Designation: F2934 – 12 (Reapproved 2023)

An American National Standard

Standard Specification for Circular Metallic Bellows Type Expansion Joint for HVAC Piping Applications[1]

This standard is issued under the fixed designation F2934; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification establishes the minimum requirements for the mechanical design, manufacture, inspection and testing of circular metallic bellows-type expansion joints used to absorb the dimensional changes resulting from piping thermal expansion or contraction, as well as the movements of terminal equipment and supporting structures.

1.2 Additional or better features, over and above the minimum requirements set by this specification, are not prohibited by this specification.

1.3 The layout of many piping systems provides inherent flexibility through natural changes in direction so that any displacements produce primarily bending or torsional strains, within acceptable limits. Where the system lacks this inherent flexibility the designer should then consider adding flexibility through the use of metallic bellows-type expansion joints.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASME/ANSI Standards:*[2]
B16.25 Butt Welding Ends
B16.5 Pipe Flanges and Flanged Fittings
B31.1 Power Piping Code
2.2 *ASME Standard:*[3]
Section IX Welding and Brazing Qualifications
2.3 *EJMA Standard:*[4]
Standards of the Expansion Joint Manufacturers Association
2.4 *Pipe Fabrication Institute Standard:*[5]
ES-3 Fabrication Tolerances

3. Terminology

3.1 Expansion joint definitions shall be in accordance with those in the EJMA standards.

3.2 *Definitions:*

3.2.1 *double expansion joint*—expansion joint consisting of two bellows joined by a common connector.

3.2.1.1 *Discussion*—The common connector is anchored to some rigid part of the installation by means of an anchor base. The anchor base may be attached to the common connector either at installation or at time of manufacture. This anchor base is an intermediate anchor and is not usually designed to withstand the full thrust load of the piping run. The dual expansion joint is installed in the middle of the piping run and the thrust is directed to the middle. Each bellows acts as a single expansion joint and absorbs the movement of the pipe section in which it is installed independently of the other bellows.

[1] This specification is under the jurisdiction of ASTM Committee F25 on Ships and Marine Technology and is the direct responsibility of Subcommittee F25.11 on Machinery and Piping Systems.

Current edition approved May 1, 2023. Published June 2023. Originally approved in 2012. Last previous edition approved in 2018 as F2934 – 12 (2018). DOI:10.1520/F2934-12R23.

[2] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

[3] Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Two Park Ave., New York, NY 10016-5990, http://www.asme.org.

[4] Available from Expansion Joint Manufacturers Association (EJMA), 25 North Broadway Tarrytown, NY 10591, http://www.ejma.org.

[5] Available from Pipe Fabrication Institute (PFI), 511 Ave. of Americas, #601, New York, NY 10011, http://www.pfi-institute.org.

3.2.2 *externally pressurized expansion joint*—typically used for straight runs of pipe accommodating axial movement, and incorporate an all stainless steel flexible bellows, an internal guide ring/sleeve, an enclosure with end plates at each end.

3.2.2.1 *Discussion*—Externally pressurized expansion joints are typically configured with a service pipe extending through the bellows, and the bellows attaching to the end of the service pipe and the end plate. The external side of the bellows is exposed to the pressure of the medium being conveyed by the service pipe and the inside of the bellows is exposed to atmosphere.

3.2.3 *gimbal expansion joint*—expansion joint designed to permit angular rotation in any plane by the use of two pairs of hinges affixed to a common floating gimbal ring.

3.2.3.1 *Discussion*—The gimbal ring, hinges, and pins are designed to restrain the thrust of the expansion joint as a result of internal pressure and extraneous forces, where applicable.

3.2.4 *hinged expansion joint*—expansion joint containing one bellow designed to permit angular rotation in one plane only by the use of a pair of pins through hinge plates attached to the expansion joint ends.

3.2.4.1 *Discussion*—The hinges and hinge pins are designed to restrain the thrust of the expansion joint as a result of internal pressure and extraneous forces. Hinged expansion joints should be used in sets of two or three to function properly.

3.2.5 *internally pressurized expansion joint*—typically incorporates an all stainless steel flexible bellows containing the pressure on the internal side.

3.2.5.1 *Discussion*—Internally pressurized expansion joints can be configured to accommodate a wide range of movements.

3.2.6 *pressure balanced expansion joint*—expansion joint designed to absorb axial movement or lateral deflection, or both, while restraining the pressure thrust by means of tie devices interconnecting the flow bellows with an opposed bellows also subjected to line pressure.

3.2.6.1 *Discussion*—This type of expansion joint is usually intended for use where a change of direction occurs in a run of piping. The flow end of a pressure balanced expansion joint sometimes contains two bellows separated by a common connector, in which case it is called a universal pressure balanced expansion joint. Inline pressure balanced expansion joints do not require a change in direction of the piping.

3.2.7 *single expansion joint*—simplest form of expansion joint, consisting of single bellows construction, designed to absorb all movement of the pipe section in which it is installed.

3.2.8 *swing expansion joint*—expansion joint designed to absorb lateral deflection or angular rotation, or both, in one plane.

3.2.8.1 *Discussion*—Pressure thrust and extraneous forces are restrained by the use of a pair of swing bars, each of which is pinned to the expansion joint ends.

