral expansion joint must be designed to permit rocking movements at the associated flange.

If a second lateral expansion joint is used as the additional joint, the anchors of the two expansion joints must be arranged at 90° in relation to one anchor (Fig. 13.15).

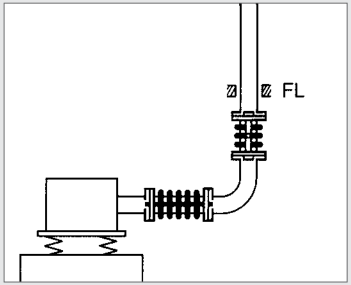


Fig. 13.14 Lateral and angular expansion joints at a vibrating aggregate

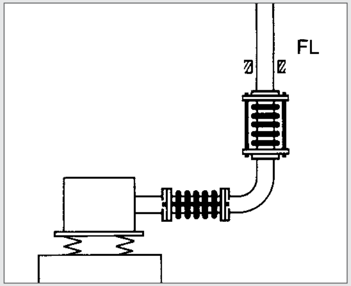


Fig. 13.15 Lateral expansion joints at a vibrating aggregate

Elbow-connected pressure balanced expansion joints

Elbow-connected pressure balanced expansion joints may be the best answer, since they can effect 3-dimensional vibrations on all planes with a smaller vibrating mass (Fig. 13.16).

This adapted special design is generally somewhat more expensive than the arrangement shown in Fig. 13.15.

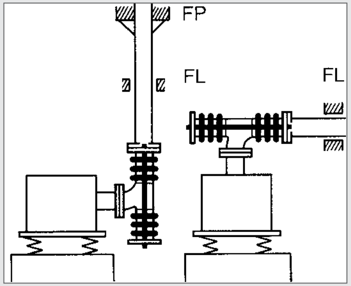


Fig. 13.16 Elbow-connected pressure balanced expansion joints at a vibrating aggregate

13 | VIBRATIONS AND NOISE

Noise-isolated expansion joints
If lateral expansion joints must be used on account of the operating conditions as described above, the insulation does not necessarily prevent transmission of structure-borne noise, since the anchoring still transmits the noise despite the use of multi-ply bellows.

Lateral expansion joints with braided anchors (Fig. 13.17) can be used in such cases if the nominal diameter is small, or alternatively specially developed HYDRA lateral expansion joints (LS and LRS types) for large diameters; the latter have tie rods with noise-isolating supports and thus ensure that the machine connection has the necessary noise isolation. The insulating pads made of stainless-steel wire which are used to support the tie rods are resistant to ageing and temperature, and are therefore able to maintain their technical characteristics almost entirely throughout the operating time, even at high temperatures (Fig. 13.18).

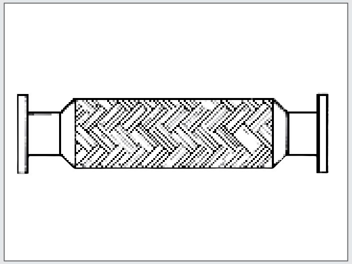


Fig. 13.17 Lateral expansion joints with small nominal diameters with braided anchoring for absorbing vibrations (noise isolated)

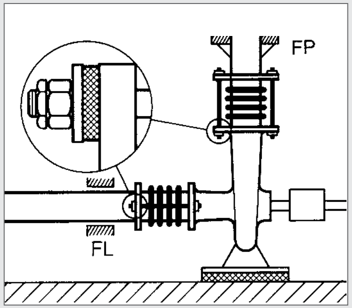
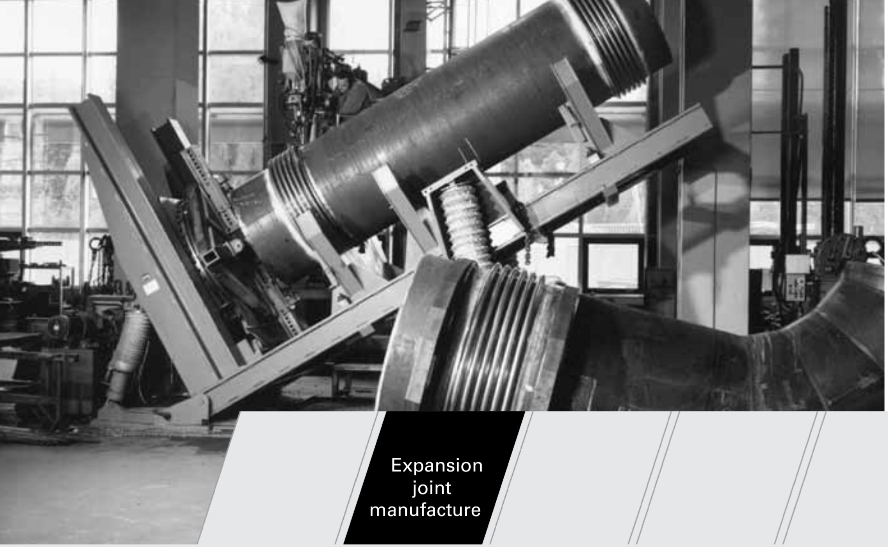


Fig. 13.18 Lateral expansion joints (noise isolated)

The permissible vibration amplitude for sustained vibrations is approximately 5% of the movement values on one plane specified in the dimension tables for 1000 stress cycles (δ, α, λ) for all expansion joints.

With all types of flexible element should be assembled as close as possible to the vibrating aggregate, in order to prevent additional movement.

An anchor or a guide support which is independent of the vibration bed should be installed directly after the compensating element, in order to reduce the free-swinging mass to a minimum. This largely precludes the risk of self oscillation.



Expansion joint manufacture

Expansion joint manufacturing necessitates a mastery of two crucial procedures – **bellows forming and welding engineering**.

Bellows forming

The bellows manufacturing process begins in the Witzenmann factory by making single, double or multi-ply cylinders using a readily formable material – predominantly austenitic, stainless stell 1.4541.

The individual cylinders are made of thin strips (0.1 to 2 mm) or plates, which are given a longitudinal seam weld with a welding factor of 1. We have suitable, high-quality machines and welding methods at our disposal. Multi-ply bellows are manufactured from cylinder packages (Fig. 14.1).

We use two basic methods to form the cylinders or cylinder packages into expansion joint bellows, whereby toroidal corrugations must be formed; the choice of method (hydraulic or mechanical) depends on the bellows geometry.

The **hydraulic method** entails applying a special hydraulic fluid from the inside, and under high pressure, to a cylinder section which has been divided up by means of external and internal tools. A corrugation is produced when the cylindrical section is stretched in the circumferential direction as a result of the internal pressure which is applied; the material only overstretches and solidifies according to the change in the geometry, and requires no after-treatment. This method is very gentle on the material. If desired, several corrugations can be formed simultaneously using the same principle, which makes this mehod especially economical if large quantities are involved.

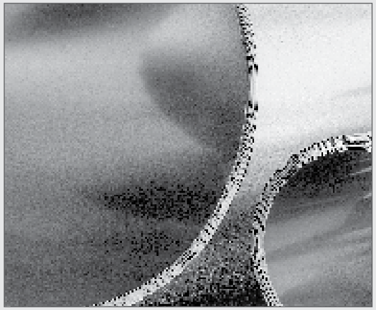


Fig. 14.1 Cylinder packages

14 | MANUFACTURE AND TESTING

Elastomer forming is a variation of the hydraulic bellows-forming method, whereby the elastomer pad performs the task of the hydraulic fluid. The pad, which like a liquid is incompressible, is pressed outwards by a flexible tool, thereby forming the corrugation, which is then final-formed by recompression. This method, where the individual corrugations are manufactured one after the other, is suitable for small and medium diameters up to approximately DN 1200. It can also be used to form cylinders with thick walls, especially if they are made up of many plies. High-force presses are available up to 1200 t.

The **mechanical method** which can be applied is a type of roll forming, and is used primarily for large diameters. Several roll forming tools simultaneously form the bellows in a single process in an machine developed by Witzenmann and constructed using our own machines. This method has been optimized and adjusted so that it can also be used to manufacture double and multi-ply bellows.
All the expansion joint bellows made by Witzenmann are based on cylinders with a longitudinal seam weld and without circumferential seam welds at the corrugation.

Other sufficiently formable materials, for which we have accumulated comprehensive know-how, can also be used to manufacture bellows in addition to the austenitic, stainless steel 1.4541 mentioned above, if the application so demands.

Welding engineering
Welding engineering is just as crucial to us as bellows forming. The above-mentioned longitudinal seam of the cylinder, which must survive the forming process without damage, is particularly important, together with the connection weld seam, which must join the bellows and the connection parts together pressure-tight.

The nature of the connection weld seams differs according to the expansion joint design, the dimensions and the combination of materials. It is essential for the connection seam to be designed so that the expansion joint remains absolutely leak tight throughout its long period operation.

The most suitable economic method should always be used to make weld seams; methods such as TIG, MIG, MAG and submerged-arc welding, which are automated to a large extent, are also employed. These methods have been well tried and tested, and are comprehensively backed up by welding procedures. Welding work is always performed by qualified welders on the basis of predefined parameters. We apply the same care to the other weld seams, e.g. at the anchoring of the hinged expansion joints, some of which are located in the force flow and are therefore required to be of a correspondingly high quality.

Testing and monitoring
Tests are carried out to back up the quality of our expansion joints, parallel to the manufacturing process and independently of the manufaturing personnel. The most important test steps and inspections which we perform in standard situations are described below.

Standard incoming inspections
Materials are subjected to an incoming inspection when they arrive at our factory; the scope of the inspection may differ according to the intended application.

Great importance is always attached at Witzenmann to the **the strip material**, which establishes whether or not stipulations laid down in our order specifications have been met:

- Certification
- Marking
- Material analysis
- Physical material values
- Dimensions/tolerances
- Surface quality

The strip material is then given an official inspection certificate according to EN 10204 - 3.1.

14 | MANUFACTURE AND TESTING

Manufacturing surveillance
The manufacturing process is constantly monitored by the company supervisory staff (foremen); in addition, the following random checks are performed by the quality department:

- Valid work instructions at workplace
- Current forming parameters for bellows manufacture
- Valid welding parameters for cylinder longitudinal seams and connection seams
- Correct welding fillers
- Preheating temperatures
- Dimensional tolerances of components and assemblies

If any special requirements which must be met, accompanying inspections may be perdormed by the quality department parallel to the manufacturing process.

Standard final inspections
The final inspections described below are performed for the finishes expansion joints before they are delivered; they can be considered to form part of the production process and do not entail any additional costs. They are documented internally. Certification of for these inspections can be provided at cost price, if this is agreed when the order is placed.

Leak tightness test
All expansion joints with welded and parts are tested for leaks. Different methods are used according to the construction type, size and application of the expansion joint.

- Nitrogen under water
  The expansion joint is clamped in a test tank between two sealing plates and filled with nitrogen, pressure 2-4 bar; the tank is then flooded with water. After a suitably defined hold time, it should not be possible to detect any bubble cavitation (leakage rate less than 10^{-4} mbar l/s).

- He sniffing method
  A gas mixture comprising nitrogen and helium is applied to the sealed, clamped expansion joint (pressure approx. 2 bar), and the expansion joint sniffed at all critical points with an He probe (leakage rate less than 10^{-5} mbar l/s).

Pressure test
Random samples of expansion joints in the same series are subjected to a pressure test in a test press. A stable inner pipe is clamped pressure tight during the pressure test to reduce the axial forces in conjunction with large diameters and high pressures. (If the available, standard testing facilities are inadequate due to extremely high reaction forces, we recommend performing the pressure test for the expansion joint together with that for the plant).

The expansion joint must not have any leaks or any formings which could give rise to doubts regarding safety.

Dimensional inspection
This checks the dimensional tolerances, in particular with regard to the installation and connection dimensions.

Visual inspection
This checks for visible defects or damage, especially to the corrugations of the bellows.

Tests and inspections, including the associated documentation, over and above the scope of those described here are possible; the necessary facilities are available; the scope of the tests should always be the subject of very careful thought and restricted to the necessary minimum for the particular application, since the costs of such tests may be extremely high and may easily exceed the value of the expansion joint.

Marking

Our **expansion joints** are normally given a permanent identification plate made of stainless steel, which contains the following information as a minimum:

- HYDRA. Witzenmann GmbH; D-75175 Pforzheim
- year / fab. no / pos
- type, PN, DN, movement
- length
- const. year

Expansion joints without connection parts (compensation bellows) are given a sticker or tag instead of an identification plate, or inscribed with a felt-tip pen.

Flanges and weld ends are marked separartly, the data being embossed.
Flanges: DN/PN/material/manufacturer's identification mark
Weld ends: DN/material/manufacturer's identification mark

Expansion joints in the low-pressure series do not normally have an identification plate, and their flanges and weld ends are not marked. In the case of expansion joints requiring acceptance, the parts used and the expansion joints are marked (identification plates) as agreed in the specification. The **pretensioners** and the **transportation safety guards**, which must be removed after the expansion joint has been installed, have a red marking (indicated by additional stickers in a contrasting colour).

Corrosion protection

Standard designs
The bellows of our expansion joints, with the exception of a few special designs, are made exclusively of stainless steels and do not normally require any type of corrosion protection; the same applies to connection parts made of stainless steel.
The ferrite steel sections of the expansion joints, such as flanges and anchoring (not weld ends) are protected externally with a rust primer for transportation and short-term storage on the building site. Weld ends are either likewise painted or spray-oiled, depending on the construction type of the expansion joint. If they are painted, the welded area is masked. All ferrite steel sections are oiled from the inside where possible.

Special designs
The corrosion protection of the steel sections can be extended by agreement for special applications, or if requested by the customer; either a special paint, a plastic coating or galvanization may be used.

Packaging

Standard packaging
Unless otherwise agreed, the expansion joints are supplied with shock proof packaging in a box, in a box on a pallet or clamped loose on a pallet, depending on their size and weight.
Only hinged expansion joints, whose bellows require protection, are normally clamped loose on pallets. The bellows protection, comprising corrugated cardboard and sheet metal, prevents damage from minor shocks and weld splatters. Large expansion joints are not packed.

Transportation safety guards
Transportation safety guards are fitted in cases where they are necessitated by heavy connection parts; they maintain the size and form of the expansion joints during transportation and prevent them from vibrating.
If metal parts must be welded or screwed on for this purpose, they are identified by red paint (this indicates that they must be removed after installation).

Special packaging
can be provided by agreement either by Witzenmann or by specialised subcontractors.

1. Operating instructions
HYDRA expansion joints require no maintenance. They are designed exclusively for the agreed conditions specified in the order. However, long-term reliable operation is only guaranteed when they are properly specified and installed in systems and when they can operate without being damaged or hindered.

2. Installation instructions
2.1 General

- Before installation, check the expansion joint for any damage
- Do not damage the bellows, do not subject it to any shocks or impacts, do not drop it
- Do not place chains or ropes around the bellows
- Protect the bellows against welding spatter – cover with non-conductive material
- Please note that electrical short-circuits caused by welding electrodes, earthing cables, etc. can ruin the bellows
- Keep the corrugations of the bellows inside and outside free from foreign matter (dirt, cement, insulating material) – check prior to and during installation
- Fit a sheet metal cover around the bellows before attaching any mineral wool insulation
- Do not use any insulating material containing corrosive substances
- Avoid torsion stresses (twisting) at all costs, both during installation and operation (see Fig. 16.1)

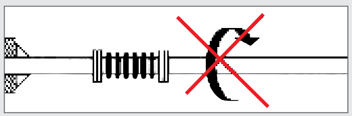


Fig. 16.1 Axial thrust in a pipe with an axial expansion joint

- Remove the clamping yoke and transport retaining fittings after installation – not before
- Make sure that the fixed points at the ends of the section of pipe containing an expansion joint are of adequate capacity. These must be able to resist the axial thrust, which can be very large, and also the adjusting force of the expansion joint, plus the friction forces of the pipe supports (see Fig. 16.2)

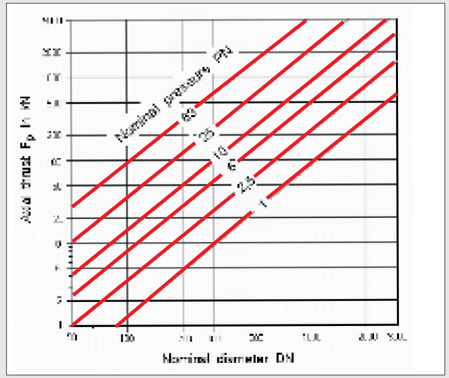


Fig. 16.2 Axial thrust in a pipe with an axial expansion joint

- Pretension axial expansion joints after installation (except versions supplied already pretensioned) – normally 50% of the movement to be accommodated – and in doing so take into account the direction of movement and the temperature during installation
- Secure fixed points and guides before pressurising the line
- Never exceed the permissible test pressure

2.2 Installation instructions for axial and universal expansion joints

- Specify only one axial expansion joint between two fixed points
- If several axial expansion joints are installed in a straight section of pipe, subdivide the pipe by means of (light) intermediate fixed points

- Pipes with axial expansion joints must be guided; guides are required on both sides of an axial expansion joint (a fixed point fulfils the guiding function) (see Figs 16.3 and 16.4 for spacings)

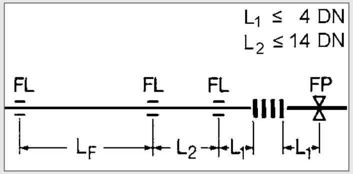


Fig. 16.3 Spacing of guides in pipes with axial expansion joints

- The incoming ends of the pipes must be aligned at the position where the expansion joint is to be installed

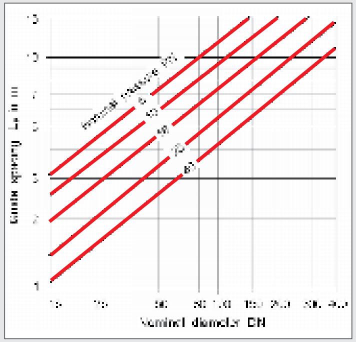


Fig. 16.4 Recommended spacings for pipe guides with axial expansion joints in the lines

2.3 Installation instructions for anchored expansion joints

- Provide suitable pipe guides or hangers in the vicinity of the expansion joint system and take account of lateral movements in the pipes
- Ensure the correct position of the axes of rotation during installation: parallel to each other and perpendicular to the direction of movement
- When installing lateral expansion joints make sure that the tie rods are positioned such that they can function properly

Appendix A

Content

Appendix A – Materials

Designations, available types, temperature limits

Material group	Material no. to DIN EN 10 027	Short name to DIN EN 10 027	Short name to DIN (old)	Semi-finished product	Documentation	Documentati-on old	Upper temp. limit °C
Unalloyed steel	1.0254	P235TR1	St 37.0	Welded tube Seamless tube	DIN EN 10217-1 DIN EN 10216-1	DIN 1626 DIN 1629	300
	1.0255	P235TR2	St 37.4	Welded tube Seamless tube	DIN EN 10217-1 DIN EN 10216-1		
	1.0427	C22G1	C 22.3	Flanges	VdTÜV-W 364		350
Common structural steel	1.0038	S235JRG2	RSt 37-2	Steel bar, flat	DIN EN 10025		300
	1.0050	E295	St 50-2	products, wire rod,			
	1.0570	S355J2G3	St 52-3	profiles	AD W1		
Heat resistant unalloyed steel	1.0460	C22G2	C 22.8	Flanges	VdTÜV W 350		450
Heat resistant steel	1.0345	P235GH	HI	Sheet	DIN EN 10028	DIN 17155	480
				Seamless tube	DIN EN 10216		450
	1.0425	P265GH	HII	Sheet	DIN EN 10028	DIN 17155	480
	1.0481	P295GH	17 Mn 4	Sheet Seamless tube	DIN EN 10028 DIN 17175	DIN 17155	500
	1.5415	16Mo3	15 Mo 3	Sheet Seamless tube	DIN EN 10028 DIN 17175	DIN 17155	530
	1.7335	13CrMo4-5	13 CrMo 4 4	Sheet Seamless tube	DIN EN 10028 DIN 17175	DIN 17155	570
	1.7380	10CrMo9-10	10 CrMo 9 10	Sheet Seamless tube	DIN EN 10028 DIN 17175	DIN 17155	600
	1.0305	P235G1TH	St 35.8	Seamless tube	DIN 17175		480
Fine-grained structural steel Standard	1.0562	P355N	StE 355	Sheet	DIN EN 10028	DIN 17102	
heat resist.	1.0565	P355NH	WStE 355	Strip			400
cold resist.	1.0566	P355NL1	TStE 355	Steel bar			(-50) [1]
special	1.1106	P355NL2	EStE 355				(-60) [1]

1) Cold resistant limit

Strength values at room temperature (RT) (guaranteed values [1)])

Material no. to DIN EN 10 027	Yield point min. R_{eH} N/mm²	Tensile strength R_m N/mm²	Breaking elongation, min.		Notched bar impact strength min. A_V (KV [2)]) J	Remarks
			A_5 %	A_{80} %		
1.0254	235	360-500	23			s ≤ 16
1.0255	235	360-500	23		at 0 °C: 27	s ≤ 16
1.0427	240	410-540	20 (transverse)		at RT: 31	s ≤ 70
1.0038	235	340-470	21-26 [1)]	17-21 [3)]	at RT: 27	3 ≤ s ≤ 100 (R_m)
1.0050	295	470-610	16-20 [1)]	12-16 [3)]		10 ≤ s ≤ 150 (KV)
1.0570	355	490-630	18-22 [1)]	14-18 [3)]	at -20 °C: 27	s < 16 (R_{eH})
1.0460	240	410-540	20		at RT: 31	s ≤ 70
1.0345	235	360-480	25		at 0 °C: 27	s ≤ 16
	235	360-500	23		at 0 °C: 27	s ≤ 16
1.0425	265	410-530	23		at 0 °C: 27	s ≤ 16
1.0481	295 270	460-580	22		at 0 °C: 27	s ≤ 16
1.5415	275 270	440-590	24		at RT: 31	s ≤ 16
1.7335	300 290	440-600	20		at RT: 31	s ≤ 16
1.7380	310 280	480-630	18		at RT: 31	s ≤16
1.0305	235	360-480	23		at RT: 34	s ≤ 16
1.0562	355	490-630	22		at 0 °C: 47	s ≤ 16
1.0565					at 0 °C: 47	s ≤ 16
1.0566					at 0 °C: 55	s ≤ 16
1.1106					at 0 °C: 90	s ≤ 16

1) Smallest value of longitudinal or transverse test
2) New designation to DIN EN 10045; average of 3 specimens in DIN EN standards
3) Dependent on product thickness

Designations, available types, temperature limits

Material group	Material no. to DIN EN 10 027	Short name to DIN EN 10 027	Semi-finished product	Documentation	Documentation old	Upper temp. limit °C
Stainless ferritic steel	1.4511	X3CrNb17	Strip	DIN EN 10088 VdTÜV-W422	DIN 17441 2)	200 nach VdTÜV
	1.4512	X2CrTi12	Strip	DIN EN 10088 SEW 400		350
Stainless austenitic steel	1.4301	X5CrNi18-10	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 300 1)
	1.4306	X2CrNi19-11	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 350 1)
	1.4541	X6CrNiTi18-10	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 400 1)
	1.4571	X6CrNiMoTi17-12-2	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 400 1)
	1.4404	X2CrNiMo17-12-2	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 400 1)
	1.4435	X2CrNiMo18-14-3	Strip Strip Sheet	DIN EN 10088	DIN 17441/97 DIN 17440/96	550 / 400 1)
	1.4565	X2CrNiMnMoNbN25-18-5-4	Strip, Strip Sheet	SEW 400 / 97	SEW 400 / 91	550 / 400 1)
	1.4539	X1NiCrMoCu25-20-5	Strip Sheet, Strip Seamless tube	DIN EN 10088 VdTÜV-W421		550 / 400 1) 400
	1.4529	X1NiCrMoCuN25-20-7	Strip Sheet, Strip Seamless tube	DIN EN 10088 VdTÜV-W 502		400
Austenitic steel of high heat resistance	1.4948	X6CrNi18-10	Strip Sheet strip Forgin Seamless tube	DIN EN 10028-7 DIN EN 10222-5 DIN 17459	DIN 17460 DIN 17460	600 600 600
	1.4919	X6CrNiMo17-13	Sheet, strip, bar Forging Seamless tube	DIN 17460 DIN 17459		600 600
	1.4958	X5NiCrAlTi31-20	Sheet, strip, bar Forging Seamless tube	DIN 17460 DIN 17459		600 600

1) Temperature limit where risk of intercrystalline corrosion
2) Earlier standard DIN 17441 7/85

Strength values at room temperature (RT) (guaranteed values 3))

