INTERNATIONAL STANDARD

ISO 15348

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Pipework — Metal bellows expansion joints — General

Tuyauteries — Compensateurs métalliques à soufflet — Généralités

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15348 was prepared by Technical Committee ISO/TC 5, *Ferrous metal pipes and metallic fittings*, Subcommittee SC 11, *Flexible metallic hoses and expansion joints*.

Annexes A to G form a normative part of this International Standard.

Introduction

This document is a base standard for metal bellows expansion joints.

Users of this International Standard are advised to consider the desirability of third-party certification of product conformity with this International Standard, based on testing and continuous product surveillance, which may be coupled with the assessment of suppliers' quality systems against ISO 9001.

Pipework — Metal bellows expansion joints — General

1 Scope

This International Standard specifies the terminology and the general rules for the design, manufacture, control and type testing of metal expansion joints incorporating corrugated bellows.

It applies to metal expansion joints equipped with one or more corrugated bellows of circular cross-section.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 4200, *Plain end steel tubes, welded and seamless — General tables of dimensions and masses per unit length*

ISO 7005-1, *Metallic flanges — Part 1: Steel flanges*

ISO 7268, *Pipe components — Definition of nominal pressure*

ISO 9328-5, *Steel plates and strips for pressure purposes — Technical delivery conditions — Part 5: Austenitic steels*

EN 1092-1, *Flanges and their joints — Circular flanges for pipes, valves, fittings and accessories, PN designated — Part 1: Steel flanges*

EN 1333, *Pipework components — Definition and selection of PN*

EN 10088-2, *Stainless steels — Part 2: Technical delivery conditions for sheet/plate and strip for general purposes*

ENV 10220, *Seamless and welded steel tubes — Dimensions and masses per unit length*

EN 10226-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Designation, dimensions and tolerances*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
expansion joint
leakproof metal device consisting of one or more bellows used to absorb movements such as caused by thermal or mechanical effects in piping or components of equipment

3.2
corrugation GB
convolution US
single flexible element of the bellows

3.3
corrugated bellows GB
convoluted bellows US
expansion element made from one or more plies, with one or more corrugations/convolutions and with or without end cuffs

NOTE It can be reinforced with rings.

3.4
ply
constituent element of the wall of the bellows

NOTE The wall can be made from one or more plies.

3.5
cuff
cylindrical section situated at one or both of the ends of the bellows to allow its attachment

3.6
cuff reinforcement collar
ring placed around the cuff to reinforce it against the effect of internal pressure and hence reduce deformation

3.7
root-reinforcing ring
element fitted outside or inside a bellows in a corrugation/convolution root, conforming to the shape of the root, to prevent its deformation under internal or external pressure

NOTE When placed between two corrugation/convolutions, it is called an intermediate reinforcing ring. When placed at the end, it is called an end corrugation/convolution-reinforcing ring.

3.8
welding ring
ring placed around the cuff to facilitate welding

3.9
internal sleeve
element which allows a satisfactory flow of medium and protects the bellows from erosion and flow-induced vibrations

NOTE It is designed so that it does not restrict the movement of the expansion joint.

3.10
pressure thrust
axial force arising from internal pressure which has to be contained to avoid undue axial deformation of the bellows

3.11
end fittings
fittings (usually weld ends, threaded ends or flanged ends) by means of which expansion joints are connected to the piping system or to equipment

3.12
restraining components
mechanical components (tie-bars, hinges, gimbal rings, etc.) designed to resist pressure thrust and external loads

NOTE They are attached to end fittings with brackets, carrier flanges or reinforcing gussets.

3.13
guide elements
components used for maintaining coaxiality during movement

3.14
external shroud
cover around the bellows, whose dimensions do not impede the movement of the expansion joint but provide limited protection of the bellows against mechanical shock and spatter

3.15
stroke indicator
device that, in normal service, indicates the movement of the bellows

NOTE If the design movement is exceeded, the device may distort permanently to indicate that an abnormal function of the system has occurred.