Material no. to DIN EN 10 027		Yield points min. $R_{p0,2}$ N/mm²	$R_{p1,0}$ N/mm²	Tensile strength R_m N/mm²	Breaking elongation, min. > 3 mm Thickness A_5 %	< 3 mm Thickness A_{80} %	Notched bar impact strength > 10 mm thickness, transverse min. KV in J	Remarks
1.4511		230		420-600		23		s ≤ 6
1.4512		210		380-560		25		s ≤ 6
1.4301	q	230	260	540-750	45	45	at RT: 60	s ≤ 6
	l	215	245		43	40		
1.4306	q	220	250	520-670	45	45	at RT: 60	s ≤ 6
	l	205	235		43	40		
1.4541	q	220	250	520-720	40	40	at RT: 60	s ≤ 6
	l	205	235		38	35		
1.4571	q	240	270	540-690	40	40	at RT: 60	s ≤ 6
	l	225	255		38	35		
1.4404	q	240	270	530-680	40	40	at RT: 60	s ≤ 6
	l	225	255		38	35		
1.4435	q	240	270	550-700	40	40	at RT: 60	s ≤ 6
	l	225	255		38	35		
1.4565	q	420	460	800-1000	30	25	at RT: 55	s ≤ 30
1.4539	q	240	270	530-730	35	35	at RT: 60	s ≤ 6
	l	225	255		33	30		
		220	250	520-720	40	40		
1.4529	q	300	340	650-850	40	40	at RT: 60	
	l	285	325		38	35		s ≤ 75
		300	340	600-800	40	40	at RT: 84	
1.4948	q	230	260	530-740	45	45	at RT: 60	s ≤ 6
	q	195	230	490-690	35		at RT: 60	s ≤ 250
	q	185	225	500-700	30		at RT: 60	
1.4919		205	245	490-690	35	30	at RT: 60	
		205	245	490-690	30		at RT: 60	
1.4958		170	200	500-750	35	30	at RT: 80	
		170	200	500-750	35		at RT: 80	s ≤ 50

3) Smallest value of longitudinal or transverse test, q = tensile test, transverse, l = tensile test, longitudinal

Designations, available types, temperature limits

Material group	Material no. to DIN EN 10 027 [1]	Short name to DIN EN 10 027	Trade name	Semi-finished product	Documentation	Upper temp. limit °C
Heat resistant steel	1.4828	X15CrNiSi20-12		Strip Sheet, Strip,	DIN EN 10095	900
					(SEW470)	
	1.4876	X10NiCrAlTi32-21	INCOLOY 800	Strip Sheet, Strip	SEW470	
				all	VdTÜV-W412	600
		X10NiCrAlTi32-21 H	INCOLOY 800 H	Strip Sheet, Strip	VdTÜV-W434	950
				all	DIN EN 10095	900
Nickel-based alloys	2.4858	NICr21Mo	INCOLOY 825	all	DIN 17750/02	
				Strip Sheet, Strip	VdTüV-W432	450
					DIN 17744 [2]	
	2.4816	NiCR15Fe	INCONEL 600		DIN EN 10095	1000
				Strip Sheet, Strip	DIN 17750/02	
			INCONEL 600 H		VdTÜV-W305	450
					DIN 17742 [2]	
	2.4819	NiMo16Cr15W	HASTELLOY C-276	Strip Sheet, Strip	DIN 17750/02	
					VdTÜV-W400	450
					DIN 17744 [2]	
	2.4856	NiCr22Mo9Nb	INCONEL 625	Flat products	DIN EN 10095	900
				Strip Sheet, Strip	DIN 17750/02	450
			INCONEL 625 H		(VdTÜV-W499)	
					DIN 17744 [2]	
	2.4610	NiMo16Cr16Ti		Strip Sheet, Strip	DIN 17750/02	
			HASTELLOY-C4	Strip Sheet, Strip	VdTÜV-W424	400
					DIN 17744 [2]	
	2.4360	NiCu30Fe	MONEL	Strip, Strip Sheet	DIN 17750/02	
					VdTÜV-W 263	425
				Seamless tube		
				Forging	DIN 17743 [2]	

1) In the case of nickel-based alloys, DIN 17007 governs the material number
2) Chemical composition

Strength values at room temperature (RT) (guaranteed values [3])

Material no. to DIN EN 10 027 [1]	Yield points min. $R_{p0,2}$ N/mm²	$R_{p1,0}$ N/mm²	Tensile strength R_m N/mm²	Breaking elongation, min. A_5 %	A_{80} %	Notched bar impact strength min. KV J	Remarks
1.4828	230	270	500-750				s ≤ 3 mm solution annealed
1.4876	170	210	450-680	22			Soft annealed
INCOLOY 800	210	240	500-750	30		at RT: 150 [4]	
(1.4876 H)	170	200	450 -700	30			solution annealed (AT)
INCOLOY 800H	170	210	450-680		28		
2.4858	240	270	≥ 550	30			Soft annealed
INCOLOY 825	235	265	550-750			at RT: 80	s ≤ 30 mm
2.4816	240		500-850				Annealed (+A)
	180	210	≥ 550		28		solution annealed (F50)
INCONEL 600	200	230	550-750	30		at RT: 150 [4]	Soft annealed
INCONEL 600 H	180	210	500-700	35	30	at RT: 150 [4]	solution annealed
2.4819	310	330	≥ 690	30			s ≤ 5 mm, solution anne-
HASTELLOY C-276	310	330	730-1000	30	30	at RT: 96	aled (F69)
					30		
2.4856	415		820-1050				s ≤ 3 mm, Annealed (+A)
INCONEL 625 H	275	305	≥ 690			at RT: 100	solution annealed (F69)
INCONEL 625	400	440	830-1000	30			s ≤ 3 mm; Soft annealed
2.4610	305	340	≥ 690	40		at RT: 96	s ≤ 5, solution annealed
HASTELLOY-C4	280	315	700-900	40	30	at RT: 96	5 < s ≤ 30
					30		
2.4360	175	205	≥ 450	30			s ≤ 50, Soft annealed
MONEL	175		450-600	30		at RT: 120	Soft annealed

3) Smallest value of longitudinal or transverse test
4) Value a_k in J/cm²

Designations, available types, temperature limits

Material group	Material designation DIN EN 1652 (new) Number	Short name	DIN 17670 (old Number	Short name	Semi-finished product	Documentation	Documentation old	Upper temp. limit °C
Copper-based alloy	CW354H	CuNi30Mn1Fe	2.0882	CuNi30Mn1Fe CUNIFER 30 [1]	Strip, Strip Sheet	DIN-EN 1652 AD-W 6/2	DIN 17664 DIN 17670	350
Copper	CW024A	Cu-DHP	2.0090	SF-Cu	Strip, Strip Sheet	DIN-EN 1652 AD-W 6/2	DIN 1787 DIN 17670	250
Copper-tin alloy	CW452K	CuSn6	2.1020	CuSn6 Bronze	Strip, Strip Sheet	DIN-EN 1652	DIN 17662 DIN 17670	
Copper-zinc alloy	CW503L	CuZn20	2.0250	CuZn 20	Strip, Strip Sheet	DIN-EN 1652	DIN 17660 DIN 17670	
	CW508L	CuZn37	2.0321	CuZn 37 Brass	Strip, Strip Sheet	DIN-EN 1652	DIN 17660 DIN 17670	
			2.0402	CuZn40Pb2	Strip, Strip Sheet	DIN 17670 DIN 17660		
	DIN EN 485-2 (new) Number	Short Name	DIN 1745-1 (old) Number	Short Name	Semi-finished product	Documentation	Documentation old	Upper temp. limit °C
Wrought aluminium alloy	EN AW-5754	EN AW-Al Mg3	3.3535	AlMg 3	Strip, Strip Sheet	DIN EN 485-2 DIN EN 575-3 AD-W 6/1	DIN 1745 DIN 1725	150 (AD-W)
	EN AW-6082	EN AW-AlSi1MgMn	3.2315	AlMgSi 1	Strip, Strip Sheet	DIN-EN 485-2 DIN-EN 573-3	DIN 1745 DIN 1725	
Pure nickel	2.4068	LC-Ni 99		LC-Ni 99	Strip, Strip	VdTÜV-W 345		600
Titanium	3.7025	Ti 1		Ti 1	Sheet Strip, Strip Sheet	DIN 17 850 DIN 17 860 VdTÜV-W 230		250
Tantalum		Ta		Ta	Strip, Strip Sheet	VdTÜV-W382		250

1) Trade name

Strength values at room temperature (RT) (guaranteed values [2])

Material no.	Yield points min. $R_{p0,2}$ N/mm²	$R_{p1,0}$ N/mm²	Tensile strength R_m N/mm²	Breaking elongation, min. A_5 %	Notched bar impact strength min. KV J	Remarks
CW354H 2.0882	≥ 120		350-420	35 [6]		R350 (F35) [4] 0.3 ≤ s ≤ 15
CW024A 2.0090	≤ 100 ≤ 140		200-250 220-260	42 [6] 33 [7] / 42 [6]		R200 (F20) [4] s > 5 mm R220 (F22) [4] 0.2 ≤ s ≤ 5 mm
CW452K 2.1020	≤ 300		350-420	45 [7] 55 [6]		R350 (F35) [4] 0.1 ≤ s ≤ 5 mm
CW503L 2.0250	≤ 150		270-320	38 [7] 48 [6]		R270 (F27) [4] 0.2 ≤ s ≤ 5 mm
CW508L 2.0321	≤ 180		300-370	38 [7] 48 [6]		R300 (F30) [4] 0.2 ≤ s ≤ 5 mm
2.0402	≤ 300		≥ 380	35		(F38) [5] 0.3 ≤ s ≤ 5 mm
Material no.	Yield points min. $R_{p0,2}$ N/mm²	$R_{p1,0}$ N/mm²	Tensile strength Rm N/mm²	Breaking elongation, min. A_5 %	Notched bar impact strength-min. KV J	Remarks
EN AW-5754 3.3535	≥ 80		190-240	14 (A50)		0.5 < s ≤ 1.5 mm State: 0 / H111 DIN EN-values
EN AW-6082 3.2315	≤ 85		≤ 150	14 (A50)		0.4 ≤ s ≤ 1.5 mm State: 0 ; DIN EN values
2.4068	≥ 80	≥ 105	340-540	40		
3.7025	≥ 180	≥ 200	290-410	30 / 24 [8]	62	0.4 < s ≤ 8 mm
TANTAL - ES	≥ 140		≥ 225	35 [3]		0.1 ≤ s ≤ 5.0 Electron beam melted Sintered in vacuum
TANTAL - GS	≥ 200		≥ 280	30 [3]		

2) Smallest value of longitudinal or transverse test
3) Measured length lo = 25 mm
4) State designation to DIN EN 1652 or (--) to DIN
5) To DIN, material not contained in the DIN EN
6) Specification in DIN EN for s > 2.5 mm
7) Breaking elongation A50, specification in DIN EN for s ≤ 2.5 mm
8) A50 for thicknesses ≤ 5 mm

Appendix A

Chemical composition
(percentage by mass)

Material group	Material no.	Short name	C[1]	Si max.	Mn	P max.	S max.	Cr	Mo	Ni	Other elements
Unalloyed steel	1.0254	P235TR1	≤ 0.16	0.35	≤ 1.20	0.025	0.020	≤ 0.30	≤ 0.08	≤ 0.30	Cu ≤ 0.30 Cr+Cu+Mo+Ni ≤ 0.70
	1.0255	P235TR2	≤ 0.16	0.35	≤ 1.20	0.025	0.020	≤ 0.30	≤ 0.08	≤ 0.30	Cu ≤ 0.30 Cr+Cu+Mo+Ni ≤ 0.70 Al_{ges} ≥ 0.02
	1.0427	C22G1	0.18 - 0.23	0.15 - 0.35	0.4 - 0.9	0.035	0.03	≤ 0.30			Al_{ges} ≥ 0.015
Common structural steel	1.0038	S235JRG2	≤ 0.17		≤ 1.40	0.045	0.045				N ≤ 0.009
	1.0050	E295				0.045	0.045				N ≤ 0.009
	1.0570	S355J2G3	≤ 0.20	0.55	1.6	0.035	0.035				Al_{ges} ≥ 0.015
Heat resist. unalloyed steel	1.0460	C22G2	0.18 - 0.23	0.15 - 0.35	0.40 - 0.90	0.035	0.030	≤ 0.30			
Heat resistant steel	1.0345	P235GH	≤ 0.16	0.35	0.4 - 1.20	0.03	0.025	≤ 0.30	≤ 0.08	≤ 0.30	Nb,Ti,V Al_{ges} ≥ 0.020 Cu ≤ 0.30 Cr+Cu+Mo+Ni ≤ 0.70
	1.0425	P265GH	≤ 0.20	0.4	0.50	0.03	0.025	≤ 0.30	≤ 0.08	≤ 0.30	
	1.0481	P295GH	0.08 - 0.20	0.40	0.9 - 1.50	0.03	0.025	≤ 0.30	≤ 0.08	≤ 0.30	
	1.5415	16Mo3	0.12 - 0.20	0.35	0.4 - 0.90	0.03	0.025	≤ 0.30	0.25 - 0.35	≤ 0.30	Cu ≤ 0.3
	1.7335	13CrMo4-5	0.08 - 0.18	0.35	0.4 - 1.00	0.030	0.025	0.7 - 1.15	0.4 - 0.6		Cu ≤ 0.3
	1.7380	10 CrMo9-10	0.08 - 0.14	0.5	0.4 - 0.80	0.03	0.025	2 - 2.50	0.9 - 1.10		Cu ≤ 0.3
	1.0305	P235G1TH	≤ 0.17	0.1 - 0.35	0.4 - 0.80	0.040	0.040				

1) Carbon content dependent on thickness. Values are for a thickness of ≤ 16mm.

Appendix A

Chemical composition
(percentage by mass)

Material group	Material no.	Short name	C max.	Si max.	Mn	P max.	S max.	Cr	Mo	Ni	Other elements
Fine-grained structural steel	1.0562	P355N	0.2	0.50	0.9 - 1.70	0.03	0.025	≤ 0.3	≤ 0.8	≤ 0.5	Al_{ges} ≥ 0.020 (s. DIN EN 10028-3) Cu, N, Nb, Ti, V Nb + Ti + V ≤ 0.12
	1.0565	P355NH	0.2	0.50	0.9 - 1.70	0.03	0.025	≤ 0.3	≤ 0.8	≤ 0.5	
	1.0566	P355NL1	0.18	0.50	0.90 - 1.70	0.030	0.020	≤ 0.3	≤ 0.8	≤ 0.5	
	1.1106	P355NL2	0.18	0.50	0.9 - 1.70	0.025	0.015	≤ 0.3	≤ 0.8	≤ 0.5	
Stainless ferritic steel	1.4511	X3CrNb17	0.05	1.00	≤ 1.0	0.040	0.015	16.0 - 18.0			Nb: 12 x % C -1,00
	1.4512	X2CrTi12	0.03	1.00	≤ 1.0	0.04	0.015	10.5 - 12.5			Ti: 6 x (C+N) - 0.65
Stainless austenitic steel	1.4301	X5CrNi18-10	0.07	1.00	≤ 2.0	0.045	0.015	17.0 - 19.5		8.00 - 10.50	
	1.4306	X2CrNi19-11	0.03	1.00	≤ 2.0	0.045	0.015	18.0 - 20.0		10.0 - 12.0	
	1.4541	X6CrNiTi18-10	0.08	1.00	≤ 2.0	0.045	0.015	17.0 - 19.0		9.0 - 12.0	Ti: 5 x % C - 0.7
	1.4571	X6CrNiMoTi 17 12 2	0.08	1.00	≤ 2.0	0.045	0.015	16.5 - 18.5	2- 2.5	10.5 - 13.5	Ti: 5 x % C - 0.7
	1.4404	X2CrNiMo 17 12 2	0.03	1.00	≤ 2.0	0.045	0.015	16.5 - 18.5	2.0 - 2.5	10.0 - 13.0	N ≤ 0.11
	1.4435	X2CrNiMo 18 14 3	0.03	1.00	≤ 2.0	0.045	0.015	17.0 - -9.0	2.5 - 3.0	12.5 - 15.0	
	1.4565	X2CrNiMuMo NbN2518-5-4	0.04	1.00	4.50 - 6.5	0.030	0.015	21.0 - 25.0	3.0 - 4.5	15.0 - 18.0	Nb ≤ 0.30, N: 0.04 - 0.15
	1.4539	X1NiCrMoCu 25-20-5	0.02	0.70	≤ 2.0	0.030	0.010	19.00 - 21	4.0 - 5.0	24.0 - 26.0	Cu, N: ≤ 0.15
	1.4529	X2NiCrMoCuN 25-20-7	0.02	0.50	≤1.0	0.03	0.01	19.0 - 21.0	6.0 - 7.0	24 - 26	Cu: 0.5 - 1 N: 0.15 - 0.25

Material group	Material no.	Short name Trade name	C	Si	Mn	P max.	S max.	Cr	Mo	Ni	Other elements
Austenitic steel of high heat resistance	1.4948	X6CrNi18-10	0.04 - 0.08	≤ 1.00	≤ 2.0	0.035	0.015	17.0 - 19.0		8.0 - 11.0	
	1.4919	X6CrNiMo 17-13	0.04 - 0.08	≤ 0.75	≤ 2.0	0.035	0.015	16.0 - 18.0	2.0 - 2.5	12.0 - 14.0	
Heat resistant steel	1.4828	X15CrNiSi 20-12	≤ 0.2	1.50 - 2.00	≤ 2.0	0.045	0.015	19.0 - 21.0		11.0 - 13.0	N: max 0.11
	1.4876 (DIN EN 10095)	X10NiCrAlTi32-21 INCOLOY 800H	≤ 0.12	≤ 1.0	≤ 2.0	0.030	0.015	19.0 - 23.0		30.0 - 34.0	Al: 0.15 - 0.60 Ti: 0.15 - 0.60
Nickel-based alloy	2.4858	NiCr21Mo INCOLOY 825	≤ 0.025	≤ 0.5	≤ 1.0	0.02	0.015	19.5 - 23.5	2.5 - 3.5	38.0 - 46.0	Ti, Cu, Al, Co ≤ 1.0
	2.4816	NiCr15Fe INCONEL 600 INCONEL 600 H	0.05 - 0.1	≤ 0.5	≤ 1.0	0.02	0.015	14.0 - 17.0		> 72	Ti, Cu, Al
	2.4819	NiMo16Cr15W HASTELLOY C-276	≤ 0.01	0.08	≤ 1.0	0.02	0.015	14.5 - 16.5	15 - 17	Re-mainder	V, Co, Cu, Fe
	2.4856	NiCr22Mo9Nb INCONEL 625 INCONEL 625 H	0.03 - 0.1	≤ 0.5	≤ 0.5	0.02	0.015	20.0 - 23.0	8.0 - 10.0	> 58	Ti, Cu, Al Nb/Ta: 3.15 - 4.15 Co ≤ 1,0
	2.4610	NiMo16Cr16Ti HASTELLOY C4	≤ 0.015	≤ 0.08	≤ 1.0	0.025	0.015	14.0 - 18.0	14.0 - 17.0	Re-mainder	Ti, Cu, Co ≤ 2,0
	2.4360	NiCu30Fe MONEL	≤ 0.15	≤ 0.5	≤ 2.0		0.02			> 63	Cu: 28 - 34% Ti, Al, Co ≤ 1.0
Copper-based alloy	2.0882	CuNi 30 Mn1 Fe CUNIFER 30	≤ 0.05		0.5 - 1.50		0.050			30.0 - 32.0	Cu: Remainder, Pb, Zn

Appendix A

Chemical composition
(percentage by mass)

HYDRA

Material group	Material no.	Short name	Cu	Al	Zn	Sn	Pb	Ni	Ti	Ta	Other elements
Copper	CW024A (2.0090)	Cu DHP (SF-Cu)	≥ 99.9								P: 0.015 - 0.04
Copper-tin alloy	CW452K (2.1020)	CuSn 6 Bronze	Re-mainder		≤ 0.2	5.5 - 7.0	≤ 0.2	≤ 0.2			P: 0.01 - 0.4 Fe: ≤ 0.1
Copper-zinc alloy	CW503L 2.0250	CuZn 20	79.0 - 81.0	≤ 0.02	Re-mainder	≤ 0.1	≤ 0.05				
	CW508L (2.0321)	CuZn 37 Brass	62.0 - 64.0	≤ 0.05	Re-mainder	≤ 0.1	≤ 0.1	≤ 0.3			
	2.0402	CuZn 40 Pb 2	57.0 - 59.0	≤ 0.1	Re-mainder	≤ 0.3	1.5 - 2.5	≤ 0.4			
Wrought aluminium alloy	EN AW-5754 (3.3535)	EN AW-Al Mg3	≤ 0.1	Re-mainder	≤ 0.1				≤ 0.15		Si, Mn, Mg
	EN AW-6082 (3.2315)	EN AW-Al Si1MgMn	≤ 0.1	Re-mainder	≤ 0.2				≤ 0.1		Si, Mn, Mg
Pure nickel	2.4068	LC-Ni 99	≤ 0.025					≥ 99	≤ 0.1		C ≤ 0.02 Mg ≤ 0.15 S ≤ 0.01 Si ≤ 0.2
Titanium	3.7025	Ti							Re-mainder		N ≤ 0.05 H ≤ 0.013 C ≤ 0.06 Fe ≤ 0.15
Tantalum	-	Ta						≤ 0.01	≤ 0.01	Rem.	