3.16
movement distributor
device mounted on an expansion joint containing several bellows that limits each of them to work within their designed movements

3.17
adjusting device
device to enable the bellows to be pre-set to given dimensions, or to meet special installation requirements

3.18
shipping bar
device that secures the expansion joint in a position determined by the manufacturer during the period of shipment, handling and installation

3.19
movements
movements of an axial, angular or lateral nature

3.19.1
axial movement
movement causing axial compression or extension of an expansion joint

3.19.2
angular movement
movement causing bending of an expansion joint

3.19.3
lateral movement
transverse movement of the ends of an expansion joint such that their axes remain parallel

3.20
spring rate
force, axial, angular or lateral in nature, or moment necessary to produce a unit deflection of 1 mm or 1 degree of the expansion joint

3.21
cycle
full movement, from an initial position to the given working position and back, under the working conditions specified

4 Types of expansion joint

4.1 General

There are four principal types of expansion joint, which are designated according to the movements absorbed (see 4.2 to 4.5 and Table 1).

NOTE If information is required on further types, refer to the manufacturer.

4.2 Axial expansion joint

Absorbs mainly axial movement. When non-pressure-balanced, it does not restrain pressure thrust. When pressure-balanced, it restrains pressure thrust.

4.3 Angular expansion joint

Absorbs angular movement. When fitted with hinges, it allows movement in a single plane. When fitted with gimbal rings, it allows movement in any plane. It restrains pressure thrust. Normally used in a set of two or three joints.

4.4 Lateral expansion joint

Absorbs lateral movement. An angular movement is also permissible when the joint is fitted with two tie-bars, the movement being perpendicular to the plane containing the tie rods. It restrains pressure thrust.

4.5 Universal expansion joint

Absorbs several movements. It does not restrain pressure thrust unless it is pressure-balanced.

5 Information to be supplied by the purchaser

The purchaser shall state, as a minimum, the following in all enquiries and orders:

a) the expansion joint type (see Table 1);

b) the nominal size (DN);

c) the design pressure;

d) the design temperature;

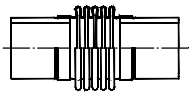
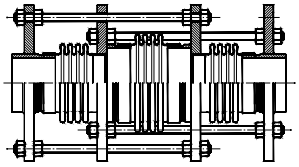
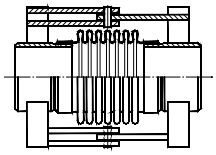
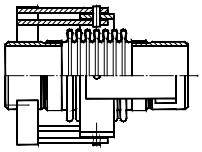
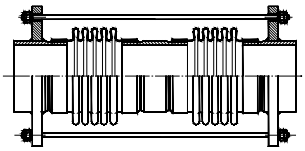
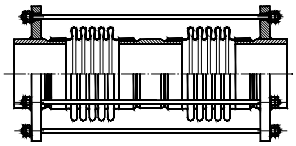
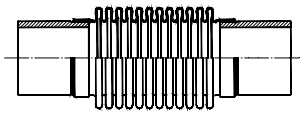
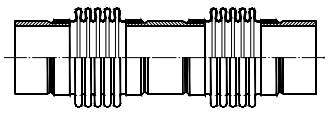
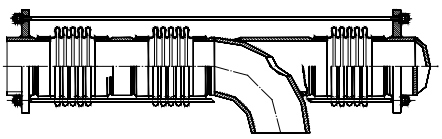
e) the movements;

f) the materials;

g) the fittings.

Dependent on the application, the relevant details listed in annex A shall also be given.

Table 1 — Types of expansion joint

Type	Design	Pressure thrust restraint	Movement				
			Axial	Angular		Lateral	
				Single plane	Multi-plane	Single plane	Multi-plane
Axial	Unrestrained 	No	X	(X)	(X)	(X)	(X)
	Balanced 	Yes	X				
Angular	Hinged 	Yes		X			
	Gimbals 	Yes		X	X		
Lateral	Two tie-bars 	Yes		X		X	X
	Three or more tie-bars 	Yes				X	X
Universal	Unrestrained, with one or two bellows 	No	X	X	X	X	X
							
	Balanced 	Yes	X	X		X	X
X = Applicable, (X) = Limited use							

6 Materials

The selection of materials for use in an expansion joint shall take into consideration the information provided in clause 5 and annex A.