Material no. to DIN	Type of value	Material strength values in N/mm^2 – Temperatures in °C													
		RT[1)]	100	150	200	250	300	350	400	450	500	550	600	700	800
1.0254	$R_{p\,0,2}$	235													
1.0255	$R_{p\,0,2}$	235													
1.0427	$R_{p\,0,2}$	220	210	190	170	150	130	110							
1.0038	$R_{p\,0,2}$	205	187		161	143	122	(values to AD W1)							
1.0570	$R_{p\,0,2}$	315	254		226	206	186								
1.0460	$R_{p\,0,2}$	240	230	210	185	165	145	125	100	80					
	$R_{p\,1/10000}$								136	80	(53)	() = values at 480 °C			
	$R_{p\,1/100000}$								95	49	(30)				
	$R_{m\,10000}$								191	113	(75)				
	$R_{m\,100000}$								132	69	(42)				
1.0345	$R_{p\,0,2}$	206	190	180	170	150	130	120	110						
	$R_{p\,1/10000}$								136	80	(53)	() = values at 480 °C			
	$R_{p\,1/100000}$								95	49	(30)				
	$R_{m\,10000}$								191	113	(75)				
	$R_{m\,100000}$								132	69	(42)				
	$R_{m\,200000}$								115	57	(33)				
1.0425	$R_{p\,0,2}$	234	215	205	195	175	155	140	130						
	$R_{p\,1/10000}$								136	80	(53)	() = values at 480 °C			
	$R_{p\,1/100000}$								95	49	(30)				
	$R_{m\,10000}$								191	113	(75)				
	$R_{m\,100000}$								132	69	(42)				
	$R_{m\,200000}$								115	57	(33)				
1.0481	$R_{p\,0,2}$	272	250	235	225	205	185	170	155						
	$R_{p\,1/10000}$								167	93	49				
	$R_{p\,1/100000}$								118	59	29				
	$R_{m\,10000}$								243	143	74				
	$R_{m\,100000}$								179	85	41				
	$R_{m\,200000}$								157	70	30				
1.5415	$R_{p\,0,2}$	275			215	200	170	160	150	145	140				
	$R_{p\,1/10000}$									216	132	(84)			
	$R_{p\,1/100000}$									167	73	(36)	() = values at 530 °C		
	$R_{m\,10000}$									298	171	(102)			
	$R_{m\,100000}$									239	101	(53)			
	$R_{m\,200000}$									217	84	(45)			
1.7335	$R_{p\,0,2}$				230	220	205	190	180	170	165				
	$R_{p\,1/10000}$									245	157	(53)			
	$R_{p\,1/100000}$									191	98	(24)	() = values at 570 °C		
	$R_{m\,10000}$									370	239	(76)			
	$R_{m\,100000}$									285	137	(33)			
	$R_{m\,200000}$									260	115	(26)			

1) Room temperature values valid up to 50 °C

Appendix A HYDRA
Strength values at elevated temperatures

Material no. to DIN	Type of value	Material strength values in N/mm^2 – Temperatures in °C													
		RT[1)]	100	150	200	250	300	350	400	450	500	550	600	700	800
1.7380	$R_{p\,0,2}$				245	230	220	210	200	190	180				
	$R_{p\,1/10000}$									240	147	83	44		
	$R_{p\,1/100000}$									166	103	49	22		
	$R_{m\,10000}$									306	196	108	61		
	$R_{m\,100000}$									221	135	68	34		
	$R_{m\,200000}$									201	120	58	28		
1.0305	$R_{p\,0,2}$	235			185	165	140	120	110	105					
	$R_{p\,1/10000}$								136	80	(53)				
	$R_{p\,1/100000}$								95	49	(30)	() = values at 480 °C			
	$R_{m\,10000}$								191	113	(75)				
	$R_{m\,100000}$								132	69	(42)				
	$R_{m\,200000}$								115	57	(33)				
1.0565	$R_{p\,0,2}$	336	304	284	245	226	216	196	167						
1.4511	$R_{p\,0,2}$	230	230	220	205	190	180	165							
1.4512	$R_{p\,0,2}$	210	200	195	190	186	180	160							
1.4301	$R_{p\,0,2}$	215	157	142	127	118	110	104	98	95	92	90			
	$R_{p\,1}$		191	172	157	145	135	129	125	122	120	120			
	$R_{m\,10000}$							(approx. values to DIN 17441)					122	48	(17)
	$R_{m\,100000}$												74	23	(5)
1.4306	$R_{p\,0,2}$	205	147	132	118	108	100	94	89	85	81	80			
	$R_{p\,1}$		181	162	147	137	127	121	116	112	109	108			
1.4541	$R_{p\,0,2}$	205	176	167	157	147	136	130	125	121	119	118			
	$R_{p\,1}$		208	196	186	177	167	161	156	152	149	147			
	$R_{m\,10000}$							(approx. values to DIN 17441)					115	45	(17)
	$R_{m\,100000}$												65	22	(8)
1.4571	$R_{p\,0,2}$	225	185	177	167	157	145	140	135	131	129	127			
	$R_{p\,1}$		218	206	196	186	175	169	164	160	158	157			
1.4404	$R_{p\,0,2}$	225	166	152	137	127	118	113	108	103	100	98			
	$R_{p\,1}$		199	181	167	157	145	139	135	130	128	127			
1.4435	$R_{p\,0,2}$	225	165	150	137	127	119	113	108	103	100	98			
	$R_{p\,1}$		200	180	165	153	145	139	135	130	128	127			
1.4565	$R_{p\,0,2}$	420	350	310	270	255	240	225	210	210	210	200			
	$R_{p\,1}$	460	400	355	310	290	270	255	240	240	240	230			
1.4539	$R_{p\,0,2}$	220	205	190	175	160	145	135	125	115	110	105			
	$R_{p\,1}$		235	220	205	190	175	165	155	145	140	135			
	$R_{m\,(VdTÜV)}$	520	440	420	400	390	380	370	360						
1.4529	$R_{p\,0,2}$	300	230	210	190	180	170	165	160						
	$R_{p\,1}$	340	270	245	225	215	205	195	190						

1) Room temperature values valid up to 50 °C

Material no. to DIN	Type of value	Material strength values in N/mm²														
		Temperatures in °C														
		RT[1]	100	150	200	250	300	350	400	450	500	550	600	700	800	900
1.4948	$R_{p\,0,2}$	230	157	142	127	117	108	103	98	93	88	83	78			
	$R_{p\,1}$	260	191	172	157	147	137	132	127	122	118	113	108			
	R_m	530	440	410	390	385	375	375	375	370	360	330	300			
	$R_{p\,1/10000}$										147	121	94	35		
	$R_{p\,1/100000}$										114	96	74	22		
	$R_{m\,10000}$										250	191	132	55		
	$R_{m\,100000}$										192	140	89	28		
	$R_{m\,200000}$										176	125	78	22		
1.4919	$R_{p\,0,2}$	205	177		147		127		118		108	103	98			
	$R_{p\,1}$	245	211		177		157		147		137	132	128			
	$R_{p\,1/10000}$											180	125	46		
	$R_{p\,1/100000}$											125	85	25		
	$R_{m\,10000}$											250	175	65		
	$R_{m\,100000}$											175	120	34		
1.4828 DIN EN 10095	$R_{p\,0,2}$	230	332		318		300		279		253		218	(Manufacturer's figures)		
	R_m	550	653		632		600		550		489		421			
	$R_{p\,1/1000}$												120	50	20	8
	$R_{p\,1/10000}$												80	25	10	4
	$R_{m\,1000}$												190	75	35	15
	$R_{m\,10000}$												120	36	18	8.5
	$R_{m\,100000}$												65	16	7,5	3.0
1.4876 DIN EN 10095 Incoloy 800H	$R_{p\,0,2}$	170	185	170	160	150	145		130		125	120	115	(Manufacturer's figures)		
	$R_{p\,1}$	210	205	190	180	170	165		150		145	140	135			
	R_m	450	425		400		390		380		360		300			
	$R_{p\,1/1000}$												130	70	30	13
	$R_{p\,1/10000}$												90	40	15	5
	$R_{m\,1000}$												200	90	45	20
	$R_{m\,10000}$												152	68	30	10
	$R_{m\,100000}$												114	48	21	8
2.4858	$R_{p\,0,2}$	235	205	190	180	175	170	165	160	155						
	$R_{p\,1}$	265	235	220	205	200	195	190	185	180						
	R_m	550	530		515		500		490	485						
2.4816 DIN EN 10095	$R_{p\,0,2}$	200	180		165		155		150	145			(Soft annealed)			
	R_m	550 -750	520		500		485		480	475						
	$R_{p\,0,2}$	180	170		160		150		150	145			(solution annealed)			
	R_m	500 -700	480		460		445		440	435						
	$R_{p\,1/10000}$										153		91	43	18	8
	$R_{p\,1/100000}$										126		66	28	12	4
	$R_{m\,1000}$												160	96	38	22
	$R_{m\,10000}$										297		138	63	29	13
	$R_{m\,100000}$										215		97	42	17	7

1) Room temperature values valid up to 50 °C

Appendix A

HYDRA

Strength values at elevated temperatures

Material no. to DIN	Type of value	Material strength values in N/mm²														
		Temperatures in °C														
		RT	100	150	200	250	300	350	400	450	500	550	600	700	800	900
2.4819 VdTÜV-W 400	$R_{p0,2}$	310	280		240		220		195							
	R_{p1}	330	305		275		215		200							
2.4856 DIN EN 10095	$R_{p\,0,2}$	410	350		320		300		280		170					
	$R_{p\,1/100000}$					Manufacturer's figures for Inconel 625 H							250	90	30	10
	$R_{m\,100000}$												290	135	45	18
	$R_{m\,1000}$													260	107	34
	$R_{m\,10000}$													190	63	20
2.4610	$R_{p\,0,2}$	305	285		255		245		225					(S <= 5)		
	$R_{p\,1}$	340	315		285		270		260							
2.4360	$R_{p\,0,2}$	175	150	140	135	132	130	130	130	(130)	() = values at 425 °C					
	R_m	450	420	400	390	385	380	375	370	(360)						
	$R_{p\,1/10000}$				107	99	92	84								
	$R_{p\,1/100000}$				102	94	86	78								
	K/S	93	87	84	82	80	78	75								
CW354H 2.0882	$R_{p\,1}$	140	130	126	123	120	117	112								
	$R_{p\,1/10000}$				107	99	92	84								
	$R_{p\,1/100000}$				102	94	86	78	Permissible tension to AD-W 6/2 für 10^5 h							
	K/S		93	87	84	82	80	78	75							
CW024A 2.0090	$R_{p\,1}$	65	58	58												
	R_m	220	220	195	170	145										
	$R_{p\,2/10000}$		58	53	46	37										
	$R_{p\,2/100000}$		56	49	40	30										
	K/S	57	57	50	43	36	Permissible tension to AD-W 6/2 für 10^5 h								(F 20)	
	K/S	67	63	56	49	41									(F 22)	
3.3535 EN-AW 5754	$R_{p\,0,2}$	80	70		Permissible tension to AD-W6/1											
	$R_{m\,100000}$		(80)	45												
2.4068 Nickel	$R_{p\,0,2}$	80	70		65		60		55		50		40			
	$R_{p\,1}$	105	95		90		85		80		75		65			
	R_m	340	290		275		260		240		210		150			
	$R_{p\,1/10000}$								75	55	35	19	10			
	$R_{p\,1/100000}$							85	60	40	23	11	6			
3.7025 Titan	$R_{p\,1}$	200	180	150	110	90										
	$R_{m\,10000}$	220	160	150	130	110										
	$R_{m\,100000}$	200	145	130	120	90										
Tantal	$R_{p\,0,2}$	140	100	90	80	70							Electron beam melted			
	R_m	225	200	185	175	160	150									
	$A_{30[\%]}$	35														
	$R_{p\,0,2}$	200	160	150	140	130							Sintered in vacuum			
	R_m	280	270	260	240	230										
	$A_{30[\%]}$	25														

1) Room temperature values valid up to 50 °C

Material no. to DIN EN	USA Standard	USA UNS designation	USA Semi-finished product applications / title	JAPAN Standard	JAPAN Designation	JAPAN Semi-finished product applications
1.0254	ASTM A 53-01	K02504 A 53	Welded and seamless black-oxidized and galvanized steel tubes	JIS G 3445 (1988)	STKM 12 A	Tubes
	ASTM A 106-99	K02501 A 106	Seamless tubes of high-temperature unalloyed steel	JIS G 3454 (1988)	STPG 370	Pipes under pressure
				JIS G 3457 (1988)	STPY 400	Welded tubes
1.0255	ASTM A 135-01	K03013 A 135	Electric resistance welded tubes	JIS G 3455 (1988)	STS 370	Pipes subjected to high pressures
1.0038	ASTM A 500-01	K03000 A 500	Welded and seamless fittings of cold-formed unalloyed steel			
1.0050				JIS G 3101 (1995)	SS 490	General structural steels
1.0570	ASTM A 694-00	K03014 A 694	Forgings of unalloyed and alloyed steel for pipe flanges, fittings, valves and other parts for high-pressure drive systems	JIS G 3106 (1999)	SM 490 A	Steels for welded constructions
				JIS G 3106 (1999)	SM 520 B	
1.0345	ASTM A 414-01	K02201 A 414	Sheet of unalloyed steel for pressure tanks	JIS G 3115 (2000)	SPV 450	Heavy plate for pressure vessels
1.0425	ASTM A 414-01	K02505 A 414		JIS G 3118 (2000)	SGV 480	
1.0481	ASTM A 414-01	K02704 A 414		JIS G 3118 (2000)	SGV 410	
1.5415	ASTM A 204-99	K12320 A 204	Sheet of molybdenum alloyed steel for pressure tanks	JIS G 3458 (1988)	STPA 12	Tubes
1.7335	ASTM A 387-99	K11789 A 387	Sheet of Cr-Mo alloyed steel for pressure tanks	JIS G 3462 (1988)	STBA 22	Boiler and heat exchanger pipes
1.7380	ASTM A 387-99	K21590 22 (22L)		JIS G 4109 (1987)	SCMV 4	Heavy plate for pressure vessels
1.0305	ASTM A 106-99	K02501 A 106	Seamless tubes of high-temperature unalloyed steel	JIS G 3461 (1988)	STB 340	Boiler and heat exchanger pipes

Material no. to DIN EN	KOREA Standard	KOREA Designation	KOREA Semi-finished product applications	CHINA Standard	CHINA Designation	CHINA Semi-finished product applications
1.0254	KS D 3583 (1992)	SPW 400	Welded tubes of carbon steel			
1.0255						
1.0038				GBT 700 (1988)	Q 235 B; U12355	(unalloyed structural steels)
1.0050	KS D 3503 (1993)	SS 490	General structural steels	GBT 700 (1988)	Q 275; U12752	
1.0570	KS D 3517 (1995)	STKM 16C	Unalloyed steel tubes for general mechanical engineering	GBT 713 (1997)	16Mng; L20162	Plate for steam boilers
				GBT 8164 (1993)	16Mn; L20166	Strip for welded tubes
1.0345	KS D 3521 (1991)	SPPV 450	Heavy plate for pressure vessels for medium application temp.			
1.0425	KS D 3521 (1991)	SPPV 315				
1.0481						
1.5415	KS D 3572 (1990)	STHA 12	Tubes for boilers and heat exchangers	GB 5310 (1995)	15MoG; A65158	Seamless tubes for pressure vessels
1.7335	KS D 3572 (1990)	STHA 22		YBT 5132 (1993)	12CrMo; A30122	Plate of alloyed structural steels
1.7380	KS D 3543 (1991)	SCMV 4	Cr-Mo steel for pressure vessels	GB 5310 (1995)	12Cr2MoG; A30138	Seamless tubes for pressure vessels
1.0305						

Material no. to DIN EN	USA			JAPAN		
	Standard	UNS designation (AISI)	Semi-finished product applications / title	Standard	Designation	Semi-finished product applications
1.0562	ASTM A 299-01	K02803 A 299	Plate of C-Mn-Si steel for pressure tanks	JIS G 3106 (1999)	SM 490 A;B;C;	Steels for welded constructions
	ASTM A 714-99	K12609 A 714 (II)	Welded and seamless tubes of high-strength low-alloy steel	JIS G 3444 (1994)	STK 490	Steels for welded constructions
1.0565	ASTM A 633-01	K12037 A633(D)	Normalized high-strength low-alloy structural steel			
	ASTM A 724-99	K12037 A724(C)	Plate of tempered unal-loyed steel for welded pressure tanks of layered construction			
1.0566	ASTM A 573-00	K02701 A 573	Plate of unalloyed struc-tural steel with improved toughness	JIS G 3126 (2000)	SLA 365	Heavy plate for pressure vessels (low temperature)
1.1106	ASTM A 707-02	K12510 A 707 (L3)	Forged flanges of alloyed and unalloyed steel for use in low temperatures	JIS G 3444 (1994)	STK 490	Tubes for general use

Material no. to DIN EN	KOREA			CHINA		
	Standard	Designation	Semi-finished product applications / title	Standard	Designation	Semi-finished product applications
1.0562						
1.0565						
1.0566	KS D 3541 (1991)	SLA1 360	Heavy plate for pressure vessels (low temperature)	GBT 714 (2000)	Q420q-D; L14204	Steels for bridge construction
1.1106				GB 6654 (1996)	16MnR; L20163	Heavy plate for pressure vessels

Material no. to DIN EN	USA: Standard	USA: UNS designation (AISI)	USA: Semi-finished product applications / title	JAPAN: Standard	JAPAN: Designation	JAPAN: Semi-finished product applications
1.4511				JIS G 4305 (1999)	SUS 430LX	Cold-rolled sheet, heavy plate and strip
1.4512	ASTM A 240-02	S40900; A 240 (409)	Sheet and strip of heatproof stainless Cr and Cr-Ni steel for pressure tanks			
1.4301	ASTM A 240-02	S30400; A 240 (304)		JIS G 4305 (1999)	SUS 304	Cold-rolled sheet, heavy plate and strip
1.4306	ASTM A 240-02	S30403; A 240 (304L)		JIS G 4305 (1999)	SUS 304L	
1.4541	ASTM A 240-02	S32100 A 240 (321)		JIS G 4305 (1999)	SUS 321	
1.4571	ASTM A 240-02	S31635 A240 (316Ti)		JIS G 4305 (1999)	SUS 316Ti	
1.4404	ASTM A 240-02	S31603 A240 (316L)		JIS G 4305 (1999)	SUS 316L	
1.4435	ASTM A 240-02	S31603 A240 (316L)		JIS G 4305 (1999)	SUS 316L	
1.4565	ASTM A 240-02	S34565 A240				
1.4539	ASTM A 240-02	N08904 A240 (904L)				
1.4529	ASTM B 625-99	N08925 B 625	Sheet and strip of low-carbon Ni-Fe-Cr-Mo-Cu alloys			

Material no. to DIN EN	KOREA: Standard	KOREA: Designation	KOREA: Semi-finished product applications	CHINA: Standard	CHINA: Designation	CHINA: Semi-finished product applications
1.4511	KS D 3698 (1992)	STS 430LX	Cold-rolled sheet, heavy plate and strip			olled sheet, heavy plate and strip
1.4512				GBT 4238 (1992)	0Cr11Ti; S11168	Hot-rolled sheet of heatproof steel, ferritic
1.4301	KS D 3698 (1992)	STS 304	Cold-rolled sheet, heavy plate and strip	GBT 3280 (1992)	0Cr18Ni9; S30408	Cold-rolled sheet, heavy plate and strip
1.4306	KS D 3698 (1992)	STS 304L		GBT 3280 (1992)	00Cr19Ni10; S30403	
1.4541	KS D 3698 (1992)	STS 321		GBT 3280 (1992)	0Cr18Ni10Ti; S32168	
1.4571	KS D 3698 (1992)	STS 316Ti		GBT 3280 (1992)	0Cr18Ni12Mo2Cu2 S31688	
1.4404	KS D 3698 (1992)	STS 316L		GBT 4239 (1991)	00Cr17Ni14Mo2; S31603	
1.4435	KS D 3698 (1992)	STS 316L		GBT 3280 (1992)	00Cr17Ni14Mo2; S31603	
1.4565						
1.4539						
1.4529	KS D 3698 (1992)	STS 317J5L	Cold-rolled sheet, heavy plate and strip			

Material no. to DIN EN	USA Standard	USA UNS designation (AISI)	USA Semi-finished product applications / title	JAPAN Standard	JAPAN Designation	JAPAN Semi-finished product applications
1.4948	ASTM A 240-02	S30409 A240 (304H)	Sheet and strip of heatproof stainless Cr and Cr-Ni steel for pressure tanks			
1.4919	ASTM A 240-02	S31609 A240 (316H)				
1.4958	ASTM A 240-02	N 08810 A 240				
1.4828	ASTM A 167-99	S30900 A 167 (309)	Sheet and strip of stainless heatproof Cr-Ni steel	JIS G 4312 (1991)	SUH 309	Heatproof sheet and heavy plate
1.4876	ASTM A 240-02	N 08800 A 240	Sheet and strip of stainless heatproof Cr and Cr-Ni steel for pressure tanks	JIS G 4902 (1991)	NCF 800	Special alloy in sheet form
2.4858	ASTM B 424-98	N 08825 B 424	Sheet and strip of low-carbon Ni-Fe-Cr-Mo-Cu alloys (UNS N08825 and N08221)	JIS G 4902 (1991)	NCF 825	
2.4816	ASTM B 168-98	N 06600 B 168	Sheet and strip of low-carbon Ni-Cr-Fe and Ni-Cr-Co-Mo alloys (UNS N06600 and N06690)			
2.4819	ASTM B 575-99	N 10276 B 575	Sheet and strip of low-carbon Ni-Mo-Cr alloys			
2.4856	ASTM B 443-99	N 06625 B 443	Sheet and strip of Ni-Cr-Mo-Nb alloy (UNS N06625)	JIS G 4902 (1991)	NCF 625	Special alloy in sheet form
2.4610	ASTM B 575-99	N 06455 B 575	Sheet and strip of low-carbon Ni-Mo-Cr alloys			
2.4360	ASTM B 127-98	N 04400 B 127	Sheet and strip of Ni-Cu alloy (UNS N04400)			

Material no. to DIN EN	KOREA Standard	KOREA Designation	KOREA Semi-finished product applications	CHINA Standard	CHINA Designation	CHINA Semi-finished product applications
1.4948						
1.4919						
1.4958						
1.4828	KS D 3732 (1993)	STR 309	Heatproof sheet and heavy plate	GBT 1221 (1992)	1Cr20Ni14Si2; S38210	Heatproof steels, austenitic
1.4876	KS D 3532 (1992)	NCF 800	Special alloys in sheet and heavy plate form	GBT 15007 (1994)	NS 111; H01110	Stainless alloys
2.4858	KS D 3532 (1992)	NCF 825		GBT 15007 (1994)	NS 142; H01420	
2.4816				GBT 15007 (1994)	NS 312; H03120	
2.4819				GBT 15007 (1994)	NS 333; H03330	
2.4856	KS D 3532 (1992)	NCF 625	Special alloys in sheet and heavy plate form	GBT 15007 (1994)	NS 336; H03360	
2.4610				GBT 15007 (1994)	NS 335; H03350	
2.4360						

Corrosion resistance

Appendix B

Corrosion resistance

Appendix B – General
Flexible metal elements are basically suitable for the transport of critical fluids if a sufficient resistance is ensured against all corrosive media that may occur during the entire lifetime.

The flexibility of the corrugated elements like bellows or corrugated hoses generally require their wall thickness to be considerably smaller than that of all other parts of the system in which they are installed.

As therefore increasing the wall thickness to prevent damages caused by corrosion is not reasonable, it becomes essential to select a suitable material for the flexible elements which is sufficiently resistant.

Special attention must be paid to all possible kinds of corrosion, especially pitting corrosion, intercrystalline corrosion, crevice corrosion, and stress corrosion cracking, (see Types of corrosion).

This leads to the fact that in many cases at least the ply of the flexible element that is exposed to the corrosive fluid has to be chosen of a material with even higher corrosion resistance than those of the system parts it is connected to (see Resistance table).

Types of corrosion
According to EN ISO 8044, corrosion is the "physicochemical interaction between a metal and its environment that results in changes in the properties of the metal, and which may lead to significant impairment of the function of the metal, the environment, or the technical system, of which these form a part. This interaction is often of an electrochemical nature".

Different types of corrosion may occur, depending on the material and on the corrosion conditions. The most important corrosion types of ferrous and non-ferrous metals are described below.

Uniform corrosion
A general corrosion proceeding at almost the same rate over the whole surface. The loss in weight which occurs is generally specified either in g/m^2h or as the reduction in the wall thickness in mm/year.

This type of corrosion includes the rust which commonly is found on unalloyed steel (e. g. caused by oxidation in the presence of water).

Stainless steels can only be affect by uniform corrosion under extremely unfavourable conditions, e.g. caused by liquids, such as acids, bases and salt solutions.

Appendix B
Corrosion resistance

Pitting corrosion
A locally limited corrosion attack that may occur under certain conditions, called pitting corrosion on account of its appearance. It is caused by the effects of chlorine, bromine and iodine ions, especially when they are present in hydrous solutions.

This selective type of corrosion cannot be calculated, unlike surface corrosion, and can therefore only be kept under control by choosing an adequate resistant material.

The resistance of stainless steels to pitting corrosion increases in line with the molybdenum content in the chemical composition of the material.

The resistance of materials to pitting corrosion can approximately be compared by the so-called pitting resistance equivalent (PRE = Cr % + 3.3 · Mo % + 30 N %), whereas the higher values indicate a better resistance.

Intergranular corrosion
These deposit processes are dependent on temperature and time in CrNi alloys,

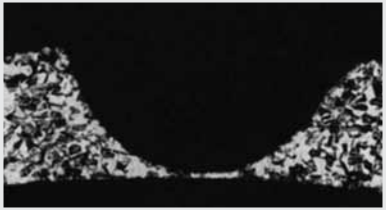


Fig. B.1: Pitting corrosion on a cold strip made of austenitic steel. Plan view (50-fold enlargement).


Fig. B.2: Sectional view (50-fold enlargement).

whereby the critical temperature range is between 550 and 650 °C and the period up to the onset of the deposit processes differs according to the type of steel. This must be taken into account, for example, when welding thick-walled parts with a high thermal capacity. These deposit-

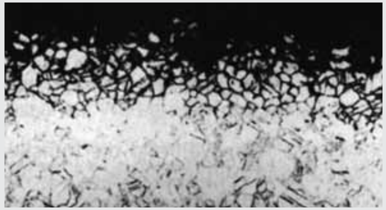


Fig. B.3: Intergranular corrosion (decay) in austenitic material 1.4828. Sectional view (100-fold enlargement).

related changes in the structure can be reversed by means of solution annealing (1000 – 1050 °C).

This type of corrosion can be avoided by using stainless steels with low carbon content (≤ 0,03 % C) or containing elements, such as titanium or niobium. For flexible elements, this may be stabilized material qualities like 1.4541, 1.4571 or low-carbon qualities like 1.4404, 1.4306.

The resistance of materials to intergranular corrosion can be verified by a standardized test (Monypenny - Strauss test according to ISO 3651-2). Certificates to be delivered by the material supplier, proving resistant to IGC according to this test are therefore asked for in order and acceptance test specifications.

Stress corrosion cracking
This type of corrosion is observed most frequently in austenitic materials, subjected to tensile stresses and exposed to a corrosive agent. The most important agents are alkaline solutions and those containing chloride.

The form of the cracks may be either transgranular or intergranular. Whereas the transgranular form only occurs at temperatures higher than 50 °C (especially in solutions containing chloride), the intergranular form can be observed already at room temperature in austenitic materials in a neutral solutions containing chloride. At temperatures above 100 °C SCC can already be caused by very small concentrations of chloride or lye – the latter always leads to the transgranular form.