When the purchaser specifies the materials, the manufacturer shall approve them.

When selecting materials, they shall whenever possible conform to ISO standards. A list of suitable ISO materials is given in annex B. Alternative equivalent materials are given in annex C.

NOTE 1 The resistance to corrosion of the material used for the bellows is of particular importance as the bellows wall is usually much thinner than the wall of the connecting pipe. It is advisable to choose a material with sufficiently high resistance to corrosion rather than to increase the wall thickness.

NOTE 2 A risk of bellows corrosion may originate not only from the internal flow medium, but also from the external environment surrounding the expansion joint.

7 Dimensions and tolerances

7.1 End fitting dimensions

The dimensions and tolerances of end fittings shall be in accordance with the following ISO Standards:

a) Flanges: ISO 7005-1.

b) Welding ends: ISO 4200.

c) Threaded ends:

1) pipe threads where pressure-tight joints are made on the threads: ISO 7-1;

2) pipe threads where pressure-tight joints are not made on the threads: ISO 228-1.

Alternative equivalent fittings are given in annex D.

7.2 Overall length

The overall length of an expansion joint shall be within the tolerance defined in Table 2.

NOTE A tight tolerance is not applied to the overall length of an axial or universal expansion joint as it may vary during handling and transport. However, any variation in the overall length does not imply a limitation of the working capability of the expansion joint.

Table 2 — Overall length tolerances for angular and lateral expansion joints

DN	Overall length mm			
	up to 500	from 501 to 1 000	from 1 001 to 4 000	greater than 4 000
	Tolerance			
up to DN 100	± 3	± 4	± 6	a
from DN 101 to DN 400	± 4	± 5	± 8	a
from DN 401 to DN 1 000	± 6	± 8	± 10	a
greater than 1 000	a	a	a	a

[a] To be agreed by the purchaser.

8 Design

8.1 Design conditions

Expansion joints shall be designed for the conditions stated in clause 5 and annex A.

8.2 Bore

Bore size shall be selected from annex E.

8.3 Pressure

Expansion joints shall be designed to be in accordance with the nominal pressures (PN) defined in ISO 7268 and listed in annex F. Alternative European nominal pressures as defined in EN 1333 are listed in annex G.

8.4 Temperature

The maximum allowable pressure of the expansion joint at the operating temperature shall be the nominal pressure (PN) (see 8.3), reduced by the factors given in annex B or annex C.

8.5 Cyclic life

Where the purchaser has not specified a requirement for cyclic life, the number of cycles shall be 1 000.

9 Manufacture

The manufacturing methods used shall ensure that the expansion joint conforms to the requirements specified in clause 8.

All welding procedures and welders employed in the manufacture of metal bellows expansion joints shall be qualified in accordance with defined procedures or by a qualified body.

10 Inspection and testing

10.1 In-process inspection during production

It is the responsibility of the manufacturer to inspect the product in accordance with his procedures.

10.2 Final examination

10.2.1 General

Unless otherwise stated by the purchaser, the tests and examinations specified in 10.2.2 to 10.2.4 shall be carried out.

10.2.2 Leak test

Unless otherwise specified, a leak test shall be carried out on each expansion joint ensuring that no leakage greater than 10^{-3} mbar·l/s occurs.

10.2.3 Dimensional checks

Expansion joints shall undergo dimensional checks for conformity with the drawing, and as a minimum the length of the joint and the dimensions of the end fittings shall be checked.

10.2.4 Optional pressure test

This test shall be carried out before the dimensional checks in 10.2.3.

Where a pressure test is required and the procedure is not otherwise specified, the following method shall be used:

— the test medium should preferably be water at ambient temperature;

— the test pressure shall be 1,5 times the design pressure selected in 8.3.

— the test pressure shall be applied and maintained for a sufficient length of time to permit a visual examination of all surface joints, but in any case for not less than 5 min.

There shall be no visible sign of leakage or of any other mode of failure.

When the expansion joint is fitted with restraining components, they shall be tested, either at the manufacturer's plant or on site, as agreed by the purchaser.

NOTE If fluids other than water are used, additional precautions may be necessary.

11 Type tests

11.1 Test methods

Type testing may be carried out by either of the following methods:

a) Range of expansion joints

A range of different expansion joints shall be tested in accordance with 11.4 to 11.7, each of the tests being carried out in accordance with 11.2.

This type test may be also used for verification of a calculation method.

b) Individual expansion joints

A number of identical expansion joints shall be tested in accordance with 11.4 to 11.7, each of the tests being carried out in accordance with 11.3.

NOTE In both instances, the same tests are applicable. They differ only in the number of test specimens subjected to each of the tests.

11.2 Range of expansion joints — Test quantities and test parameters

— 25 expansion joints for the fatigue test (see 11.4);

— 5 expansion joints for the corrugation deformation test (see 11.5);

— 5 expansion joints for the burst test (see 11.7);

— 10 expansion joints for the buckling test (see 11.6).

The expansion joints shall be chosen so that at least two of the following parameters are different:

— pressure;

— diameter;

— corrugation profile (height, pitch and thickness);

— movement.

11.3 Individual expansion joints — Test quantities

Three expansion joints shall be used for each of the tests specified.

11.4 Cyclic test

Subject the expansion joint to the nominal pressure and cycle it at the nominal pressure for the movement specified, at a frequency not exceeding 20 cycles per minute.

The expansion joint shall exceed 1 000 cycles, or the figure agreed with the purchaser, without failure.

11.5 Corrugation deformation test

With the expansion joint in the neutral position, apply a pressure of at least 1,5 times the nominal pressure to the joint for 5 min.

After releasing the pressure, the width of the bellows convolution, at its mean diameter, shall not have a deformation exceeding 7 % at any point on its circumference.

11.6 Buckling test

With the expansion joint in the neutral position, pressurize the joint to 2,25 times the nominal pressure for 5 min.

The change in pitch of the corrugations of the bellows shall not exceed 15 % of its initial value without pressure.

11.7 Burst test

With the expansion joint in the neutral position, pressurize the expansion joint to 4 times the nominal pressure for 5 min.

There shall be no leakage even if the joint has undergone deformation.

12 Marking

The minimum markings for each expansion joint shall be as follows:

c) a reference to this International Standard, i.e. ISO 15348;

d) the manufacturer’s name or trademark or other mark of identification;

e) the nominal size;

f) the nominal pressure.

Additional information may be added at the purchaser’s request or to ensure traceability.

Annex A
(normative)

Technical-data sheet

Expansion joint type				
Nominal size (DN)				mm
Design conditions				
Design pressure			MPa	bar
Design temperature				°C
Movement				
	(1) axial	+/–		mm
	(2) lateral	+/–		mm
	(3) angular	+/–		degrees
	combined		(.....) + (.....) + (.....)	
Vibration	frequency			Hz
	amplitude			mm
	direction			
Required number of cycles				
Medium				
Velocity of medium				m/s
External environment				
Pre-tension	❒ yes		❒ no	
	if yes:		value	mm
			value	degrees
Insulation	❒ yes		❒ no	
Maximum allowable constraints				
Spring rate	axial			N/mm
	lateral			N/mm
	angular			N·m/degree
Thrust force	axial			N
	lateral			N
Moment				N·m
Pressure thrust				N

Fittings[a]				
Welding ends	❒ yes	❒ no		
Flanges	❒ yes	❒ no		
	if yes: standard			
Overall dimensions[a]				
	length			mm
	height			mm
	width			mm
Accessories[a]				
Internal sleeve	❒ yes	❒ no		
Shrouds	❒ yes	❒ no		
Shipping bar	❒ yes	❒ no		
Special accessories				
Required checks				
Dimensional				
Visual				
Hydraulic test				
Leak test	❒ air	❒ helium	❒ other	
	if other: medium used			
Dye penetrant test	❒ yes	❒ no		
Particular specifications				
Particular specifications				
(for example: climatic and seismic conditions, external loads on expansion joints)				
Quality standard				
X-rays of longitudinal welds before forming	❒ yes		%	❒ no
Longitudinal X-rays of welding ends	❒ yes		%	❒ no
Material certificates	❒ yes			❒ no
	if yes: type			
Design regulations				

[a] In the event of particular conditions, to be specified.