Stress corrosion cracking takes the same forms in non-ferrous metals as in austenitic materials.

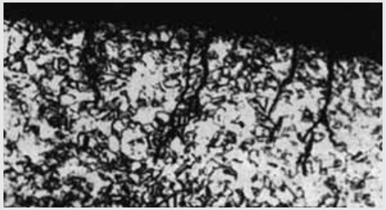


Fig. B.4: Transgranular stress corosion cracking on a cold strip made of austenitic steel. Sectional view (50-fold enlargement).

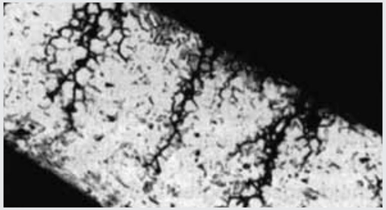


Fig. B.5: Intergranular stress corosion cracking on a cold strip made of austenitic steel. Sectional view (50-fold enlargement).

Damage caused by intergranular stress corrosion cracking can occur in nickel and nickel alloys in highly concentrated alkalis at temperatures above 400 °C, and in solutions or water vapour containing hydrogen sulphide at temperatures above 250 °C.

A careful choice of materials based on a detailed knowledge of the existing operating conditions is necessary to prevent from this type of corrosion damage.

Crevice corrosion

Crevice corrosion is a localized, seldom encountered form of corrosion found in crevices which are the result of the design or of deposits. This corrosion type is caused by the lack of oxygen in the crevices, oxygen being essential in passive materials to preserve the passive layer.

Because of the risk of crevice corrosion design and applications should be avoided which represent crevice or encourage deposits.

The resistance of high-alloy steels and Ni-based alloys to this type of corrosion increases in line with the molybdenum content of the materials. Again pitting resistance equivalent (PRE) (see Pitting corrosion) can be taken as criteria for a ssessing the resistance to crevice corrosion.

Appendix B
Corrosion resistance

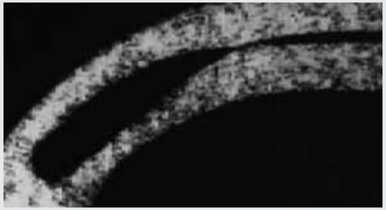


Fig. B.6: Crevice corrosion on a cold strip made from austenitic steel. Sectional view (50-fold enlargement).

Contact corrosion

A corrosion type which may result from a combination of different materials.

Galvanic potential series are used to assess the risk of contact corrosion, e.g. in seawater. Metals which are close together on this graph are mutually compatible; the anodic metal corrodes increasingly in line with the distance between two metals.

Materials which can be encountered in both the active and passive state must also be taken into account. A CrNi alloy, for example, can be activated by mechanical damage to the surface, by deposits (diffusion of oxygen made more difficult) or by corrosion products on the surface of the material. This may result in a potential difference between the active and passive surfaces of the metal, and in material erosion (corrosion) if an electrolyte is present.

Dezincing

A type of corrosion which occurs primarily in copper-zinc alloys with more than 20% zinc.

During the corrosion process the copper is separated from the brass, usually in the form of a spongy mass. The zinc either remains in solution or is separated in the form of basic salts above the point of corrosion. The dezincing can be either of the surface type or locally restricted, and can also be found deeper inside.

Conditions which encourage this type of corrosion include thick coatings from corrosion products, lime deposits from the water or other deposits of foreign bodies on the metal surface. Water with high chloride content at elevated temperature in conjunction with low flow velocities further the occurrence of dezincing.

Appendix B
Corrosion resistance

Contact corrosion

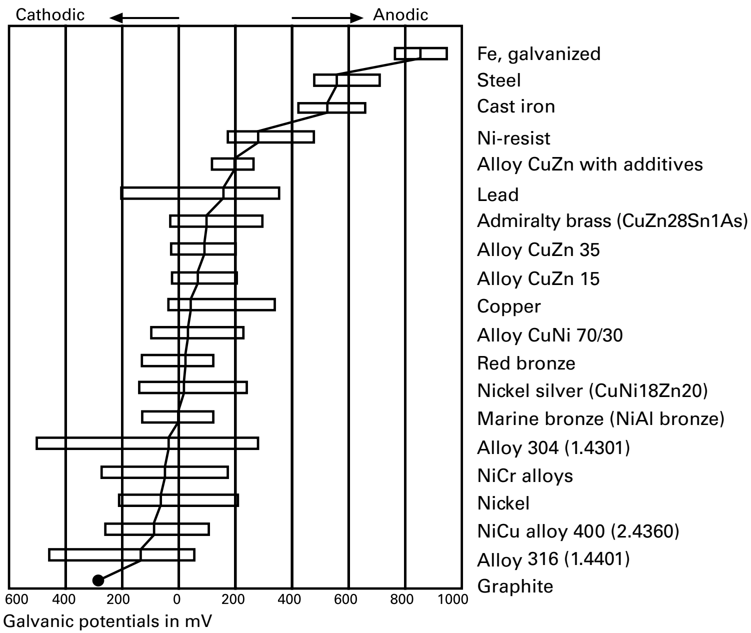


Fig. B.7:Galvanic potentials in seawater
Source: DECHEMA material tables

Resistance table

The table below provides a summery of the resistance to different media for metal materials most commonly used for flexible elements.

The table has been drawn up on the basis of relevant sources in accordance with the state of the art; it makes jet no claims to completeness.

The main function of the table is to provide the user with an indication of which materials are suitable or of restricted suitability for the projected application, and which can be rejected right from the start.

The data constitutes recommendations only, for which no liability can be accepted.

The exact composition of the working medium, varying operating states and other boundary operating conditions must be taken into consideration when choosing the material.

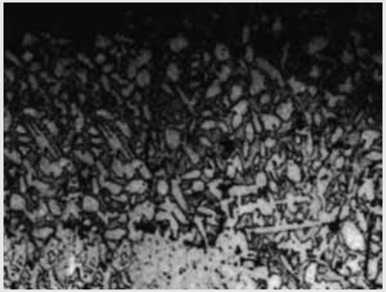


Fig. B.8: Dezincing on a Copper-Zinc alloy (Brass / CuZn37). Sectional view (100-fold enlargement).

Assessment	Corrosion behaviour	Suitability
0	resistant	suitable
1 P S	uniform corrosion with reduction in thickness of up to 1 mm/year risk of pitting corrosion risk of stress corrosion cracking	restricted suitability
2	hardly resistant, uniform corrosion with reduction in thickness of more than 1 mm/year up to 10 mm/year	not recommended
3	not resistant (different forms of corrosion)	unsuitable

Meanings of abbreviations:

dr:	dry condition	cs:	cold-saturated (at room temperature)
mo:	moist condition	sa:	saturated (at boiling point)
hy:	hydrous solution	bp:	boiling point
me:	melted	adp:	acid dew point

Medium			Materials																	
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: steels 2.4858 / alloy	Nickel alloys: 8252.4816 / alloy 600	Nickel alloys: 2.4856 / alloy 625	Nickel alloys: 2.4610, 2.4819 /alloy C-4, C-246	Nickel alloys: 2.4360 / alloy 400	Copper alloys: 2.0882 / alloy CuNi 70/30	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Acetanilide (Antifebrine) C_8H_9NO		<114	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
Acetic acid	5	20	3	0	0	0	0	1	0	0	1				0	3	0	0	0	
CH_3COOH or $C_2H_4O_2$	5	bp	3	3	0	0	0	1	0	0	1						0	0		
50	20	3	3	0	0	0	1	0	0	1				0	3	1	0	0	0	
50	bp	3	3	3	0	0	1	0	0	1				3	3	0	0	3	1	
80	20	3	3	P	P	0	1	0	0	1					3	0	0	0	0	
96	20	3	3	3	P	0	1	0	0	1					3	0	0			
98	bp	3	3	3	3	0	1	0	0	1						0	0			
Acetic acid vapour	33	20		3	1	1														
100	>50		3	3	3	0	1		0	1	3			3	3	0		1		
100	<bp		3	3	3	0	3		0	3	3			3	3	0		3		
Acetic aldehyde $CH_3–CHO$	100	bp	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acetic anhydride	all	20	1	0	0	0	0	1	0	0	1	1	3	0	0	1	0	0	0	0
$(CH_3–CO)_2O$	100	60	3		0	0				0				1	1	1	0	0	1	0
100	bp	3		0	0		3		0					1	0	0	3	0		
Acetic anilide (Antifebrine)		<114	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0
Acetone CH_3COCH_3	100	bp	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acetyl chloride CH_3COCl		20	1	1	1	1	1	1	0	0	1	1		1	1	1		0	1	0
Acetylene dr		20	0	0	0	0	0	0	0	0	0	3	3	3	3	0	0	0	0	3
H-C≡C-H dr		200	1	0	0	0	0	0	0	0	0	3	3	3	3	3	0	0	1	3
Acetylene dichloride hy	5	20																	1	
$C_2H_2Cl_2$ dr	100	20	0	P	P	P	0	0	0		0					0			0	
Acetylen tetrachloride	100	20	0	0	0	0				0					0	0	0		0	
$CHCl_2–CHCl_2$	100	bp	0	0	0	0				0					1	0	1		3	
	bp	1												3	1			3		
Adipic acid $HOOC(CH_2)_4COOH$	all	200	0	0	0	0	0	0	0	0	0					0	0	0	0	0
Alcohol see ethyl or methyl alcohol																				

Medium			Materials																		
				Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Allyl alcohol CH_2CHCH_2OH	100	bp			0	0	0	0	0	1	0					0				
Allyl chloride $CH_2{=}CHCH_2Cl$	100	25				0	0	0	0		0					0				
Alum $KAl(SO_4)_2$ hy hy sa	100 10 10 	20 20 <80 	1 1 1 3	1 0 1 3	0 0 0 1	0 0 0 	0 	1 	 3	0 1 1 	 3	1 1 1 	 1 	 1 	1 1 		 0 0 	0 0 0 	1 1 	
Aluminium me Al		750	3	3	3	3					3					3	3			
Aluminium acetate hy $(CH_3{-}COO)_2Al(OH)$ hy	3 sa	20 	3 3	0 0	0 0	0 0				0 1						0 	0 0	 1		
Aluminium chloride hy $AlCl_3$	5	20	3	3	3	P	1	1	0	0	1	3	3	1	3	1	0	0	3	1
Aluminium fluoride hy AlF_3	10	25	3	3	3	3				1	1				1	1	0	3	1	1
Aluminium formate $Al(HCOO)_3$			1	0	0	0	0	0	0	0				0	1	0	0	0	0	
Aluminium hydroxide hy $Al(OH)_3$	10	20	1	3	0	0	0		0	0	1	0			0		0	0	1	
Aluminium nitrate $Al(NO_3)_3$			0	0	0	0	0	0	0	0	0						0	0	1	
Aluminium oxide Al_2O_3		20	1	1	0	0	0		0	0	3	0	0	0	0			0	3	
Aluminium potassium sulphate see alum																				
Aluminium sulphate hy $Al_2(SO_4)_3$ hy	10 15	<bp 50	3 3	3 3	3 3	0 1	0 	1 1	0 1	1 1	3 1	3 1	3 1	3 1	3 1	1 1	0 0	0 0	3 3	
Ammonia dr NH_3 hy hy hy	10 2 20 sa	20 20 40 bp	0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0	 0 0	0 0 1 3	0 0 1 1	0 0 1 1	1 0 3 3	0 3 	S S 	S S 	0 3 3 	3 3 3 	0 0 0 0	0 0 0 0	0 1 	0 0

Appendix B HYDRA
Resistance tables

Medium			Materials																		
				Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Ammonia bromide hy NH_4Br	10	25	3	P	P	P	0		0	1								0	1	
Ammonium acetate $CH_3{-}COONH_4$			1	0	0	0												0	0	
Ammonium alum hy $NH_4Al(SO_4)_2$	cs	20			0	0											3	0		
Ammonium bicarbonate hy $(NH_4)HCO_3$			0	0	0	0	1	3			3	3			3			0	0	
Ammonium bifluoride hy NH_4HF_2 hy	10 100	25 20	3 3	3 3	3 0	3 0				0 0							3 3	0 0		
Ammonium bromide see ammonia bromide																				
Ammonium carbonate hy $NH_4)_2CO_3$ hy	1 50	20 bp	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 1	0 0	1 1			1 1	 1		0 0	0 0	0 0
Ammonium chloride hy NH_4Cl hy hy	1 10 50	20 100 bp	1 1 1	P P P	P P P	P P P	0 0 0	0 0 1	0 0 0	0 0 1	0 1 1	1 1 1	S S 	S S 	1 1 1	1 1 1	0 0 0	0 1 1	1 1 1	1 1 1
Ammonium fluoride NH_4F hy hy	10 hg 20	25 70 80	1 3 3	1 	0 3	0 3				0 0			 3	 3	 3		1 	0 0		
Ammonium fluosilicate hy $(NH_4)_2SiF_6$	20	40	3		1	0	0	0	0	0	0					0				
Ammonium formate hy $HCOONH_4$ hy	10 10	20 70	1 	0 	0 	0 	0 	0 	0 	0 	0 						0 	0 0	0 0	
Ammonium hydroxide NH_4OH	100	20		0	0	0	0	0	0	0	3	3			3	0	0	0	1	
Ammonium nitrate hy NH_4NO_3 hy	5 100	20 bp	3 3	0 0	0 0	0 0	0 0	1 	0 	0 0	3 3	3 	 3	 3	3 3			0 0	0 0	
Ammonium oxalate hy $(COONH_4)_2$ hy	10 10	20 bp	1 3	1 3	0 1	0 0		1 1	0 0	0 	1 1	1 1			1 1		0 1	0 0		
Ammonium perchlorate hy NH_4ClO_4	10	20		P	P	P				1							0			

Medium				Materials																	
					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Ammonium persul- phate $(NH_4)S_2O_8$	hy hy	5 10	20 25	 3	0 1	0 1	0 1	0	1	0	0 0	3 3	3 3	 3	 3	3 3	3 3	0 0	0	3	 3
Ammonium phos- phate $NH_4H_2PO_4$	hy	5	25	0	1	1	0	0	1	0	0	1	1			3	1	0	0	1	
Ammonium rhodanide NH_4CNS			70		0	0	0											0		0	
Ammonium sulphate $(NH_4)_2SO_4$	hy hy hy	1 10 sa	20 20 bp	0 0 1	0 1	0 1 0	0 0	0 0	1 3	0	0 1 3	1 1 2	3 3 3	 3	 1	3 3	1 1	0 3 0	0 0 0	P P	 1
Ammonium sulphite $(NH_4)_2SO_3$		cs sa	20 bp		1 3	0 1	0 1	3 3	3 3			3 3	3 3			3 3	3 3	0 0	0 0		
Ammonium sulphocyanate see ammonium rhodanide																					
Amyl acetate $CH_3–COOC_5H_{11}$		all 100	20 bp	 1		 1	 1	1	1 0	1 1	1 1	1 0	1 0			1	1 0		1	1 0	
Amyl alcohol $C_5H_{11}OH$		100 100	20 bp	0 1	0 0	0 0	0 0		0	0	0	0	0	0	0	0	0	 0	0	 1	
Amyl chloride $CH_3(CH_2)_3CH_2Cl$		100	bp	1		P	P	0	1	0	0	1	0			0	1	0	0	3	
Amyl thiol		100	160			0	0				0										
Aniline $C_6H_5NH_2$		100 100	20 180			0 1	0 1	0	1	0	0	3 1	3	3	3	3	3	0		0 3	0 0
Aniline chloride $C_6H_5NH_2HCl$	hy hy	5 5	20 100		P P	P P	P P				0 0		3			3	3	0 0	0	3	
Aniline hydrochloride see anilin chloride																					
Aniline sulphate			20				0				0									1	
Aniline sulphite	hy hy	10 cs	20 20				0 0		1		0 0										
Antifreeze Glysantine			20		0	0	0	0	0	0	0	0					0	0	0	0	

Medium				Materials																	
					Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Antimony Sb	me	100	650	3						0	0							3		3	
Antimony trichloride $SbCl_3$	dr hy		20 100	0 1	3 3	3 3	3 3										0 0			3 3	
Aqua regia $3HCl+HNO_3$			20	3	3	3	3		3		3		3	3	3	3		0	0		1
Arsenic As			65 110			0 1	0 1														
Arsenic acid H_3AsO_4	hy hy	 90	20 110	3	 3	0 3	0 3		 3				 3			 3				 3	
Asphalt			20	0	0	0	0						0	0	0	0	0			0	
Azobenzene $C_6H_5–N=N–C_6H_5$			20		0	0	0	0	0	0	0	0						0	0	0	
Baking powder	mo			1	0	0	0	0	0	0	0	0				1				0	
Barium carbonate $BaCO_3$			20	3	0	0	0	0		0	0	0	0	0	0	0		0	0	1	
Barium chloride $BaCl_2$	hy hy	5 25	20 bp		P P	P P	P P	1 1	1 1	0 0	0 0	1 1	3			3	1 1	0 0	0 0	3 P	
Barium hydroxide $Ba(OH)_2$ hy hy hy 	solid hy all 100 cs sa 50	100 all bp 815 20 bp 100	20 20 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0 0 0 0	0 0 0 0	0 0 1 1	1 1	 1 1 1	0 0 1	1 1 0 0	0 0 1	1 1 0	0 0 0	0 0 1 0 0 0	0 1 0 0 0 0 0	0 0	 0 3	3 3	
Barium nitrate $Ba(NO_3)_2$	hy	all	bp		0	0	0	0	1	0			3			3		0	0	0	
Barium sulphate $BaSO_4$			25	0	0	0	0	0		0		0	0	0	0	0	1	0	0	0	
Barium sulphide BaS			25		0	0	0						3	1	3	3					

Medium: Designation / Chemical formula	Concentration %	Temperature °C	Materials: Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: steels 2.4858 / alloy	Nickel alloys: 8252.4816 / alloy 600	Nickel alloys: 2.4856 / alloy 625	Nickel alloys: 2.4610, 2.4819 /alloy C-4, C-246	Nickel alloys: 2.4360 / alloy 400	Copper alloys: 2.0882 / alloy CuNi 70/30	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Basic aluminium acetat see aluminium acetat																				
Beer 100	100 bp	20 3	3 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 1	1 0	0 1	1 0	0 0	0 0	0 0	0	
Benzaldehyde dr C_6H_5–CHO		bp		0	0	0					1						1	0	0	0
Benzene 100	100 bp	20	 0	0 0	0 0	0	0 1	0 1	0 1	1 1	0 1	0	0	0	 1	0 1	0 0	0 1	0	1
Benzenesulfonic acid hy C_6H_5–SO_3H hy	5 5	40 60	3 3	0 3	0 1	0 1														
Benzine	100	25		0	0	0	0	0	0	0	0	0	0	0	1		0		1	
Benzoic acid hy C_6H_5COOH hy	all all	20 bp	1 3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	 3	0 0	0 0	0 0	0 0	0 0	0 3	
Benzyl alcohol C_6H_5–CH_2OH	all	20	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0			
Biphenyl C_6H_5–C_6H_5	100 100	20 400	0 0	0 0	S S	S S	0 0	0 0	0 0	0 0	0 0	0	0	0	0 0	0 0	0 0	0 0	0 0	
Blood		20	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Boiled oil		20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Borax hy $Na_2B_4O_7$ hy	cs sa		1 3	0 0	0 0	0 0						0	0	0	0		0 0	0 0	0 1	
Boric acid hy H_3BO_3 hy hy	50 50 70	100 150 150	3 3 3	0 1 1	0 0 1	0 0 1	0 0 0	1 1 1	0 0 0	0 0 0	1 1 1	 0	1 1 1	 1	1 1 1	1 1 1	0 0 0	0 0 0	1 1 1	1 0 0
Boron B		20 900	0 0	0	0	0														
Bromine dr Br mo	100 100	20 20	P P	P P	P P	P P	1	0 3	0	0 3	0 0	 1	0 3	0 1	0 3	0 0	3 0		3 3	0 0
Bromine water 1	0.03 20	20	 P	P P	P P	P														

Appendix B
Resistance tables
HYDRA

Medium: Designation / Chemical formula	Concentration %	Temperature °C	Materials: Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: steels 2.4858 / alloy	Nickel alloys: 8252.4816 / alloy 600	Nickel alloys: 2.4856 / alloy 625	Nickel alloys: 2.4610, 2.4819 /alloy C-4, C-246	Nickel alloys: 2.4360 / alloy 400	Copper alloys: 2.0882 / alloy CuNi 70/30	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Bromoform dr $CHBr_3$ mo		20	0 3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0			0 0	0 0				3 3	
1,3-Butadiene CH_2=CHCH=CH_2							0	0	0		0				0	0			0	
Butane C_4H_{10}	100 100	20 120	0	0 1	0 0	0 0	0	0	0	0	0	0	0	0	1	0			1	
Butanol CH_3–CH_2–CH_2– CH_2OH	100 100	20 bp	0 0	0 0	0 0	0 0	0	0 0	0	0 0	0 0	0	0	0	0	0	0 0	0 0	0 0	0
Butter		20	3	0	0	0	0	0	0	0					3				0	
Buttermilk		20	3	0	0	0	0		0	0	3			3	3				0	
Butylacetate $CH_3COOC_4H_9$		20 bp	1 1	0 0	0 0	0 0	0 0		0 0	0 0	1 0	0 0	0	0	0 0		0 0	0 0	0 0	0
Butyric acid hy CH_3–CH_2–CH_2–COOH hy	cs sa	20 bp	3 3	0 3	0 3	0 0	1 1	3 3	0 0	0 0	1 1					3 3			0 1	
Cadmium me Cd					3	3														
Calcium me Ca		850	3		3	3														
Calcium bisulphite $CaSO_3$	cs sa	20 bp	3 3	3 3	0 3	0 0						1	3	1	0		0 0			
Calcium carbonate $CaCO_3$		20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Calcium chlorate hy $Ca(ClO_3)_2$ hy	10 10	20 100		P 3	P 3	P P	1 1	1 1	1 1	1 1	1 1	3 3			1 1	1 1		0 0		
Calcium chloride hy $CaCl_2$ hy cs sa	5 10	100 20 3 3	3 3 P 3	P P P P	P P P P	P P 0 0	 0 0 0	 0 0 0	 0 0 0	0 0 1 3	 0 0 0	 0 3 3	 3	 1 0	 1 1	 0 0 P	0 0 0 0	0 0 3 3	3 3	
Calcium hydroxide $Ca(OH)_2$			0	0	0	0	1	1	0	0	1	0	0	0	1	1	0	0	3	

Medium			Materials																	
	Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula	%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Calcium hypochlorite hy $Ca(OCl)_2$ hy	2 cs	20 	3 3	3 3	3 3	P P	0	3	0	0 1	3	3			3	3	0	0 0	3 3	
Calcium nitrate $Ca(NO_3)_2$	 all	20 100	3 3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0						0 0		0 0	
Calcium oxalate mo $(COO)_2Ca$		20	1	0	0	0	0	0	0	0	0	0	0	0			0	0	3	
Calcium oxide CaO		20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		3	
Calcium sulphate mo $CaSO_4$ mo		20 bp	1 1	0 0	0 0	0 0	0 0		0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	1 1	
Calcium sulphite hy $CaSO_3$ hy	cs sa		0 0	0 0	0 0	0 0									1 1		0 0	0 0	1 1	
Carbolic acid $C_6H_5(OH)$ hy	 90	20 bp bp	0 3 3	0 3 3	0 3 3	0 0 0	0	1	0	0 1 1	1 0 0	0			0	1 0 0	0 0 0	0 0 0	0 3 3	
Carbon dioxide dr CO_2 dr mo mo	100 100 20 100	<540 1000 25 25	0 3 1 3	1 1 1	0 0 0	0 0 0	0 0 0	0 3 0 1	0 0 0	0 0 0	0 0 1	 0 0	 3	 1	3 1 0	0 1	 0	0 0 0 0	 3 3	
Carbon monoxide CO	100 100	20 <540	0 3	0 0	0 0	0 0		0 3	0	0 0	0 1				0 3	0 3	0 0	0 0	0 1	0 3
Carbon tetrachloride dr dr CCl_4 mo mo		20 bp 25 bp	0 1 1 3	0 0 1	0 0 1	0 0 1 1	0 0	0 0	0 0	0 0 0	0 0 0	0 0	0 0	0 0	0 0 1	0 0 0	0 0 0	0	0 3 3 3	
Carbonic acid see carbon dioxide																				
Caustic-soda solution see sodium hydroxide																				
Chilean nitrate see sodium nitrate																				
Chloral CCl_3–CHO		20								0								0	3	