Annex B
(normative)

Materials and temperature derating factors

Table B.1 — Derating factors and limiting temperatures for materials given in ISO 9328-5

Material (ISO 9328-5)	Temperature °C													
	−200	20	50	100	150	200	250	300	350	400	450	500	550	600
	Correction factor													
X2CrNi1810	1	1	0,93	0,81	0,7	0,64	0,6	0,57	0,54	0,51	0,5	0,49	0,47	0,47
X5CrNi189	1	1	0,93	0,81	0,7	0,64	0,6	0,57	0,54	0,52	0,51	0,5	0,49	0,47
X6CrNiNb1810	1	1	0,95	0,88	0,8	0,76	0,72	0,69	0,68	0,66	0,65	0,65	0,64	0,63
X6CrNiTi1810	1	1	0,94	0,86	0,76	0,73	0,7	0,67	0,65	0,63	0,61	0,6	0,59	0,57
X2CrNiMo1712	1	1	0,93	0,83	0,72	0,66	0,62	0,59	0,56	0,55	0,53	0,51	0,5	0,49
X5CrNiMo1712	1	1	0,93	0,83	0,72	0,66	0,63	0,6	0,57	0,55	0,54	0,52	0,5	0,5
X6CrNiMoTi1712	1	1	0,94	0,84	0,75	0,69	0,65	0,62	0,6	0,58	0,56	0,54	0,53	0,52

Annex C
(normative)

European materials and temperature derating factors

Table C.1 — Derating factors and limiting temperatures for materials given in EN 10088-2

Material (EN 10088-2)	Temperature °C												
	−200	20	50	100	150	200	250	300	350	400	450	500	550
	Derating factor												
1.4306	1	1	0,89	0,72	0,64	0,58	0,54	0,5	0,48	0.46	0,44	0,43	0,43
1.4301	1	1	0,9	0,73	0,66	0,6	0,55	0,51	0,49	0,48	0,46	0,46	0,46
1.4550	1	1	0,93	0,83	0,78	0,74	0,7	0,66	0,64	0,62	0,6	0,59	0,58
1.4541	1	1	0,93	0,83	0,78	0,74	0,7	0,66	0,64	0,62	0,6	0,59	0,58
1.4404	1	1	0,78	0,73	0,67	0,61	0,58	0,53	0,51	0,5	0,49	0,47	0,47
1.4401	1	1	0,91	0,78	0,7	0,65	0,61	0,57	0,55	0,53	0,52	0,51	0,5
1.4571	1	1	0,92	0,8	0,76	0,72	0,68	0,64	0,62	0,6	0,59	0,58	0,58

Annex D
(normative)

European end fittings

D.1 Flanges

Conforming to EN 1092-1.

D.2 Welding ends

Conforming to EN 10220.

D.3 Threaded ends

— Pipe threads where pressure-tight joints are made on the thread: EN 10226-1.

— Pipe threads where pressure-tight joints are not made on the threads: EN ISO 228-1.

Annex E
(normative)

Nominal sizes (DN)

Table E.1 — Nominal sizes

Nominal size mm
15
20
25
32
40
50
65
80
100
125
150
200
250
300
350
400
450
500
600
700
800
900
1 000

Annex F
(normative)

Nominal pressures (PN)

Table F.1 — Nominal pressures in accordance with ISO 7268

Nominal pressure (PN) bar
2,5
6
10
16
20
25
40
50
100
150
250

Annex G
(normative)

European nominal pressures (PN)

Table G.1 — European nominal pressures as specified in EN 1333

European nominal pressures (PN) bar
2,5
6
10
16
25
40
63
100

Bibliography

[1] ISO 9001, *Quality management systems — Requirements*

ICS 23.040.70

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