Appendix B
Resistance tables
HYDRA

Medium			Materials																	
	Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula	%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Chloramine			3	3	1	0	0		0	0	0									
Chloric acid hy $HClO_3$		20	3	3	3	3	0			0							0	0	3	3
Chlorinated lime see calcium hypochlorite																				
Chlorine dr Cl_2 dr dr mo mo	100 100 100	200 300 400 20 150	0 3 3 3 3	0 3 3 3 3	0 3 3 3 3	0 0 3 3 3	 0	0 0 0	0 0 0	0 0 0 0 0	0 0 0	0	0	0	0	0	1 0 0	0 0 0	0 3 3	0
Chlorine dioxide hy ClO_2	0.5	20	3	3	3	3				1				3			0	0		
Chloroacetic acid CH_2Cl–COOH hy	all 30	20 80	3 3	3 3	3 3	L 3	3	 3	1	1 0	3	3	 3	 3	3 3	 1	0 0	0 0	3 3	
Chlorobenzene dr C_6H_5Cl mo	 100	 20	0 0	0 P	0 P	0 P	 0	 0	 0	0 0	 0	 0	 0	 0	 1	 1	 0	 0	 1	
Chloroethane C_2H_5Cl																				
Chloroform dr $CHCl_3$ mo			1 3	1 P	1 P	1 P	0 0	0 0	0 0	0	0 0	0	0	0	0	0	0 0		0 3	
Chloronaphthaline $C_{10}H_7Cl$			0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	
Chlorophenol $C_6H_4(OH)Cl$			1	0	0	0				0										
Chlorosulphon acid hy $HOSO_2Cl$ mo	100	20 20	0 3	0 3	0 3	0 1	0 1	0 1	0 1	0	0				0 3	0 3	0 3	0 0	0 3	3 3
Chrome alum hy $KCr(SO_4)_2$ sa	1 cs	20 3	3 3 3	3 3 3	0 1 3	0 0	 0	 0		 1	1 0	 3	 3		 3	 1 0	0 0	 3	1 3	
Chromic acid hy Cr_2O_3 hy (H_2CrO_4) hy hy hy hy hy	5 5 10 10 10 50 60	20 90 20 65 bp bp 20	3 3 3 3 3 3 3	3 3 0 3 3 3 3	0 3 0 3 3 3 3	0 3 0 3 3 3 3	1 1 1 3 1	3 3 3 3 3	0	0 1 0 0 0 3	3 3 3 3 3 3 3	3 3 3 3 3 3 3	3 3 3 3 3 3 3	3 3 3 3 3 3 3	3 3 3 3 3 3 3	3 3 3 3 3 3 3	0 0 0 0 0 0 0	0 0 0 0 0 0 0	1 1 3 3 3	0

Medium			Materials																	
				Stainless steels		Nickel alloys						Copper alloys		Pure metals						
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Chromic-acid anhydride see chromium oxide																				
Chromium oxide CrO_3			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Chromium sulphate $Cr_2(SO_4)_3$	cs sa		3 3	0 0	0 1	0 1		0 1	0 0	0 0	0 0					0 0				
Cider	 bp	20 3	3 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0				 0	0 0	0 0	0 1	1 0	0
Citric acid hy $C_6H_8O_7$ hy	all all	<80 bp	3 3	3 3	0 3	0 0		0 0		0 0										
Combustion gases free from S or H_2SO_4 and Cl with S or H_2SO_4 and Cl	 and ≤400	 ≤400 >adp 0	 0 0	 0 0	 0 0	 0			 0	 0										
Copper (II) acetate hy $CU_2(CH_3COO)_4$ hy		20 bp	3 3	0 0	0 0	0 0	0	1	0	0	1	3		3 3	3	1	0 0	0	3 3	1
Copper (II) chloride hy $CuCl_2$ hy	1 cs	20	3 3	3 3	P 3	P 3	0 3	3 3		1 0	3 3	3			3 3	3 3	0 0	0 0	3 3	
Copper (II) nitrate hy $Cu(NO_3)_2$ hy hy	1 50 cs	20 bp		0 0 0	0 0 0	0 0 0	0 0	3 3 3		0 1 1	3 3 3	3 3			3 3	3 0 3	0 0 0	0 3 0	3 3	
Copper (II) sulphate hy $CuSO_4$ hy	cs sa		3 3	0 1	0 0	0 0	0 0	3 3		0 0	3 3	3			3 3	3 3	0 0	0 0	3 3	 0
Cresol $C_6H_4(CH_3)OH$	all all	20 bp	3 3	1 1	0 1	0 0		0 0	0 0	 1	0 0					0 0	0 0		0 3	0 0
Crotonaldehyde $CH_3–CH{=}CH–CHO$		20 bp	3		0 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0		0				0 0	
Cyclohexane $(CH_2)_6$			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Diammonium phosphate see ammonium phosphate																				

Appendix B
Resistance tables
HYDRA

Medium			Materials																	
				Stainless steels		Nickel alloys						Copper alloys		Pure metals						
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Dibromethane $CH_2Br–CH_2Br$			1		0	0										0			3	
Dichlorfluormethane dr CF_2Cl_2 dr mo		bp 20 20			0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0	0 0 0							0 0 0	0 0 0	
Dichloroethane dr $CH_2Cl–CH_2Cl$ mo	100 100	20 20	0	P P	P P	P P	1	0				0	1		1		0	0 0	0	1 1
Dichloroethylene see acethylene dichloride																				
Diethyl ether $(C_2H_5)_2O$			0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Ethane $CH_3–CH_3$		20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ether see diethyl ether																				
Ethereal oils		20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl alcohol C_2H_5OH	all all	20 bp	0 1	0 0	0 0	0 0	0 0	0 0	0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0
Ethylbenzene $C_6H_5–C_2H_5$			1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ethyl chloride C_2H_5Cl			0	S	S	S	0	0	0	1	0	0	1	1	1	0		0	1	0
Ethylene $CH_2{=}CH_2$		20	0	0	0	0													0	
Ethylene dibromide see dibromethane																				
Ethylene dichloride see dichloroethane																				
Ethylene glycol $CH_2OH–CH_2OH$	100	20	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0	0	
Exhaust gases see combustion gas																				

Medium			Materials																	
				Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo steels	2.4858 / alloy 825	2.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Fats			0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	
Fatty acid	100	20	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0
$C_{17}H_{33}COOH$	100	60	3	0	0	0	0	0	0	0	0		1	1	1	0	0	0	1	0
100	150	3	3	0	0	0	0	0	0	1		1	1	3	0	0	0	3	0	
100	180	3	3	3	0	0	0	0	0	1		1	3	3	0	0	0	3	0	
100	300	3	3	3	0	0	0	0	0			3	3	3	0	0	0	3	0	
Fixing salt see sodium thiosulphate																				
Flue gases see combustion gases																				
Fluorine mo		20	3	3	3	3				0	0	3	3	3	3	0	3		3	0
F dr	100	20	0	0	0	0				0	0	0	0	0	0	0	0		3	0
dr	100	200	0	0	P	P				0	0				3	0	0		3	
dr	100	500	3							0									3	
Fluorosilicic acid	100	20	3	3	P	P				1		1	3	1	1				3	
$H_2(SiF_6)$	25	20	3	3	3	3	1	1	1	1	3		3	1	1	1	3		3	
70	20	3	3	3	3				1									3		
vapour			3	3	3	3				1							2		3	
Formaldehyde hy	10	20	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0		1	0
CH_2O hy	40	20	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0		1	0
hy	all	bp	3	0	0	0				0							0		3	
Formic acid	10	20	3	3	1	0	0	1	0	0	1		0		0	1	0	0	0	1
HCOOH	10	bp	3	3	3	1	0	1	0	0	1		0			3	0		3	3
80	bp	3	3	3	3	0	1	0	0	3		0		0	1	3		3	3	
85	65	3	3	3	3	0	1	0	0	2		0		1	1	3		3		
Fuels																				
Benzine		20		0	0	0	0	0	0	0	0		0	0	0	0			0	
	bp		0	0	0	0	0	0	0	0		0	0	0	0			0		
Benzene		20		0	0	0	0	0	0	0	0		0	0	0	0			0	
	bp		0	0	0	0	0	0	0	0		0	0	0	0			0		
Benzine-alcohol-mixture		20		0	0	0	0	0	0	0	0		0	0	0	0			0	
Diesel oil		20		0	0	0	0	0	0	0	0		0	0	0	0			0	
Furfural	100	25	1	1	1	1				0		0	3	0	0			0	0	
100	bp	3	1	1	1				0					3			0	0		
Gallic acid hy	1	20	1	0	0	0				0								0		
$C_6H_2(OH)_3COOH$	100	20	3	0	0	0												0		
100	bp	3	0	0	0		3										0			

Appendix B
Resistance tables
HYDRA

Medium			Materials																	
				Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo steels	2.4858 / alloy 825	2.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Gelatine		20	0	0	0	0		0		0								0		0
	80	1	0	0	0		0			0	0	1	0	0	0	0		0	0	
Glacial acetic acid CH_3CO_2H see acetic acid																				
Glass me		1200	1		1	1														
Glauber salt see sodium sulphate																				
Gluconic acid $CH_2OH(CHOH)_4–COOH$	100	20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Glucose hy $C_6H_{12}O_6$		20		0	0	0						0	1	0	0		0		0	
Glutamic acid		20	1	P	P	0	0	1	0	0	1					1				
HOOC–CH_2–CH_2– $CHNH_2$–COOH		80	3	P	P	0		1		1										
Glycerine	100	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
$CH_2OH–CHOH–CH_2OH$	100	bp	1	1	0	0		0	0	0	0		1		0	0		0	0	
Glycol see ethylenglycol																				
Glycolic acid		20	3	1	1	1				0							0		1	
$CH_2OH–COOH$		bp	3	3	3	3				0							0		1	
Glysantine see antifreeze																				
Hexachloroethane $CCl_3–CCl_3$		20			0	0	0	0	0	0	0						0		3	
Hexamethylene- hy	20	60	1		0	0				0										1
tetramine hy $(CH_2)_6N_4$	80	60	3		0	0				0										
Household ammonia see ammonium hydroxide																				
Hydrazene $H_2N–NH_2$		20	0		0		3	3			3					3			1	

Medium			Materials																	
				Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Hydrazine sulphate hy $(NH_2)_2H_2SO_4$	10	bp	3		3	3														
Hydrobromic acid aqueous solution of hydrogen bromide (HBr)		20	3	3	3	3	3	3	3	3	3	3	3	3	3	3		0	3	3
Hydrochloric acid HCl 0.5 1 2 5 15 32 32	0.2 0.5 bp 20 65 20 20 20 bp	20 20 3 3 3 3 3 3 3	3 3 3 3 3 3 3 3 3	3 3 3 3 3 3 3 3 3	P 3 3 P 3 3 3 3 3	P P 3 3 3 	 3 3 3 		 3 0 0 0 0 0 3	0 0 1 1 3 	 3 3 3 	 3 	 3 1 	 3 3 3 3 	 1 3 3 	P 1 0 0 3 3 3	0 0 0 0 0 3 0 0 0	0 0 3 3 3 3 3	 0 1 	
Hydrochloric-acid gas see hydrogen chloride																				
Hydrofluoric acid HF 80 90	10 80 bp 30	20 20 	3 1 	3 	3 	3 1	1 1 1	1 1 	0 1 1 	0 1 1 0	1 1 		3 	3 	3 1 1	1 1 3 3	3 3 3 3	3 3 3 3	3 3 	
Hydrogen H		<300 >300	0 3		0 0	0 0				0 0			0 		0 				0 0	
Hydrogen bromide dr HBr mo	100 30	20 20	0 3	0 3	0 3	0 3											 0			
Hydrogen chloride dr HCl dr dr dr		20 100 250 500	0 0 1 3	3 3 3 3	1 3 3 3	1 3 3 3	0 0 0 	0 0 0 1	0 0 0 	0 0 0 0			3 3 3 3	3 	3 3 3 3				1 1 3 3	0 3 3
Hydrogen cyanide dr HCN hy hy	 20 cs	20 20 20	3 3 3	0 1 1	0 0 0	0 0 0	0 0 0	1 1 0	0 0 0	0 0 0	1 1 3	3 3 3	3 3 3	3 3 3	1 1 1	0 0 0	0 0 0	0 0 0	0 0 0	
Hydrogen fluoride HF	5 100	20 500	 3	3 3	3 3	3 3	3 3	0 3	0 	0 0	0 3		 3		3 3	0 0	3 3	3 3	3 3	
Hydrogen peroxide H_2O_2	all	20	3	3	0	0	0	1	0	0	1	3	3	3		3	1	3	0	0

Medium			Materials																	
				Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula	Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Hydrogen sulphide dr H_2S dr dr mo	100 100 100 	20 100 200 20	1 3 3 3	S S 3 3	0 0 0 0	0 0 0 0	0 	1 0	 0	0 0	1 0	0 3	0 3	0 3	0 0 3	0 1	0 0	0 0 	0 0 0	1 3
Hydroiodic acid dr mo		20 20	0 3	0 3	0 3	0 3														
Hypochlorous acid HOCl		20	3	3	3	3											0		3	
Indol		20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
Ink see gallic acid																				
Iodine dr J_2 mo mo	100 	20 20 bp	0 3 3	P 3 3	P 3 3	P 3 3				0 1 1	0 3 3	3 	3 	3 	3 	 3 3	3 0 		0 3 3	 3 3
Iodoform dr CHJ_3 mo		60 20	0 3	0 3	0 P	0 P													0 	
Iron (II) chloride hy $FeCl_2$ hy	10 cs	20 	0 		P 	P 	 3	 3		1 0	 3	1 3	3 	1 	1 3	 3	0 0	0 0	3 3	
Iron (II) sulphate hy $FeSO_4$	all	bp	0	0	0	0				0	0					3	0		3	
Iron (III) chloride dr $FeCl_3$ hy hy hy	100 5 10 50	20 25 65 20	0 3 3 3	P 3 1 3	P 3 1 3	P 3 1 3	1 3 	3 3 3		0 0 3 1	3 3 	3 3 3	3 3 3	3 3 3	3 3 3	3 3 0 	0 0 0 0	0 0 0	3 3 	
Iron (III) nitrate hy $Fe(NO_3)_3$ hy	10 all	20 bp	3 3	0 0	0 0	0 0	 3	 3	 3	0 3	 3				 3	 0	0 			
Iron (II) sulphate hy $FeSO_4$	all	bp	0	0	0	0				0	0					3	0		3	
Iron (III) sulphate hy $Fe(SO_4)_3$ hy	<30 all	20 bp	3 3	0 1	0 0	0 0	0 	3 		0 0	1 	3 	3 	3 	3 	3 	0 0	0 0	3 3	
Isatine $C_8H_5NO_2$		20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	

Medium				Materials	Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Kalinite																					
see alum																					
Ketene			20		0	0	0	0	0	0	0						0	0	0	0	
$R_2C{=}C{=}O$			bp		0	0	0	0	0	0	0						0	0	0	0	
Lactic acid	hy	1	20	3	3	0	0	0		0	0		0	3	1	0		0	0	0	
$C_3H_6O_3$	hy	all	20	3	3	1	0				0							0	0	3	
	hy	10	bp	3	3	3	3	0	3		0	3	1			1	3	0	0	3	
	hy	all	bp	3	3	3	1				0							0	0	3	
Lactose	hy		20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	
$C_{12}H_{22}O_{11}$																					
Lead	me		388	3	1	1	1		0			3				3		0	0		
Pb			900	3	3	3	3				0										
Lead acetate	me			3	0	0	0				0	0			3	3				3	
$(CH_3{-}COO)_2Pb$																					
Lead acide		<20	<30					0	0	0		1					1				
$Pb(N_3)_2$																					
Lead nitrate	hy		100	1	0	0	0	0	0	0	0	0						0	0	0	
$Pb(NO_3)_2$																					
Lime																					
see calcium oxide																					
Lithium	me		300	0	0	0	0	0	0	0	0	3	3	3	3	3		0		3	
Li																					
Lithium chloride	hy	cs		3	3	3	P	0	0	0	0	1					0	0			
LiCl																					
Lithium hydroxide	hy	all	20	1	0	0	0	0	0	0		0					0	0			
LiOH																					
Magnesium	me		650		1	3	3	3	3		3	3	3	3	3	3	3	0	0	3	
Mg																					
Magnesium	hy		20	0	0	0	0	0	0	0	0	0	0			0	0	0	0	1	
carbonate $MgCO_3$	hy		bp	0	0	0	0	0	0	0	0	0	0			0	0	0	0	1	

Appendix B
Resistance tables
HYDRA

Medium				Materials	Stainless steels			Nickel alloys					Copper alloys			Pure metals					
Designation Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Magnesium chloride	hy	5	20	3	3	P	P	0	0	0	0	0	3			3	0	0	0	3	
$MgCl_2$	hy	5	bp	3	3	3	3	0	0	0	0	0	3			3	0	0	0	3	
	hy	50	bp	3	3	3	3				0							0	0	3	
Magnesium hydroxide	hy	cs		0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
$Mg(OH)_2$	hy	sa		0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	
Magnesium nitrate		cs		0	0	0	0	3	3		3	0	3	0	0	3	3	0	0	1	
$Mg(NO_3)_2$																					
Magnesium oxide																					
see magnesium hydroxide																					
Magnesium sulphate	hy	0.1	20	0	1	0	0				0							0	0	3	
$MgSO_4$	hy	5	20	3	1	0	0	0	1	0	0	1	0	3	0	0	1	0	0	0	
	hy	50	bp	3	1	0	0				1							0	0	0	
Maleic acid	hy	5	20	3	0	0	0	0	1	0	0	1	0				1			0	
HOOC–HC=CH–	hy	50	100	3	0	0	0		1		0									0	
COOH																					
Maleic anhydride		100	285								0										
Mallic acid	hy		20	3	3	0	0	0	1	0	0	1	3			3	3	0	0	0	
	hy	50	100	3	3	0	0	0	1	0	0	1	3	3	3	3	3	0	0	0	
Malonic acid			20			1	1	1	1	1	1	1					1	1		1	
$CH_2(COOH)_2$			50					1	1	1	1	1					1	1			
		100					3	3		3	3					3	3				
Manganese(II)	hy	5	100	3	P	P	P	1	1	1		1	3			3	1	0	0		
chloride $MnCl_2$	hy	50	20	1	3	P	P	1	1	1		1	3			3	1	0	0		
Manganese(II)		cs			0	0	0	0	0	0	0	0				0	0	0			
sulphate $MnSO_4$																					
Maritime climate	mo			2P	1P	1P	0	0	0	0	0	0	0	1	0	0	0	0	0	2	1
Methanol																					
see methyl alcohol																					
Menthol					0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
$C_{10}H_{19}OH$																					

Medium			Materials																		
	Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals						
Designation Chemical formula	%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Mercury dr Hg	100 all	20 <500	0 1	P 1	P 1	P 0		0 0	0 0	0 0	3 3	3 3	3 3	3 3	3 3	0	0 0	 0	1 3	3
Methane CH_4		200 600	0	0	0	0	0	0	0 0	0	0	0	0	0	0 0	0			0	
Methyl acetate CH_3COOCH_3	60 60	20 bp	0 0		0 0	0 0				0 0							0 0	0 0		
Methyl alcohol CH_3OH	<100 100	20 bp	 1	0 3	0 1	0 1	0	0 0	0 0	0 0	0 0		 0	 0	0 0	0 0	0 0	1 0	 1	 0
Methylamine hy $CH_3–NH_2$	25	20	1	0	0	0	0		0	0	3	3	3	3	3		0		0	
Methyl chloride dr CH_3Cl mo mo	100	20 20 100	0 3	0 P P	0 P P	0 P P		0 0 0	0 0 0	0	0		0	0	0 1	0	0 0 0		0 3 3	
Methyldehyde see formaldehyde																				
Methylene dichloride dr CH_2Cl_2 mo mo		20 20 bp	0	P P P	P P P	P P P	 0 1		 1 1	 1 1	 1 1	0 0 1			 0 0	 1 1	0 0 0		0 3 3	
Milk of lime $Ca(OH)_2$		20 bp	0 0	1 1	0 0	0 0													0 0	
Milk sugar see lactose																				

Medium			Materials																		
	Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals						
Designation Chemical formula	%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Mixed acids HNO_3 % / H_2SO_4 % / H_2O %																				
90 / 10 / –	20	0		0	0					3		3	3	3	3	0		1	3	
50 / 50 / –	20			0	0											0		3		
50 / 50 / –	90		3	1	1															
50 / 50 / –	120		3	3	3															
38 / 60 / 2	50		3	0	0															
25 / 75 / –	50		3	1	0															
25 / 75 / –	90		3	3	1															
25 / 75 / –	157		3	3	3															
15 / 20 / 65	20	3	3	0	0															
15 / 20 / 65	80		3	1	0															
10 / 70 / 20	50		3	0	0															
10 / 70 / 20	90		3	1	0															
5 / 30 / 65	20	3	3	0	0															
5 / 30 / 65	90	3	3	0	0															
5 / 30 / 65	bp	3	3	1	1															
5 / 15 / 80	134		3	1	1															
Molasses				0	0	0	0	0	0	0	0					0	0	0	0	
Monochloroacetic acid see chloroacetic acid																				
Naphthaline $C_{10}H_8$	100 100	20 390	0 0	0 0	0 0	0 0											0		1	
Naphthaline chloride	100 100	45 200								0 0										
Naphthaline sulphonic acid $C_{10}H_7SO_2H$	100 100	20 bp	0	 3	0 3	0 3				0 0										
Naphthenic acid hy	100	20		P	P	P	0	0	0		0					1			0	
Nickel (II) chloride hy $NiCl_2$ hy	10 10 tot	20 bp 70	3 3	P 3	P P	P P 0	0	1	0	0 0 1	1	1	3	1	3	1	0 0			0
Nickel (II) nitrate hy $Ni(NO_3)_2$ hy	10 <100	25 25	3 3	0 0	0 0	0 0	0 0	0 3	0	0 1	3 3	3			3 3	3 3	0 0	0 0	3 3	
Nickel (II) sulphate hy $NiSO_4$ hy		20 bp	3 3	0 0	0 0	0 0	0	1 0	1	1 1	1 1					3 3	0 0			

Medium: Designation, Chemical formula		Concentration %	Temperature °C	Materials: Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: steels 2.4858 / alloy	Nickel alloys: 8252.4816 / alloy 600	Nickel alloys: 2.4856 / alloy 625	Nickel alloys: 2.4610, 2.4819 /alloy C-4, C-246	Nickel alloys: 2.4360 / alloy 400	Copper alloys: 2.0882 / alloy CuNi 70/30	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Nitric acid		1	20	3	0	0	0				0	0	1	3	3	3	0	0	0		
HNO_3		1	bp	3	0	0	0				1	3					3	0	0		
5		20	3	0	0	0	0	3		0	3	3			3	3	0	0	3		
5		bp	3	1	0	0				1							0	0			
10		bp	3	1	0	0				1	3					3	0	0			
15		bp	3	1	0	0				3							0	0			
25		bp	3	3	0	0				3							1	0			
50		bp	3	3	3	1	0	3		3	3	3			3	3	1	0	3		
65		20	3	0	0	0		0		0							0	0	1		
65		bp	3	3	3	3	0	3		3	3	3			3	3	0	0	3		
99		bp	3	3	3	3	0	3		3	3	3			3	3	0	3			
20		290	3	3	3	3				3							3	0			
40		200	3	3	3	3				3							3	0			
Nitrobenzene $C_6H_x(NO_2)_y$	hy			0	0	0	0	0	0	0	1	0	0	0	0	0	0	0		0	
Nitrobenzoic acid $C_6H_4(NO_2)COOH$	hy		20	1	0	0	0	0	0	0	0	0	0	0	0		0			0	
Nitroglycerine $C_3H_5(ONO_2)_3$	hy		20	0	0	0	0													0	
Nitrogen		100	20	0		0	0		0	0	0	0	0	0	0	0	0	0		0	0
N		100	900	1													3				
Nitrous acid HNO_2 similar to nitric acid																					
Oleic acid see fatty acid																					
Oleum see sulphur trioxide																					
Oxalic acid	hy	all	20	3	3	0	0	1	1	0	0	1					3	0	0	0	
$C_2H_2O_4$	hy	10	bp	3	3	3	3	0	1	0	0	1	1			1	3	3	0	3	
	hy	sa		3	3	3	3	1	1	1	1	1									
Oxygen O			500	1	0	0	0					0			3	3				0	3
Ozone					0	0	0	0	0	0	0	0				1		0		0	
Paraffin			20	0	0	0	0											0		0	
$CnH_{2n}+_2$	me		120	0	0	0	0						0	0	0	0		0		0	

Medium: Designation, Chemical formula		Concentration %	Temperature °C	Materials: Non-/low- alloy steels	Stainless steels: Ferritic steels	Stainless steels: Austenitic steels	Stainless steels: Austenitic + Mo	Nickel alloys: steels 2.4858 / alloy	Nickel alloys: 8252.4816 / alloy 600	Nickel alloys: 2.4856 / alloy 625	Nickel alloys: 2.4610, 2.4819 /alloy C-4, C-246	Nickel alloys: 2.4360 / alloy 400	Copper alloys: 2.0882 / alloy CuNi 70/30	Copper alloys: Tombac	Copper alloys: Bronze	Pure metals: Copper	Pure metals: Nickel	Pure metals: Titanium	Pure metals: Tantalum	Pure metals: Aluminium	Pure metals: Silver
Perchlorethane see hexachlorethane																					
Perchloric acid (60%)		10	20	3	3	3	3											0		3	
$HClO_4$		100	20	3	3	3	3											0			
Perchlorethylene			20	0	0	0	0							0	0	0	0			0	
C_2Cl_4			bp	0	1	1	1							1	1	0	0			3	
	mo			3	P	P	P														
Perhydrol see hydrogen superoxide																					
Petroleum			20	0	0	0	0		0	0	0	0	0	1	0	0	0	0		0	
		bp	0	0	0	0		0	0	0	0		1	0	0	3	0		0		
Petrol see benzine (benzene)																					
Phenol see carbolic acid																					
Phloroglucinol $C_6H_3(OH)_3$			20		0	0	0	0	0	0	0	0						0	0	0	
Phosgene $COCl_2$	dr		20		0	0	0	0	0	0	0	0						0	0	0	
Phosphoric acid	hy	1	20	3	0	0	0	0	0	0	0	1	3			3	0	0	0	3	
H_3PO_4	hy	10	20	3	3	0	0				0							0	0		
	hy	30	bp	3	3	1	1				1	1	1	2	1	3	3	3	0	3	
	hy	60	bp	3	3	3	3				1							3	0		
	hy	80	20	3	3	1	0		0	0	0				0	1		3	0		0
	hy	80	bp	3	3	3	3		0		3				1		3	3	0		1
Phosphorous P	dr		20	0	0	0	0														
Phosphorous penta-chlorite PCl_5	dr	100	20	0	0	0					0					0	1				
Phtalic acid and			20	0		0	0				0	0		0	0	0	0			0	0
phtalic anhydride			200		0	3	0				0	0				0	0				0
$C_6H_4(COOH)_2$	dr		bp			0	0	0								0			0	0	

Medium				Materials																	
Designation Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Austenitic steels	Austenitic + Mo	Nickel alloys: steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	Copper alloys: 2.0882 / alloy CuNi 70/30	Tombac	Bronze	Pure metals: Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Picric acid	hy	3	20	3	0	0	0											0		1	0
$C_6H_2(OH)(NO_2)_3$	hy	cs		3	0	0	0	3	3		0	3	3	3	3	3	3	0		0	
	me		150	3	0	0	0											0		3	
Plaster																					
see calcium sulphate																					
Potash lye																					
see potassium hydroxide																					
Potassium	me		604	0		0	0				1							0		0	
K			800			0	0				1							0	1	0	
Potassium acetate	me	100	292	1		0	0									1		0			
$CH_3–COOK$	hy		20	1	0	0	0		0	0	0	0			1	1	0	0			
Potassium bisulphate	hy	5	20	3	3	2	0											0			
$KHSO_4$	hy	5	90	3	3	3	3											3			
Potassium bitartrate	hy	cs		3	3	0	0										0	0		0	
$KC_4H_5O_6$	hy	sa		3	3	3	1										1	0		0	
Potassium bromide	hy	5	30	3	P	P	P	0	1	0	0	1	0	0		0	0	0	0	3	
KBr																					
Potassium carbonate	hy	50	20	1	0	0	0	0	0	0	0	0	1	3	1	1	0	0	0	3	0
K_2CO_3	hy	50	bp	3	3	0	0	0	0	0	0	0		3			0	0	0	3	0
Potassium chlorate	hy	5	20	3	0	0	0	0	1	0		1	3	1	1	1	1	0		0	
$KClO_3$	hy	sa		3	0	0	0	0	3	0	0	3	3			1	3	0	0	1	
Potassium chloride	hy	10	20	3	3	P	P	0	0	0	0	0	0							1	
KCl	hy	10	<bp	3	3	P	P				1		3							1	
	hy	30	bp	3	3	P	P				1	0		3	1	3		0		0	0
	hy	cs		3	P	P	P				1										
	hy	sa		3	3	P	P				1										
Potassium chromate	hy	10	20	0		0	0	0	0	0	0	1	0	0	0	0	0	0		0	
K_2CrO_4	hy	10	bp	1		0	0											0		0	
Potassium cyanide	hy	10	20	3	0	0	0	0	3		0	1	3			3	3		0	3	
KCN	hy	10	bp	3	0	0	0						3	3	3	3				3	

Appendix B
Resistance tables
HYDRA

Medium				Materials																	
Designation Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Stainless steels: Ferritic steels	Austenitic steels	Austenitic + Mo	Nickel alloys: steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	Copper alloys: 2.0882 / alloy CuNi 70/30	Tombac	Bronze	Pure metals: Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Potassium	hy	10	40	3	0	0	0	1	1	1	1	1	0			3	1	0	0	0	
dichromate	hy	25	40	3	3	0	0	1	1	1	1	1	3	3	3	3	1	0	0	0	0
$K_2Cr_2O_7$	hy	25	bp	3	3	0	0				1		3	3	3	3		0	0	0	
Potassium	hy	1	20	0	0	0	1	1	0	0	0	0			0	1	0	0	0		
ferricyanide	hy	cs			0	0	0		0		0	0			0		0	0	0	0	3
$K_3(Fe(CN)_6)$	hy	sa		3	0	P	0		0		0						0	0	0	0	3
Potassium	hy	1	20		0	0	0	1	1	0	0	0	0			0	1	0	0	0	
ferrocyanide	hy	25	20		0	0	0	0	0	0	0	0	0		0		0	0	0	0	3
$K_4(Fe(CN)_6)$	hy	25	bp		1	1	0	0	0	0	0	0	0				0	0	0	0	3
Potassium fluoride	hy	cs		0	0	0	0				0									3	
KF	hy	sa		1	0	0	0				0										
Potassium hydroxide	hy	10	20		0	S	S	1	1	1	1	0	0			3	0	0	3	3	
KOH	hy	20	bp		0	S	S	1	1	1	1	0	3				0	0	3	3	
	hy	30	bp		3	S	S	1	3		1	0				3	0	3	3	3	
	hy	50	20	S	0	S	S	1	1	1	0	0	3				0	0	3	3	
	hy	50	bp	S	3	3	3	1	3		1	0	3			3	0	3	3	3	
	hy	sa		S	3	S	S				1		0						3	3	0
	me	100	360	3	3	3	3		3		3						0	3	3	3	
Potassium	hy	all	20		P	P	P	3	3		0	3	3				3	0		3	
hypochloride KClO	hy	all	bp		P	P	P	3	3		1	3	3				3	0		3	
Potassium iodide	hy		20	0	P	P	P	0	1	1	0	3	0			0	3	0	0	3	
KJ	hy		bp	0	3	P	P	0	1	1	0	3	0			0	3	0	0	3	
Potassium nitrate	hy	all	20		0	0	0	0	1	1	1	1					1	0		0	
KNO_3	hy	all	bp		0	0	0				1							0		1	
Potassium nitrite		all	bp	1	0	0	0	1	0	0	0	0	1	1	1	1	1				
KNO_2																					
Potassium permang-	hy	10	20	0	0	0	0				0	1	0				0	0	0	0	3
anate $KMnO_4$	hy	all	bp	3	1	1	1	0	1	1	1	1	0			0	0	0	0	0	
Potassium persulphate	hy	10	50	3	3	0	0		0		0	3		3	3	3	3	0		3	3
$K_2S_2O_8$																					
Potassium silicate			20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0		3	
K_2SiO_3																					
Potassium sulphate	hy	10	25	3	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	
K_2SO_4	hy	all	bp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	

Medium				Materials																	
Designation Chemical formula		Concentration %	Temperature °C		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
				Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Protein solutions			20	1	0	0	0	0	0	0	0	0	0					0	0	0	
Pyridine	dr	all	20		0	0	0											0		0	
C_5H_5N		all	bp		0	0	0		0	0	0	0					0	0		0	
Pyrogallol		all	20	3	0	0	0				0				0			0		0	
$C_6H_3(OH)_3$		all	bp	3	0	0	0				1				0			0		0	
Quinine bisulphate	dr		20	3	3	3	0	0		0	0	1	0			0		0	0		
Quinine sulphate	dr		20	3	0	0	0	0		0	0	1	0		0	0		0	0		
Quinol				3		0	0	0	0	0		1					1			0	
HO–C_6H_4–OH																					
Salicylic acid	dr	100	20	1	0	0	0	0	1	0	0	1	0			0	1	0	0	0	
HOC_6H_4COOH	mo	100	20	3		0	0				1	0						0			
	hy	cs		3		0	0	0	1	0	0	0	0				0	0		1	
Salmiac see ammonium chloride																					
Salpetre see potassium nitrate																					
Seawater at flow velocity v (m/s)																					
0 < v ≤ 1.5			20	1	P	P	P	P	P	0	0	P	1			1	P				
1.5 < v < 4.5			20	1	0	0	0	P	0	0	0	0	0	0		3	1				
Siliceous flux acid see fluorsilicic acid																					
Silver nitrate	hy	10	20	3	0	0	0	0	1	1	1	3	3	3	3	3	3	0	0	3	
$AgNO_3$	hy	10	bp	3	0	0	0										3	0			
	hy	20	60	3	0	0	0											0			
	hy	40	20	3	0	0	0				1							0			
	me	100	250	3	3	0	0														
Soap	hy	1	20	0	0	0	0		0	0		0	0	1	0	0	0	0		0	
	hy	1	75	0	0	0	0					0	0	1	0	0	0			0	
	hy	10	20	0	0	0	0										0	0		0	
Sodium ($O_2 \leq 0.005$ %)			200	0	0	0	0											0		1	
Na	me		600	3	1	0	0											0			

Appendix B

Resistance tables

HYDRA

Medium				Materials																	
Designation Chemical formula		Concentration %	Temperature °C		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
				Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Sodium acetate	hy	10	25	0	0	0	0		0	0	0	0				0	0	0	0	0	0
CH_3–COONa	hy	sa		3	0	0	0				0							0	0		
Sodium aluminate		100	20	0	0	0	0											0			
Na_3AlO_3	hy	10	25	0	0	0	0				1							0		3	
Sodium arsenate	hy	cs		0	0	0	0											0		0	
Na_2HAsO_4																					
Sodium bicarbonate		100	20		0	0	0											0		0	
$NaHCO_3$	hy	10	20	0	0	0	0	0	1	1	1	1	0	3	1	1	1	0		0	
	hy	cs			0	0	0	0	1	0	0	1	0			0	1	0	0	1	
	hy	sa			0	0	0				1							0			
Sodium bisulphate	hy	all	20	3	3	3	0	0	1	1	1	1	3	3	1	1	1	0	0	0	
$NaHSO_4$	hy	all	bp	3	3	3	1	0	1	1	1	1	3	3	1	3	1	0	0	1	
Sodium bisulphite	hy	10	20	3	3	0	0				1			1	0	3	0	0		0	
$NaHSO_3$	hy	50	20	3	0	0	0				1	0		1	0	3	0	0			
	hy	50	bp	3	3	3	0					0						0			
Sodium borate	hy	cs			0	0	0	0		0	0	1	0			0		0	0	1	
$NaBo_3$ 4 H_2O	me			3	3	3	3				3										
(Borax)																					
Sodium bromide	hy	all	20	3	3	3	P				1							0		3	
NaBr	hy	all	bp	3	3	3	P				1							0		3	
Sodium carbonate	hy	1	20	3	0	0	0	0	1	0	0	0	0			0	0	0	0	2	
Na_2CO_3	hy	all	bp		0	0	0	0	0	0	0						0	0	0	3	
	hy		400	3	3	3	3														
	me		900	3	3	3	3					0					0				
Sodium chloride	hy	0.5	20		P	P	P	0	1	0	0	0	0				1	0	0		
NaCl	hy	2	20		P	P	P	0	1	0	0	0	0				1	0	0		
	hy	cs		3	P	P	P	0	1	0	0	0	0			0	1	0	0	2	0
	hy	sa		3	3	3	P	0	1	0	1	0	0			0	1	0	0	3	0
Sodium chlorite	dr	100	20	3	P	P	0		0									0			
$NaClO_2$	hy	5	20			3	P											0			
	hy	5	bp			3	3				1							0			
	hy	10	80	3		3	P		0		1							0			
Sodium chromate	hy	all	bp	0	0	0	0	0	0	0	0	0	0	0	0	0				0	
Na_2CrO_4																					

Medium				Materials																		
					Stainless steels			Nickel alloys					Copper alloys			Pure metals						
Designation Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Sodium cyanide	me		600	1								3	3	3	3	3				3	3
NaCN	hy	cs		1	0	0	0					3	1	3	3	3	0	0		3	3
Sodium fluoride	hy	10	20	0		0	0								3					0	
NaF	hy	10	bp	0		0	0														
	hy	cs				S	S													0	
Sodium hydrogensulphate see sodium bisulphate																					
Sodium hydrogensulphite see sodium bisulphite																					
Sodium hydroxide	solid	100	all	0	0	0	0		0	0	0	0					0				0
NaOH	hy	<10	<60	0	0	0	0		0	0	0						0				
	hy	<10	<bp	3	3	0	0		0	0	0						0				
	hy	<20	<60	0	0	0	0		0	0	0						0				
	hy	<20	<bp	3	3	0	0		0	0	0						0				
	hy	<40	<60	0	0	0	0		0	0	0						0				
	hy	<40	<100	3	3	0	0		0	0	0						0				
	hy	<40	<100	3	3	3	3		0	0	0						0				
	hy	<50	<60	0	0	0	0		0	0	0						0				
	hy	<50	<100	3	3	0	0		0	0	0						0				
	hy	<50	<100	3	3	3	3		0	0	0						0				
	hy	<60	<90	3	3	0	0		0	0	0						0				
	hy	<60	<140	3	3	3	3		0	0	0						0				
	hy	<60	<140	3	3	3	3		3	0	3						0				
	hy	<60	>140	3	3	3	3		3	0	3						0				
Sodium hypochlorite	hy	5	20	3	3	3	P	0	3		0	3	3			3	3	0		3	
NaOCl	hy	10	50	3		P	P		0		1							0		3	
Sodium hyposulphite		all	20		3	0	0	0	1	1	1	1	3			3	1		0		
$Na_2S_2O_4$		all	bp		3	0	0	0	1	1	1	1	3			3	1		0		
Sodium iodide					P	P	P	0	0	0	0						0			1	
NaJ																					
Sodium nitrate	hy	5	20	3	0	0	0	0	0	0	0	1	0			0	1	0	0	0	
$NaNO_3$	hy	10	20	1	0	0	0	0	0	0	1	1	0	3	1	1	1	0	0	0	
	hy	<10	bp	3	0	0	0				0						1	0	0	3	3
	hy	30	20	1	0	0	0	0	0	1	1	1	0				1	0	0	0	
	hy	30	bp	1	0	0	0	0	0		3	1					1	0	0	0	
	me		320	3	0	0	0				0						1	0	0	0	3
Sodium nitrite	hy		20			0	0	1	0	0	0	0	0			1	3	0	0	1	
$NaNO_2$																					

Medium				Materials																		
					Stainless steels			Nickel alloys					Copper alloys			Pure metals						
Designation Chemical formula		Concentration %	Temperature °C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Sodium perborate	hy	10	20	3	0	0	0				1							1			
$NaBO_2$	hy	10	bp	3	0	0	0				1							1			
Sodium perchlorate	hy	10	20	3	3	0	0	1			1							0			
$NaClO_4$	hy	10	bp	3		0	0	1			1							0			
Sodium peroxide	hy	10	20	3	1	0	0	1	1	1	1	0	3			3	0	3	3	3	3
Na_2O_2	hy	10	bp	3	3	0	0	1	1	1	1	0	3			3	1	3	3	3	3
	me		460					3	1		3	3					0				
Sodium phosphate	hy	10	20		0	0	0	0	0	0	0	0	0	3	1	1	0	0	0	0	
Na_2HPO_4	hy	10	bp		0	0	0	0	0	0	0	0				3		0	0	1	
	hy	cs			0	0	0	0	0	0	0	0					0	0	0	0	
Sodium salicylate	hy	all	20		0	0	0	0			0					0	0	0		0	
$C_6H_4(OH)COONa$																					
Sodium silicofluoride	hy	cs		3	3	3	3	0	0	1	1	0				0				1	
$Na_2(SiF_6)$																					
Sodium sulphate	hy	10	20	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Na_2SO_4	hy	cs		3	1	0	0	0	1	0	0	1	0			0	1	0	0	0	
	hy	sa		3	3	0	0	0	0	0	0	0						0	0	1	
Sodium sulphide	hy	1	20	3	0	0	0	0	0			1					1	0			
Na_2S	hy	cs	20	3	3	3	0	0	1	0	0		3			3	1	0	0	1	
	hy	sa		3	3	3	1											0		3	
Sodium sulphite	hy	10	20	3	1	0	0					0	1	3	1	1		0		0	
Na_2SO_3	hy	50	bp	3	3	0	0											0		3	
Sodium superoxide see sodium peroxide																					
Sodium tetraborate see borax																					
Sodium thiosulphate	hy	1	20	1	0	0	0					0					0	0		0	
$Na_2S_2O_3$	hy	10	20	3	0	0	0											0		0	
	hy	25	bp	3	P	P	P										0	0		1	
cs			3	3	0	0		1			1	3			3	1	0	0	0		
Spirit of terpentine		100	20	3	0	0	0						0	1	0	0		0		0	
100		bp	3	0	0	0						0	1	0	0		0		0		

Medium			Materials																	
Designation Chemical formula	Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
	%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Spirits		20	1	0	0	0	0	0	0	0	0									
	bp	3	0	0	0	0	0	0	0	0										
Steam																				
$0_2 < 1$ ppm; Cl < 10 ppm		< 560	1	1	1	0				0							0			
$0_2 > 1$ ppm; Cl < 10 ppm		< 315	S	S	S	S				0						0	0			
$0_2 > 15$ ppm; Cl < 3 ppm		> 450	S	S	S	S				0							0			
Stearic acid	100	20	1	0	0	0		0	0	0	0	1	3	1	1	0	0		0	0
$CH_3(CH_2)_{16}COOH$	100	95	3	0	0	0	0	1		0	1	1			0	1	0	0	3	
100	180								1							0		3		
Succinic acid HOOC–CH_2–CH_2–COOH		bp	1	0	0	0	0	0	0	0	0	0	0	0						
Sulphur dr	100	60	0	0	0	0				0						0				
S me		130	1	0	0	0		0		0	3	3	3	3	3	3	0			3
me		240	3	0	0	0				0					3		0			
mo		20	3	2	1	0				0	3	3	3	3	3	3	0			
Sulphur dioxide dr	100	20	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SO_2 dr	100	60	3	3	1	1				0							0		0	
dr	100	400	3	3	3	0				1			3				0		0	3
dr	100	800	3	3	3	3				3						3	0		0	
mo	100	20	3	3	3	0	0	0	0	0	0	3	3	1	3	0	0	0	3	
mo	100	60	3	3	3	0				0							0		3	
mo	100	70	3	3	3	3				0							0		3	
Sulphuric acid	0.05	20	3	1	0	0											0	0	1	
H_2SO_4	0.05	bp	3	1	1	0											1	0	3	
	0.1	20	3	3	0	0											0	0	1	
	0.2	bp	3	3	3	0											1	0	3	
	0.8	bp	3	3	3	3											1	0	3	
	1	20	3	3	1	0		1	0	0	1	3			1	0	0	0	1	
	3	bp	3	3	3	3				1		3					1	0	3	
5	bp	3	3	3	3	1	3		3	1	3			3	3	3	0	3		
7.5	20	3	3	1	0											1	0	1		
10	bp	3	3	3	3	1	3		3	3	3			3	3	3	0	3		
25	20	3	3	3	3				0		3					3	0	1		
25	bp	3	3	3	3				3		3					3	0	3		
40	20	3	3	3	3				0	1	3	3	3	3		1	0	1		
40	bp	3	3	3	3				3		3					3	0	3	1	
50	20	3	3	3	3	1	3		0	3	3			3	3	3	0	3		
50	bp	3	3	3	3	3	3		3	3	3			3	3	3		3		

Medium			Materials																	
Designation Chemical formula	Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
	%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Sulphuric acid	60	20	3	3	3	3				0	1		3	3	3	0	3	0	3	
H_2SO_4	80	20	3	3	1	1				0	1	3	3	1	1		3	0	3	
90	20	3	3	1	0				0							3	0	3		
96	20	1	1	1	0				0	3	3			1	1	3	0	3		
Sulphurous acid hy	1	20	3	3	0	0		1		0	3					3		0	1	
H_2SO_3 hy	cs		3	3	0	0				0	3						1	0	3	
hy	sa		3	3	1	0				1								0	3	
Sulphur trioxide hy	100	20																	3	
SO_3 dr	100	20	0				2	3		0	3	2	0	0	0	3		3	0	
Tannic acid hy	5	20	3	0	0	0		0			0	0	1	0	0	0	0		0	
$C_{76}H_{52}O_{46}$ hy	25	100	3	3	0	0											0			
hy	50	bp	3	3	0	0						0					0			
Tar		20	0	0	0	0						0	1	0	0		0		1	
Tartaric acid hy	10	20	1	0	0	0	0	1	0	0	1	0	3	0		1	0	0	3	
hy	10	bp	3	1	0	0	0	3		1	3	0	3			3	1	0	3	
hy	25	20	3	1	0	0		0		0	0	0			0		0	0	3	
hy	25	bp	3	3	1	0		0		1	1	0			1		1	0	3	
hy	50	20	3	3	0	0				0		0					0	0	3	
hy	50	bp	3	3	3	3				1		0					3	0	3	
Tetrachloroethane see acetylen tetrachloride																				
Tetrachloroethylene pure	100	20	0	0	0	0				0		0	0	0	0	0	0		0	
pure	100	bp			0	0				0		0	0	0	0	0	0		0	
mo		20	3	3	P	P				0		1	3	1	1	0	0		3	
mo		bp	3	3	P	P				0		1	3	1	1	0	0		3	
Tin chloride	5	20	3	3	3	3	3	3		0	1	3				1	0	0	3	
$SnCl_2$; $SnCl_4$	sa		3	3	3	3														
Toluene	100	20	0	0	0	0					0	0	0	0	0		0		0	
C_6H_5-CH_3	100	bp	0	0	0	0					0	0	0	0	0		0		0	
Town gas			0	0	0	0	0	0	0	0	1	1	0	0	1	1				
Trichloroacetaldehyde see chloral																				
Trichloroethylene pure	100	20	0	0	0	0				0		0	0	0	0	0	0		0	
$CHCl=CCl_2$ pure	100	bp			0	0				0		0	0	0	0	0	0		0	
mo		20	3	3	P	P				0		1	3	1	1	0	0		3	
mo		bp	3	3	P	P				0		1	3	1	1	0	0		3	

Medium			Materials																	
Designation Chemical formula	Concentration	Temperature		Stainless steels			Nickel alloys					Copper alloys			Pure metals					
	%	°C	Non-/low- alloy steels	Ferritic steels	Austenitic steels	Austenitic + Mo	steels 2.4858 / alloy	8252.4816 / alloy 600	2.4856 / alloy 625	2.4610, 2.4819 /alloy C-4, C-246	2.4360 / alloy 400	2.0882 / alloy CuNi 70/30	Tombac	Bronze	Copper	Nickel	Titanium	Tantalum	Aluminium	Silver
Trichloromethane see chloroform																				
Tricresylphosphate			0	0	0	0	0	0	0	0					0					0
Trinitrophenol see picric acid																				
Trichloroacetic acid see chloroacetic acid																				
Urea	100	20	0	0	0	0				0	0					0	0	0	0	
$CO(NH_2)_2$	100	150	3		1	0		3		1	1					1	0	0	3	1
Uric acid hy		20	3	0	0	0	0	1	0	0	0	0			1		0		3	
$C_5H_4O_4N_3$ hy		100	3	0	0	0	0	1	0	0	0	0			1		0		3	
Vinyl chloride dr		20	0	0	0	0				0				0					0	
$CH_2{=}CHCl$		<400	0	0	0	0				0						0	0			
Water vapour see steam																				
Wine		20	3	0	0	0		0					3	3		3		0	3	
	bp	3	0	0	0		0					3	3		3		0	3		
Yeast		20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yellow potassium prussiate see potassium ferricyanide																				
Zinc chloride hy	5	20	3	P	P	P	0	1	0	0	1	3				1	0	0	3	
$ZnCl_2$ hy	5	bp	3	3	3	3	0	3		1	3	3				1	0	0	3	
hy	10	20	3	P	P	P					3					0	0	0	0	
hy	20	20	3	P	P	P						3	3	3			0	0		
hy	75	20	3	3	P	P											0	0		
Zinc sulphate hy	2	20	3	0	0	0				0		0					0	0	0	
$ZnSO_4$ hy	20	bp	3	0	0	0				1							0	0	3	
hy	30	bp	3	3	0	0				1							0	0	3	
hy	cs		3	0	0	0	0	1	0	1	1	0				1	0	0	1	
hy	sa		3	3	0	0				1							0	0	3	

Content

Appendix C – Pipes/Flanges/Pipe bends

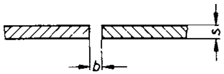
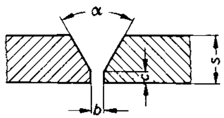
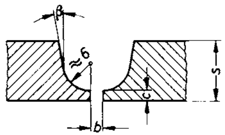
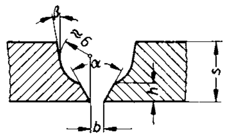
nominal width	exterior dia-meter	stan-dard wall thick-ness	masses (weights) in relation to length in kg/m wall thickness in mm											
DN	mm	mm	1.6	1.8	2	2.3	2.6	2.9	3.2	3.6	4	4.5	5	5.6
6	10.2	1.6	**0.339**	0.373	0.404	0.448	0.487							
8	13.5	1.8	**0.470**	0.519	**0.567**	0.635	0.699	0.758	0.813					
10	17.2	1.8	0.616	0.684	**0.750**	0.845	0.936	1.02	1.10	0.879	1.30	1.41		
15	21.3	2	**0.777**	0.866	**0.952**	1.08	1.20	1.32	**1.43**	1.21	**1.71**	1.86	2.01	
20	26.9	2	**0.998**	**1.11**	**1.23**	1.40	1.56	1.72	**1.87**	1.57	**2.26**	2.49	2.70	2.94
25	33.7	2	**1.270**	1.42	**1.56**	**1.78**	1.99	2.20	**2.41**	2.07	2.93	**3.24**	3.54	3.88
32	42.4	2.3	**1.610**	1.80	**1.99**	**2.27**	**2.55**	2.82	3.09	2.67	3.79	4.21	**4.61**	5.08
40	48.3	2.3	**1.840**	2.06	**2.28**	**2.61**	**2.93**	3.25	3.56	**3.44**	4.37	4.86	**5.34**	5.90
50	60.3	2.3	**2.320**	2.60	**2.88**	**3.29**	3.70	**4.11**	4.51	**3.97**	**5.55**	6.19	6.82	**7.55**
65	76.1	2.6	**2.940**	3.30	3.65	**4.19**	**4.71**	**5.24**	5.75	5.03	7.11	7.95	**8.77**	9.74
80	88.9	2.9	3.440	3.87	**4.29**	**4.91**	5.53	**6.15**	**6.76**	6.44	8.38	9.37	10.3	**11.5**
100	114.3	3.2	4.450	4.99	**5.54**	6.35	**7.16**	**7.97**	**8.77**	7.57	10.9	12.2	13.5	15.0
125	139.7	3.6	5.450	6.12	**6.79**	7.79	**8.79**	9.78	**10.8**	**9.83**	**13.4**	15.0	16.6	18.5
150	168.3	4	6.580	7.39	8.20	9.42	10.6	11.8	**13.0**	**12.1**	**16.2**	**18.2**	20.1	22.5
200	219.1	4.5		9.65	10.7	12.3	13.9	15.5	17.0	14.6	21.2	**23.8**	26.4	29.5
250	273.0	5			13.4	15.4	17.3	19.3	21.3	**19.1**	26.5	29.8	**33.0**	36.9
300	323.9	5.6					20.6	23.0	25.3	**23.9**	**31.6**	**35.4**	39.3	**44.0**
350	355.6	5.6					22.6	25.2	27.8	28.4	**34.7**	39.0	**43.2**	**48.3**
400	406.4	6.3					25.9	28.9	31.8	31.3	**39.7**	44.6	**49.5**	55.4
450	457	6.3							35.8	35.8	**44.7**	50.2	**55.7**	62.3
500	508	6.3							39.8	40.3	49.5	55.9	**62.0**	**69.4**
600	610	6.3							47.9	44.8	59.8	67.2	74.6	**83.5**
700	711	7.1								53.8	69.7	78.4	87.1	97.4
800	813	8									79.8	89.7	99.6	112
900	914	10									89.8	101	112	125
1000	1016	10									99.8	112	125	140

Appendix C
Seamless and Welded Steel Pipes
DIN EN 10220, edition 03.2003 (extract), weights and measures

nominal width	exterior dia-meter	stan-dard wall thick-ness	masses (weights) in relation to length in kg/m wall thickness in mm											
DN	mm	mm	6.3	7.1	8	8.8	10	11	12.5	14.2	16	17.5	20	22.2
6	10.2	1.6												
8	13.5	1.8												
10	17.2	1.8												
15	21.3	2												
20	26.9	2	3.20	3.47	3.73									
25	33.7	2	4.26	4.66	5.07	5.40								
32	42.4	2.3	5.61	6.18	6.79	7.29	7.99							
40	48.3	2.3	6.53	7.21	7.95	8.57	9.45	10.1	11.0					
50	60.3	2.3	8.39	9.32	10.3	11.2	12.4	13.4	14.7	16.1	17.5			
65	76.1	2.6	10.8	**12.1**	13.4	14.6	16.3	17.7	19.6	21.7	23.7	25.3	27.7	
80	88.9	2.9	12.8	14.3	**16.0**	17.4	19.5	21.1	23.6	26.2	28.8	30.8	34.0	36.5
100	114.3	3.2	**16.8**	18.8	21.0	**22.9**	25.7	28.0	31.4	35.1	38.8	41.8	46.5	50.4
125	139.7	3.6	**20.7**	23.2	26.0	28.4	**32.0**	34.9	39.2	43.9	48.8	52.7	59.0	64.3
150	168.3	4	25.2	**28.2**	31.6	34.6	39.0	**42.7**	48.0	54.0	60.1	65.1	73.1	80.0
200	219.1	4.5	**33.1**	37.1	**41.6**	45.6	51.6	56.5	**63.7**	71.8	80.1	87.0	98.2	108
250	273.0	5	**41.4**	46.6	52.3	57.3	**64.9**	71.1	80.3	90.6	101	110	125	137
300	323.9	5.6	49.3	**55.5**	62.3	68.4	**77.4**	84.9	96.0	108	121	132	150	165
350	355.6	5.6	54.3	61.0	**68.6**	75.3	85.2	**93.5**	106	120	134	146	166	183
400	406.4	6.3	**62.2**	69.9	78.6	**86.3**	97.8	107	**121**	137	154	168	191	210
450	457	6.3	**70.0**	78.8	88.6	97.3	**110**	121	137	155	174	190	216	238
500	508	6.3	**77.9**	87.7	98.6	108	123	**135**	153	173	194	212	241	266
600	610	6.3	**93.8**	106	119	130	148	162	**184**	209	234	256	291	322
700	711	7.1	109	**123**	139	152	173	190	215	244	274	299	341	377
800	813	8	125	141	**159**	175	198	218	247	280	314	343	391	433
900	914	10	141	159	179	**196**	**223**	245	278	315	354	387	441	488
1000	1016	10	157	177	199	219	**248**	273	309	351	395	431	491	544

Appendix C

Gap shapes for steel pipes, guidelines for fusion welding of blunt seams, welding seam preparation acc. to DIN EN ISO 9692-1, edition 05.2004 (extract)

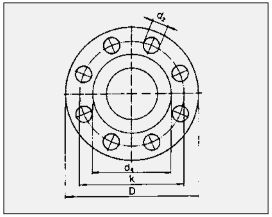
ident. no.	wall thickness	term	symbol [1]	gap shape	dimensions: Flank angle approx.		bar distance [2]	bar height	Flank height
–	s	–	–	–	α	β	b	c	h
–	mm	–	–	–	degree	degree	mm	mm	mm
1	up to 3	I-seam			–	–	0 to 3	–	–
2	up to 16	V-seam			40 to 60 for SG 60 for E and G	–	0 to 4	to 2	–
3	over 12	U-seam			–	8	0 to 3	to 2	–
4	over 12	U-seam on V-root			60	8	0 to 3	–	~ 4

[1] see DIN 1912 for additional symbols

[2] the given dimensions apply to attached parts

Appendix C
Standard flanges
DIN 2501: edition 02.1972, DIN EN 1092: edition 06.2002 (extract)

Connection dimension PN 1 / PN 2,5 / PN 6



	DIN 2501	*DIN EN 1092*
Exterior diameter	*D*	*D*
Sealing ridge diameter	d_4	d_1
Hole circle diameter	*k*	*K*
Bolt hole diameter	d_2	*L*

nominal width	nominal pressure 1 and 2.5						nominal pressure 6					
DN	D	d_4	k	bolts		d_2	D	d_4	k	bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
6	connection dimensions see nominal pressure 6						65	25	40	4	M 10	11
8							70	30	45	4	M 10	11
10							75	35	50	4	M 10	11
15							80	40	55	4	M 10	11
20							90	50	65	4	M 10	11
25							100	60	75	4	M 10	11
32							120	70	90	4	M 12	14
40							130	80	100	4	M 12	14
50							140	90	110	4	M 12	14
65							160	110	130	4	M 12	14
80							190	128	150	4	M 16	18
100							210	148	170	4	M 16	18
125							240	178	200	8	M 16	18
150							265	202	225	8	M 16	18
200							320	258	280	8	M 16	18
250							375	312	335	12	M 16	18
300							440	365	395	12	M 20	22
350							490	415	445	12	M 20	22
400							540	465	495	16	M 20	22
450							595	520	550	16	M 20	22
500							645	570	600	20	M 20	22

nominal width	nominal pressure 1 and 2.5						nominal pressure 6					
DN	D	d_4	k	bolts		d_2	D	d_4	k	bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
600	connection dimensions see nominal pressure 6						755	670	705	20	M 24	26
700							860	775	810	24	M 24	26
800							975	880	920	24	M 27	30
900							1075	980	1020	24	M 27	30
1000							1175	1080	1120	28	M 27	30
1200	1375	1280	1320	32	M 27	30	1405	1295	1340	32	M 30	33
1400	1575	1480	1520	36	M 27	30	1630	1510	1560	36	M 33	36
1600	1790	1690	1730	40	M 27	30	1830	1710	1760	40	M 33	36
1800	1990	1890	1930	44	M 27	30	2045	1920	1970	44	M 36	39
2000	2190	2090	2130	48	M 27	30	2265	2125	2180	48	M 39	42
2200	2405	2295	2340	52	M 30	33	2475	2335	2390	52	M 39	42
2400	2605	2495	2540	56	M 30	33	2685	2545	2600	56	M 39	42
2600	2805	2695	2740	60	M 30	33	2905	2750	2810	60	M 45	48
2800	3030	2910	2960	64	M 33	36	3115	2960	3020	64	M 45	48
3000	3230	3110	3160	68	M 33	36	3315	3160	3220	68	M 45	48
3200	3430	3310	3360	72	M 33	36	3525	3370	3430	72	M 45	48
3400	3630	3510	3560	76	M 33	36	3735	3580	3640	76	M 45	48
3600	3840	3770	3770	80	M 33	36	3970	3790	3860	80	M 52	56
3800	4045	3970	3970	80	M 36	39	no standard flanges					
4000	4245	4120	4170	84	M 36	39						

Appendix C

Standard flanges

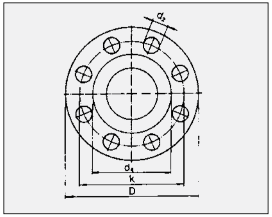
DIN 2501: edition 02.1972, DIN EN 1092: edition 06.2002 (extract)

Appendix C

Standard flanges

DIN 2501: edition 02.1972, DIN EN 1092: edition 06.2002 (extract)

Connection dimension PN 10 / PN 16



	DIN 2501	*DIN EN 1092*
Exterior diameter	*D*	*D*
Sealing ridge diameter	d_4	d_1
Hole circle diameter	*k*	*K*
Bolt hole diameter	d_2	*L*

nominal width	nominal pressure 10						nominal pressure 16					
DN	D	d_4	k	bolts		d_2	D	d_4	k	bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
6	connection dimensions see nominal pressure 40						connection dimensions see nominal pressure 40					
8												
10												
15												
20												
25												
32												
40												
50												
65							connection dimensions see nominal pressure 40*					
80							connection dimensions see nominal pressure 40					
100							220	158	180	8	M 16	18
125	connection dimensions see nominal pressure 16						250	188	210	8	M 16	18
150							285	212	240	8	M 20	22
200	340	268	295	8	M 20	22	340	268	295	12	M 20	22
250	395	320	350	12	M 20	22	405	320	355	12	M 24	26
300	445	370	400	12	M 20	22	460	378	410	12	M 24	26
350	505	430	460	16	M 20	22	520	438	470	16	M 24	26
400	565	482	515	16	M 24	26	580	490	525	16	M 27	30
450	615	532	565	20	M 24	26	640	550	585	20	M 27	30
500	670	585	620	20	M 24	26	715	610	650	20	M30	33

* DIN 2501: 4 / DIN EN 1092: 8, but 4 are permitted if agreed

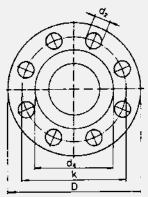
nominal width	nominal pressure 10						nominal pressure 16					
DN	D	d_4	k	bolts		d_2	D	d_4	k	bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
600	780	685	725	20	M 27	30	840	725	770	20	M 33	36
700	895	800	840	24	M 27	30	910	795	840	24	M 33	36
800	1015	905	950	24	M 30	33	1025	900	950	24	M 36	39
900	1115	1005	1050	28	M 30	33	1125	1000	1050	28	M 36	39
1000	1230	1110	1160	28	M 33	36	1255	1115	1170	28	M 39	42
1200	1455	1330	1380	32	M 36	39	1485	1330	1390	32	M 45	48
1400	1675	1535	1590	36	M 39	42	1685	1530	1590	36	M 45	48
1600	1915	1760	1820	40	M 45	48	1930	1750	1820	40	M 52	56
1800	2115	1960	2020	44	M 45	48	2130	1950	2020	44	M 52	56
2000	2325	2170	2230	48	M 45	48	2345	2150	2230	48	M 56	62
2200	2550	2370	2440	52	M 52	56	2555	2360	2440	52	M 56	62
2400	2760	2570	2650	56	M 52	56	no standard flanges					
2600	2960	2780	2850	60	M 52	56						
2800	3180	3000	3070	64	M 52	56						
3000	3405	3210	3290	68	M 56	62						
3200	no standard flanges											
3400												
3600												
3800												
4000												

Appendix C

Standard flanges

DIN 2501: edition 02.1972, DIN EN 1092: edition 06.2002 (extract)

Connection dimension PN 25 / PN 40



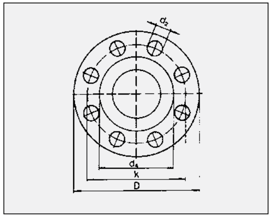
	DIN 2501	*DIN EN 1092*
Exterior diameter	*D*	*D*
Sealing ridge diameter	d_4	d_1
Hole circle diameter	*k*	*K*
Bolt hole diameter	d_2	*L*

nominal width	nominal pressure 25						nominal pressure 40					
DN	D	d_4	k	bolts		d_2	D	d_4	k	bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
6							75	32	50	4	M 10	11
8							80	38	55	4	M 10	11
10							90	40	60	4	M 12	14
15							95	45	65	4	M 12	14
20							105	58	75	4	M 12	14
25							115	68	85	4	M 12	14
32	Connection dimension siehe Nominal pressure 40						140	78	100	4	M 16	18
40							150	88	110	4	M 16	18
50							165	102	125	4	M 16	18
65							185	122	145	8	M 16	18
80							200	138	160	8	M 16	18
100							235	162	190	8	M 20	22
125							270	188	220	8	M 24	26
150							300	218	250	8	M 24	26
200	360	278	310	12	M 24	26	375	285	320	12	M 27	30
250	425	335	370	12	M 27	30	450	345	385	12	M 30	33
300	485	395	430	16	M 27	30	515	410	450	16	M 30	33
350	555	450	490	16	M 30	33	580	465	510	16	M 33	36
400	620	505	550	16	M 33	36	660	535	585	16	M 36	39
450	—	—	—	—	—	—	685	560	610	20	M 36	39
500	730	615	660	20	M 33	36	755	615	670	20	M 39	42

nominal width	nominal pressure 25						nominal pressure 40					
DN	D	d_4	k	bolts		d_2	D	d_4	k	bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
600	845	720	770	20	M 36	39	890	735	795	20	M 45	48
700	960	820	875	24	M 39	42	995	840	900	24	M 45	48
800	1085	930	990	24	M 45	48	1140	960	1030	24	M 52	56
900	1185	1030	1090	28	M 45	48	1250	1070	1140	28	M 52	56
1000	1320	1140	1210	28	M 52	56	1360	1180	1250	28	M 52	56
1200	1530	1350	1420	32	M 52	56	1575	1380	1460	32	M 56	62
1400	1755	1560	1640	36	M 56	62	1795	1600	1680	36	M 56	62
1600	1975	1780	1860	40	M 56	62	2025	1815	1900	40	M 64	70
1800	2195	1985	2070	44	M 64	70						
2000	2425	2210	2300	48	M 64	70						
2200												
2400												
2600												
2800												
3000												
3200							no standard flanges					
3400												
3600	no standard flanges											
3800												
4000												

Appendix C
Standard flanges
DIN 2501: edition 02.1972, DIN EN 1092: edition 06.2002 (extract)

Connection dimension PN 63 / PN 100



	DIN 2501	DIN EN 1092
Exterior diameter	*D*	*D*
Sealing ridge diameter	d_4	d_1
Hole circle diameter	*k*	*K*
Bolt hole diameter	d_2	*L*

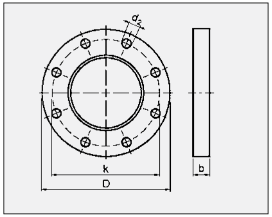
nominal width	nominal pressure 63						nominal pressure 100					
DN	D	d_4	k	bolts		d_2	D	d_4	k	bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
6	Connection dimension siehe Nominal pressure 100											
8												
10							100	40	70	4	M 12	14
15							105	45	75	4	M 12	14
20*							130	58	90	4	M 16	18
25							140	68	100	4	M 16	18
32*							155	78	110	4	M 20	22
40							170	88	125	4	M 20	22
50	180	102	135	4	M 20	22	195	102	145	4	M 24	26
65	205	122	160	8	M 20	22	220	122	170	8	M 24	26
80	215	138	170	8	M 20	22	230	138	180	8	M 24	26
100	250	162	200	8	M 24	26	265	162	210	8	M 27	30
125	295	188	240	8	M 27	30	315	188	250	8	M 30	33
150	345	218	280	8	M 30	33	355	218	290	12	M 30	33
200	415	285	345	12	M 33	36	430	285	360	12	M 33	36
250	470	345	400	12	M 33	36	505	345	430	12	M 36	39
300	530	410	460	16	M 33	36	585	410	500	16	M 39	42
350	600	465	525	16	M 36	39	655	465	560	16	M 45	48
400	670	535	585	16	M 39	42	715	535	620	16	M 45	48
500	800	615	705	20	M 45	48	870	615	760	20	M 52	56
600	930	735	820	20	M 52	56	990	735	875	20	M 56	62

* Only DIN EN 1092

nominal width	nominal pressure 63						nominal pressure 100					
DN	D	d_4	k	bolts		d_2	D	d_4	k	bolts		d_2
	D	d_1	K	number	thread	L	D	d_1	K	number	thread	L
700	1045	840	935	24	M 52	56	1145	840	1020	24	M 64	70
800	1165	960	1050	24	M 56	62	no standard flanges					
900	1285	1070	1170	28	M 56	62						
1000	1415	1180	1290	28	M 64	70						
1200	1665	1380	1530	32	M 72	78						

Appendix C
Flanges for exhaust pipes on ships
DIN 86044, edition 09.1980 (extract)

Connection dimension



	DIN 86044
Exterior diameter	*D*
Flange thickness	*b*
Hole circle diameter	*k*
Bolt hole diameter	d_2

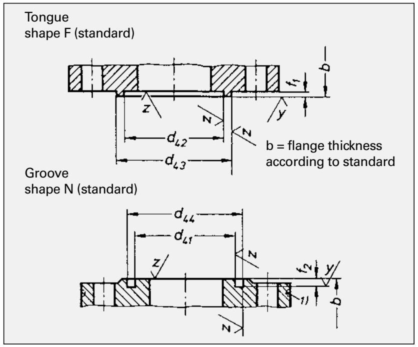
nominal width	flange			bolts		
DN	D	b	k	number	thread	d_2
200	320	16	280	8	M 16	18
250	375	16	335	12	M 16	18
300	440	16	395	12	M 20	22
350	490	16	445	12	M 20	22
400	540	16	495	16	M 20	22
450	595	16	550	16	M 20	22
500	645	16	600	20	M 20	22
(550)	703	20	650	20	M 20	22
600	754	20	700	20	M 20	22
(650)	805	20	750	20	M 20	22
700	856	20	800	24	M 20	22
(750)	907	20	860	24	M 20	22
800	958	20	900	24	M 20	22
(850)	1010	20	950	28	M 20	22
900	1060	20	1010	28	M 20	22
(950)	1110	20	1060	28	M 20	22
1000	1162	20	1110	32	M 20	22
1100	1266	20	1210	32	M 20	22

Avoid values in brackets, if possible.

nominal width	flange			bolts		
DN	D	b	k	number	thread	d_2
1200	1366	20	1310	36	M 20	22
1300	1466	20	1410	40	M 20	22
1400	1566	20	1510	40	M 20	22
1500	1666	20	1610	44	M 20	22
1600	1766	20	1710	48	M 20	22
1700	1866	20	1810	48	M 20	22
1800	1966	20	1910	52	M 20	22
1900	2066	20	2010	56	M 20	22
2000	2166	20	2110	56	M 20	22
2100	2266	20	2210	60	M 20	22
2200	2366	20	2310	64	M 20	22
2300	2466	20	2410	64	M 20	22
2400	2566	20	2510	68	M 20	22
2500	2666	20	2610	72	M 20	22
2600	2766	20	2710	72	M 20	22
2700	2866	20	2810	76	M 20	22
2800	2966	20	2910	80	M 20	22
2900	3066	20	3010	80	M 20	22
3000	3166	20	3110	84	M 20	22

Appendix C
Flanges with tongue or groove
DIN 2512: edition 08.1999 (extract), DIN EN 1092: edition 06.2002 (extract)

Dimensions (tongue, groove), PN 10 bis PN 160 / 100



DIN 2512	DIN EN 1092
d_{42}	w
d_{43}	x
d_{41}	z
d_{44}	y
f_1	f_2
f_2	f_3
$z \checkmark = \sqrt{R_z = 160}$ turned $y \checkmark = \sqrt{R_z = 40}$	*Sealing face turned* R_z = 3,2 - 12,5

nominal width	tongue			groove		
DN	d_{42}	d_{43}	f_1	d_{41}	d_{44}	f_2
	w	x	f_2	z	y	f_3
	+0,5 0	0 -0,5	+0,5 0	0 -0,5	+0,5 0	+0,5 0
4/6*	20	30	4,5	19	31	4,0
8*	22	32		21	33	
10	24	34		23	35	
15	29	39		28	40	
20	36	50		35	51	
25	43	57		42	58	
32	51	65		50	66	
40	61	75		60	76	
50	73	87		72	88	
65	95	109		94	110	
80	106	120		105	121	
100	129	149	5,0	128	150	4,5
125	155	175		154	176	
150	183	203		182	204	
200	239	259		238	260	

nominal width	tongue			groove		
DN	d_{42}	d_{43}	f_1	d_{41}	d_{44}	f_2
	w	x	f_2	z	y	f_3
	+0,5 0	0 -0,5	+0,5 0	0 -0,5	+0,5 0	+0,5 0
250	292	312	5,0	291	313	4,5
300	343	363		342	364	
350	395	421	5,5	394	422	5,0
400	447	473		446	474	
500	549	575		548	576	
600	649	675		648	676	
700	751	777		750	778	
800	856	882		855	883	
900	961	987		960	988	
1000	1062	1092	6,5	1060	1094	6,0

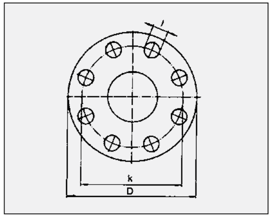
*) only for flanges applied in cryogenics. Avoid values in brackets, if possible.

Appendix C

Flanges according to US standards

ANSI B 16.5

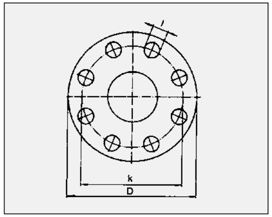
Connection dimension Class 150



D Exterior diameter
k Hole circle diameter
l Bolt hole diameter

nominal width		flange				bolts				
		exterior diameter		hole circle diameter		number	hole diameter		thread	
DN		D		k		–	l		–	
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch
15	**1/2**	88.9	3 1/2	60.3	2 3/8	4	15.9	5/8	12.7	1/2
20	**3/4**	98.4	3 7/8	69.8	2 3/4	4	15.9	5/8	12.7	1/2
25	**1**	107.9	4 1/4	79.4	3 1/8	4	15.9	5/8	12.7	1/2
32	**1 1/4**	117.5	4 5/8	88.9	3 1/2	4	15.9	5/8	12.7	1/2
40	**1 1/2**	127.0	5	98.4	3 7/8	4	15.9	5/8	12.7	1/2
50	**2**	152.4	6	120.6	4 3/4	4	19.0	3/4	15.9	5/8
65	**2 1/2**	177.8	7	139.7	5 1/2	4	19.0	3/4	15.9	5/8
80	**3**	190.5	7 1/2	152.4	6	4	19.0	3/4	15.9	5/8
100	**4**	228.6	9	190.5	7 1/2	8	19.0	3/4	15.9	5/8
125	**5**	254.0	10	215.9	8 1/2	8	22.2	7/8	19.0	3/4
150	**6**	279.4	11	241.3	9 1/2	8	22.2	7/8	19.0	3/4
200	**8**	342.9	13 1/2	298.4	11 3/4	8	22.2	7/8	19.0	3/4
250	**10**	406.4	16	361.9	14 1/4	12	25.4	1	22.2	7/8
300	**12**	482.6	19	431.8	17	12	25.4	1	22.2	7/8
350	**14**	533.4	21	476.2	18 3/4	12	28.6	1 1/8	22.2	1
400	**16**	596.9	23 1/2	539.7	21 1/4	16	28.6	1 1/8	25.4	1
450	**18**	635.0	25	577.8	22 3/4	16	31.7	1 1/4	28.6	1 1/8
500	**20**	698.5	27 1/2	635.0	25	20	31.7	1 1/4	28.6	1 1/8
600	**24**	812.8	32	749.3	29 1/2	20	34.9	1 3/8	31.7	1 1/4
700	**28**	869.9	34 1/4	806.4	31 3/4	24	34.9	1 3/8	31.7	1 1/4
800	**32**	984.2	38 3/4	914.4	36	28	34.9	1 3/8	31.7	1 1/4
900	**36**	1168.4	46	1085.8	42 3/4	32	41.3	1 5/8	38.1	1 1/2
1000	**40**	1346.2	53	1257.3	49 1/2	36	41.3	1 5/8	38.1	1 1/2

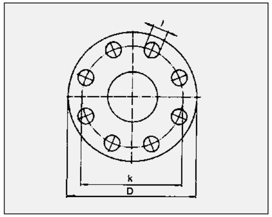
Connection dimension Class 300



D Exterior diameter
k Hole circle diameter
l Bolt hole diameter

nominal width		flange				bolts				
		exterior diameter		hole circle diameter		number	hole diameter		thread	
DN		D		k		–	l		–	
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch
15	**1/2**	95.2	3 3/4	66.7	2 5/8	4	15.9	5/8	12.7	1/2
20	**3/4**	117.5	4 5/8	82.5	3 1/4	4	19.0	3/4	15.9	5/8
25	**1**	123.8	4 7/8	88.9	3 1/2	4	19.0	3/4	15.9	5/8
32	**1 1/4**	133.3	5 1/4	98.4	3 7/8	4	19.0	3/4	15.9	5/8
40	**1 1/2**	155.6	6 1/8	114.3	4 1/2	4	22.2	7/8	19.0	3/4
50	**2**	165.1	6 1/2	127.0	5	8	19.0	3/4	15.9	5/8
65	**2 1/2**	190.5	7 1/2	149.2	5 7/8	8	22.2	7/8	19.0	3/4
80	**3**	209.5	8 1/4	168.3	6 5/8	8	22.2	7/8	19.0	3/4
100	**4**	254.0	10	200.0	7 7/8	8	22.2	7/8	19.0	3/4
125	**5**	279.4	11	234.9	9 1/4	8	22.2	7/8	19.0	3/4
150	**6**	317.5	12 1/2	269.9	10 5/8	12	22.2	7/8	19.0	3/4
200	**8**	381.0	15	330.2	13	12	25.4	1	22.2	7/8
250	**10**	444.5	17 1/2	387.3	15 1/4	16	28.6	1 1/8	25.4	1
300	**12**	520.7	20 1/2	450.8	17 3/4	16	31.7	1 1/4	28.6	1 1/8
350	**14**	584.2	23	514.3	20 1/4	20	31.7	1 1/4	28.6	1 1/8
400	**16**	647.7	25 1/2	571.5	22 1/2	20	34.9	1 3/8	31.7	1 1/4
450	**18**	711.2	28	628.6	24 3/4	24	34.9	1 3/8	31.7	1 1/4
500	**20**	774.7	30 1/2	685.8	27	24	34.9	1 3/8	31.7	1 1/4
600	**24**	914.4	36	812.8	32	24	41.3	1 5/8	38.1	1 1/2
700	**28**	971.5	38 1/4	876.3	34 1/2	28	44.4	1 3/4	41.3	1 5/8
800	**32**	1092.2	43	996.9	39 1/4	28	47.6	1 7/8	44.4	1 3/4
900	**36**	1270.0	50	1168.4	46	32	54.0	2 1/8	50.8	2
1000	**40**	1447.8	57	1339.8	52 3/4	36	54.0	2 1/8	50.8	2

Connection dimension Class 400



D Exterior diameter
k Hole circle diameter
l Bolt hole diameter

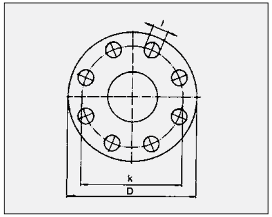
nominal width		flange				bolts				
		exterior diameter		hole circle diameter		number	hole diameter		thread	
DN		D		k		–	l		–	
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch
15	**1/2**	95.2	3 3/4	66.7	2 5/8	4	15.9	5/8	12.7	1/2
20	**3/4**	117.5	4 5/8	82.5	3 1/4	4	19.0	3/4	15.9	5/8
25	**1**	123.8	4 7/8	88.9	3 1/2	4	19.0	3/4	15.9	5/8
32	**1 1/4**	133.3	5 1/4	98.4	3 7/8	4	19.0	3/4	15.9	5/8
40	**1 1/2**	155.6	6 1/8	114.3	4 1/2	4	22.2	7/8	19.0	3/4
50	**2**	165.1	6 1/2	127.0	5	8	19.0	3/4	15.9	5/8
65	**2 1/2**	190.5	7 1/2	149.2	5 7/8	8	22.2	7/8	19.0	3/4
80	**3**	209.5	8 1/4	168.3	6 5/8	8	22.2	7/8	19.0	3/4
100	**4**	254.0	10	200.0	7 7/8	8	25.4	1	22.2	7/8
125	**5**	279.4	11	234.9	9 1/4	8	25.4	1	22.2	7/8
150	**6**	317.5	12 1/2	269.9	10 5/8	12	25.4	1	22.2	7/8
200	**8**	381.0	15	330.2	13	12	28.6	1 1/8	25.4	1
250	**10**	444.5	17 1/2	387.3	15 1/4	16	31.7	1 1/4	28.6	1 1/8
300	**12**	520.7	20 1/2	450.8	17 3/4	16	34.9	1 3/8	31.7	1 1/4
350	**14**	584.2	23	514.3	20 1/4	20	34.9	1 3/8	31.7	1 1/4
400	**16**	647.7	25 1/2	571.5	22 1/2	20	38.1	1 1/2	34.9	1 3/8
450	**18**	711.2	28	628.6	24 3/4	24	38.1	1 1/2	34.9	1 3/8
500	**20**	774.7	30 1/2	685.8	27	24	41.3	1 5/8	38.1	1 1/2
600	**24**	914.4	36	812.8	32	24	47.6	1 7/8	44.4	1 3/4
700	**28**	971.5	38 1/4	876.3	34 1/2	28	47.6	1 7/8	44.4	1 3/4
800	**32**	1092.2	43	996.9	39 1/4	28	54.0	2 1/8	50.8	2
900	**36**	1270.0	50	1168.4	46	32	54.0	2 1/8	50.8	2
1000	**40**	1447.8	57	1339.8	52 3/4	36	66.7	2 5/8	63.5	2 1/2

Appendix C

Flanges according to US standards

ANSI B 16.5

Connection dimension Class 600



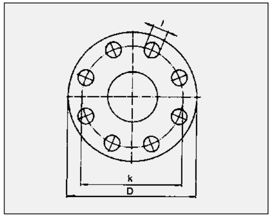
D Exterior diameter
k Hole circle diameter
l Bolt hole diameter

nominal width		flange				bolts				
		exterior diameter		hole circle diameter		number	hole diameter		thread	
DN		D		k		–	l		–	
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch
15	**1/2**	95.2	3 3/4	66.7	2 5/8	4	15.9	5/8	12.7	1/2
20	**3/4**	117.5	4 5/8	82.5	3 1/4	4	19.0	3/4	15.9	5/8
25	**1**	123.8	4 7/8	88.9	3 1/2	4	19.0	3/4	15.9	5/8
32	**1 1/4**	133.3	5 1/4	98.4	3 7/8	4	19.0	3/4	15.9	5/8
40	**1 1/2**	155.6	6 1/8	114.3	4 1/2	4	22.2	7/8	19.0	3/4
50	**2**	165.1	6 1/2	127.0	5	8	19.0	3/4	15.9	5/8
65	**2 1/2**	190.5	7 1/2	149.2	5 7/8	8	22.2	7/8	19.0	3/4
80	**3**	209.5	8 1/4	168.3	6 5/8	8	22.2	7/8	19.0	3/4
100	**4**	273.0	10 3/4	215.9	8 1/2	8	25.4	1	22.2	7/8
125	**5**	330.2	13	266.7	10 1/2	8	28.6	1 1/8	25.4	1
150	**6**	355.6	14	292.1	11 1/2	12	28.6	1 1/8	25.4	1
200	**8**	419.1	16 1/2	349.2	13 3/4	12	31.7	1 1/4	28.6	1 1/8
250	**10**	508.0	20	431.8	17	16	34.9	1 3/8	31.7	1 1/4
300	**12**	558.8	22	488.9	19 1/4	20	34.9	1 3/8	31.7	1 1/4
350	**14**	603.2	23 3/4	527.0	20 3/4	20	38.1	1 1/2	34.9	1 3/8
400	**16**	685.8	27	603.2	23 3/4	20	41.3	1 5/8	38.1	1 1/2
450	**18**	742.9	29 1/4	654.0	25 3/4	20	44.4	1 3/4	41.3	1 5/8
500	**20**	812.8	32	723.9	28 1/2	24	44.4	1 3/4	41.3	1 5/8
600	**24**	939.8	37	838.2	33	24	50.8	2	47.6	1 7/8
700	**28**	1016.0	40	914.4	36	28	50.8	2	47.6	1 7/8
800	**32**	1130.3	44 1/2	1022.3	40 1/4	28	54.0	2 1/8	50.8	2
900	**36**	1314.4	51 3/4	1193.8	47	28	66.7	2 5/8	63.5	2 1/2
1000	**40**	1492.2	58 3/4	1365.2	53 3/4	28	73.0	2 7/8	69.8	2 3/4

Flanges according to US standards

ANSI B 16.5

Connection dimension Class 900



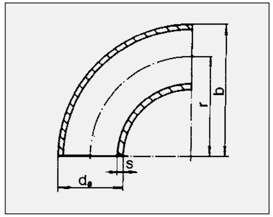
D Exterior diameter
k Hole circle diameter
l Bolt hole diameter

nominal width		flange				bolts				
		exterior diameter		hole circle diameter		number	hole diameter		thread	
DN		D		k		–	l		–	
–	inch	mm	inch	mm	inch	–	mm	inch	mm	inch
15	**1/2**	120,6	4 3/4	82.5	3 1/4	4	22.2	7/8	19.0	3/4
20	**3/4**	130,2	5 1/8	88.9	3 1/2	4	22.2	7/8	19.0	3/4
25	**1**	149,2	5 7/8	101.6	4	4	25.4	1	22.2	7/8
32	**1 1/4**	158,7	6 1/4	111.1	4 3/8	4	25.4	1	22.2	7/8
40	**1 1/2**	177,8	7	123.8	4 7/8	4	28.6	1 1/8	25.4	1
50	**2**	215,9	8 1/2	165.1	6 1/2	8	25.4	1	22.2	7/8
65	**2 1/2**	244,5	9 5/8	190.5	7 1/2	8	28.6	1 1/8	25.4	1
80	**3**	241,3	9 1/2	190.5	7 1/2	8	25.4	1	22.2	7/8
100	**4**	292,1	11 1/2	234.9	9 1/4	8	31.7	1 1/4	28.6	1 1/8
125	**5**	349,2	13 3/4	279.4	11	8	34.9	1 3/8	31.7	1 1/4
150	**6**	381,0	15	317.5	12 1/2	12	31.7	1 1/4	28.6	1 1/8
200	**8**	469,9	18 1/2	393.7	15 1/2	12	38.1	1 1/2	34.9	1 3/8
250	**10**	546,1	21 1/2	469.9	18 1/2	16	38.1	1 1/2	34.9	1 3/8
300	**12**	609,6	24	533.4	21	20	38.1	1 1/2	34.9	1 3/8
350	**14**	641,2	25 1/4	558.8	22	20	41.3	1 5/8	38.1	1 1/2
400	**16**	704,8	27 3/4	615.9	24 1/4	20	44.4	1 3/4	41.3	1 5/8
450	**18**	787,4	31	685.8	27	20	50.8	2	47.6	1 7/8
500	**20**	857,2	33 3/4	749.3	29 1/2	20	54.0	2 1/8	50.8	2
600	**24**	1041,4	41	901.7	35 1/2	20	66.7	2 5/8	63.5	2 1/2

Pipe bends 90º

DIN 2605, part 1, edition 1991-02 (extract)

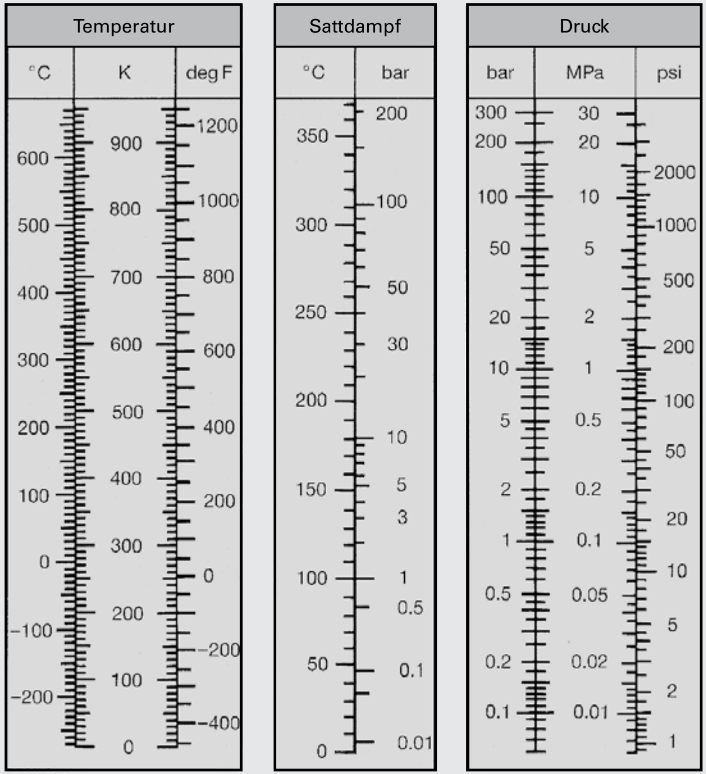
Dimensions



nominal width	exterior diameter	wall thickness	**type 2:** r ~ 1,0 x d_a		**type 3:** r ~ 1,5 x d_a	
DN	d_a	s	r	b	r	b
–	mm	mm	mm	mm	mm	mm
50	60.3	2.9	51	81	76	106
65	76.1	2.9	63	102	95	133
80	88.9	3.2	76	121	114	159
100	114.3	3.6	102	159	152	210
125	139.7	4.0	127	197	190	260
150	168.3	4.5	152	237	229	313
200	219.1	6.3	203	313	305	414
250	273	6.3	254	391	381	518
300	323.9	7.1	305	467	457	619
350	355.6	8.0	356	533	533	711
400	406.4	8.8	406	610	610	813
450	457	10	457	686	686	914
500	508	11	508	762	762	1016
600	610	12.5	610	914	914	1219
700	711	12.5	711	1066	1067	1422
800	813	12.5	813	1220	1219	1626
900	914	12.5	914	1371	1372	1829
1000	1016	12.5	1016	1524	1524	2032

Up to nominal width DN 600, the wall thickness s corresponds to the standard wall thickness of seamless pipes according to DIN 2448.

Appendix D – Conversion tables



Pressure (absolut)	Saturation temperature	Kinematic viscosity of steam	Density of steam
bar	°C	10^{-6} m²/s	kg/m³
p	t	ν"	ρ"
0.020	17.513	650.240	0.01492
0.040	28.983	345.295	0.02873
0.060	36.183	240.676	0.04212
0.080	41.534	186.720	0.05523
0.10	45.833	153.456	0.06814
0.14	52.574	114.244	0.09351
0.20	60.086	83.612	0.1307
0.25	64.992	68.802	0.1612
0.30	69.124	58.690	0.1912
0.40	75.886	45.699	0.2504
0.45	78.743	41.262	0.2796
0.50	81.345	37.665	0.3086
0.60	85.954	32.177	0.3661
0.70	89.959	28.178	0.4229
0.80	93.512	25.126	0.4792
0.90	96.713	22.716	0.5350
1.0	99.632	20.760	0.5904
1.5	111.37	14.683	0.8628
2.0	120.23	11.483	1.129
2.5	127.43	9.494	1.392
3.0	133.54	8.130	1.651
3.5	138.87	7.132	1.908
4.0	143.62	6.367	2.163
4.5	147.92	5.760	2.417

Druck (absolut)	Saturation temperature	Kinematic viscosity of steam	Density of steam
bar	°C	10^{-6} m²/s	kg/m³
p	t	ν"	ρ"
5.0	151.84	5.268	2.669
6.0	158.84	4.511	3.170
7.0	164.96	3.956	3.667
8.0	170.41	3.531	4.162
9.0	175.36	3.193	4.655
10.0	179.88	2.918	5.147
11.0	184.07	2.689	5.637
12.0	187.96	2.496	6.127
13.0	191.61	2.330	6.617
14.0	195.04	2.187	7.106
15.0	198.29	2.061	7.596
20.0	212.37	1.609	10.03
25.0	223.94	1.323	12.51
30.0	233.84	1.126	15.01
34.0	240.88	1.008	17.03
38.0	247.31	0.913	19.07
40.0	250.33	0.872	20.10
45.0	257.41	0.784	22.68
50.0	263.91	0.712	25.33
55.0	269.93	0.652	28.03
60.0	275.55	0.601	30.79
65.0	280.82	0.558	33.62
70.0	285.79	0.519	36.51
75.0	290.50	0.486	39.48

SI-Basic Units

Quantity	SI-Basic Unit	
	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Current intensity	Ampere	A
Thermodynamic temperature	Kelvin	K
Substance quantity	Mol	mol
Light intensity	Candela	cd

Prefix Symbols

Prefix	Prefix symbol	Multiplication factor
Piko	p	10^{-12}
Nano	n	10^{-9}
Micro	µ	10^{-6}
Milli	m	10^{-3}
Centi	c	10^{-2}
Deci	d	10^{-1}
Deca	de	10^{1}
Hecto	h	10^{2}
Kilo	k	10^{3}
Mega	M	10^{6}
Giga	G	10^{9}

Length – SI-Unit meter, m

Symbol	Name	in m
mm	millimeter	0.0010
km	kilometer	1000.0000
in	inch	0.0254
ft	foot (=12 in)	0.3048
yd	yard (=3 ft / =36 in)	0.9144

Mass – SI-Unit kilogram, kg

Symbol	Name	in kg
g	gram	0.00100
t	ton (D)	1000.00000
oz	ounce	0.02835
lb	pound	0.45360
sh tn	short ton (US)	907.20000
tn	ton (UK)	1016.00000

Time – SI-Unit second, s

Symbol	Name	in s
min	minute	60
h	hour	3600
d	day	86400
a	year	$3.154 \cdot 10^{7}$ (≙ 8760 h)

Temperature – SI-Unit Kelvin, K (also see the foregoing conductor table)

Symbol	Name	in K	in °C
°C	degree centigrade	ϑ/°C + 273.16	1
deg F	degree Fahrenheit	ϑ/deg F · 5/9 + 255.38	(ϑ/deg F - 32) · 5/9

Angle – SI-Unit Radiant, rad = m/m

Symbol	Name	in rad
	full angle	2π
gon	gon (new degree)	$\pi/200$
°	degree	$\pi/180$
'	minute	$\pi/1.08 \cdot 10^{-4}$
"	second	$\pi/6.48 \cdot 10^{-5}$

Pressure – SI-Unit Pascal, Pa = N/m² = kg/ms²

Symbol	Name	in Pa	in bar
Pa = N/m^2	Pascal	1	0.00001
hPa = mbar	Hektopascal = millibar	100	0.001
kPA	Kilopascal	1000	0.01
bar	Bar	100000	1
MPa = N/mm^2	Megapascal	1000000	10
mm WS	millimeter water column	9.807	0.0001
lbf/in^2 = psi	pound-force per square inch	6895	0.0689
lbf/ft^2	pound-force per square foot	47.88	0.00048

Appendix D
Conversion tables

Energy (also called Work, Quantity of Heat) SI-Unit Joule, J = Nm = Ws

Symbol	Name	in J
kWs	kilowatt-second	1000
kWh	kilowatt-hour	$3.6 \cdot 10^6$
kcal	kilocalorie	4186
lbf x ft	pound-force foot	1.356
Btu	British thermal unit	1055

Volume – SI-Unit Watt, W = m² kg/s³ = J/s

Symbol	Name	in W
kW	kilowatt	1000
PS	horsepower	735.5
hp	horsepower	745.7

Volume – SI-Unit, m³

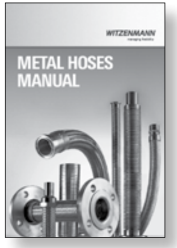
Symbol	Name	in m^3
l	liter	0.001
in^3	cubic inch	$1.6387 \cdot 10^{-5}$
ft^3	cubic foot	0.02832
gal	gallon (UK)	0.004546
gal	gallon (US)	0.003785

Appendix D

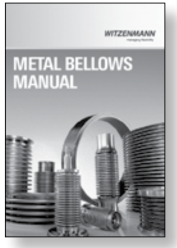
Greek alphabet

α	Alpha	Α	Alpha
β	Beta	Β	Beta
γ	Gamma	Γ	Gamma
δ	Delta	Δ	Delta
ε	Epsilon	Ε	Epsilon
ζ	Zeta	Ζ	Zeta
η	Eta	Η	Eta
ϑ θ	Theta	Θ	Theta
ι	Jota	Ι	Jota
ϰ	Kappa	Κ	Kappa
λ	Lambda	Λ	Lambda
μ	My	Μ	My
ν	Ny	Ν	Ny
ξ	Xi	Ξ	Xi
ο	Omikron	Ο	Omikron
π	Pi	Π	Pi
ϱ	Rho	Ρ	Rho
σ ς	Sigma	Σ	Sigma
τ	Tau	Τ	Tau
υ	Ypsilon	Υ	Ypsilon
φ	Phi	Φ	Phi
χ	Chi	Χ	Chi
ψ	Psi	Ψ	Psi
ω	Omega	Ω	Omega

Folders to further products



The Manual of the Metal Hoses



The Manual of the Metal Bellows

For further information see
www.witzenmann.de/service

Notes

Notes

Notes

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