3.2.9 *universal expansion joint*—expansion joint containing two bellows joined by a common connector for the purpose of absorbing any combination of axial movement, lateral deflection, and angular rotation.

3.2.9.1 *Discussion*—Universal expansion joints are usually furnished with control rods to distribute the movement between the two bellows of the expansion joint and stabilize the common connector when a universal expansion joint is used for lateral movement only and installed at a change in direction of the piping and is intended to absorb the thermal growth of that section of the piping, it must be designed with tie rods suitable to absorb the full pressure thrust of the expansion joint.

4. Ordering Information

4.1 An expansion joint is a unique product and must be specifically designed for the intended service. It is the responsibility of the piping system designer to supply sufficient engineering data necessary for the complete design. The information compiled by the piping system designer must be complete and contain all pertinent data detailing the conditions under which the expansion joint is expected to operate.

4.2 Orders for each expansion joint shall include the following information:

4.2.1 *Title,* designation number, and latest revision of this specification.

4.2.2 *Size*—The nominal pipe diameter or specific ducting diameter.

4.2.3 *Type of Expansion Joint*—Single, double, universal, guided, hinged, gimbal, swing, or pressure balanced.

4.2.4 *Flow Characteristics:*

4.2.4.1 *Flow Medium*—Indicate whether the medium is gas or liquid.

4.2.4.2 *Flow velocity,* medium density, or viscosity, or combination thereof.

4.2.4.3 *Flow direction.*

4.2.5 *Pressure in psig (N/mm^2)*—Design, operating, and test pressures.

4.2.6 *Temperate in °F (°C)*—Design, operating, and installation temperatures.

4.2.7 *Movement*—Axial (extension, compression); lateral (single plane, multiplane); angular; torsional (to be avoided). Differentiate between start-up, operational, or field installation tolerance movements.

4.2.8 *Materials*—Material types (including that for the bellows shall be specified by the purchaser (see 5.1 for material restrictions).

4.2.9 *Internal Liner*—Liner shall be specified when needed because of flow velocity or other flow conditions. Specific criteria for liners is shown in Section C-3 of the EJMA Standards (see 6.6).

4.2.10 *External Cover*—To protect personnel having close access to the bellows, when thermal insulation is to be added in the field, or when external mechanical damage is possible (see 6.5).

4.2.11 *End Fittings*—The type of end connections such as flanged, threaded, or others to match the mating piping or terminal equipment.

4.2.12 *Accessories*—Specify what accessories are required and the conditions under which they operate. Consider items such as insulation lugs, tie, limit, or control rods, pantographic linkages, trunions, gimbals, drains, purge connections, anchor bases, and interplay monitoring devices.

4.2.13 *Dimensional Limitations*—If space limitations exist specify the maximum overall length, maximum outside diameter, minimum inside diameter, and installation tolerances.

4.2.14 *Operating Forces*—Specify calculated bellows spring forces and pressure thrust forces if they are required for subsequent anchor design or other piping systems analysis. If there are maximum allowable values, these must also be specified.

4.2.15 *Installation Position*—horizontal, vertical (flow up or down). Specify if liner drainage holes are required.

4.2.16 *Cycle Life Requirements*—Specify an anticipated number of thermal cycles over the intended life of the expansion joint.

4.2.17 *Testing Requirements*—Specify testing requirements in addition to the hydrostatic test required by 9.4 (for example, vacuum testing, testing at operating temperature).

4.2.18 *Inspection Requirements*—Specify inspection requirements in addition to the inspection required by Section 9 (that is, radiographic, fluorescent penetrant, or mass spectrometer).

4.2.19 *Piping Code Requirements*—Specify any piping or design code that must be used as the basis for design in addition to those specified in 5.2.

4.2.20 *Special Requirements*—Specify the magnitude of special system conditions such as vibration, shock, or hydraulic surge. When vibration is present the customer shall provide the natural frequency of the equipment. The design engineer shall design the bellows natural frequency to be less than ⅔ of the system frequency or two times greater than the system frequency.

4.2.21 *Shipping Requirements*—Specify whether special packing is required including protection for extended outside storage, export handling, or special lifting considerations for heavy or large assemblies.

4.2.22 *Piping Drawing*—In addition to specifying the above information it would be beneficial to provide a drawing of the proposed piping system.

4.2.23 *Supplementary Requirements*—Specify any additional requirements not identified herein.

4.3 Fig. 1 and Fig. 2 should be used as a guide in ordering expansion joints to this specification.

5. Materials and Manufacture

5.1 *Materials:*

5.1.1 Pressure-containing parts shall be manufactured from material specifications and grades listed in ANSI B31.1. End connection materials shall have in service properties similar to the bellows material. Flanges shall meet ANSI B16.5.

5.1.2 All other materials of construction shall be of the type specified by the user and shall conform to an ASTM or ASME material specification. Materials not identified by the ordering data shall be of the manufacturer's standard and of the same quality used for the intended purpose in commercial practice.

5.1.3 Materials used shall be free from defects that would adversely affect the performance of the expansion joint.

5.1.4 All material incorporated in the work covered by this specification shall be new. The use of rebuilt or used products is not allowed under this specification.

5.1.5 Materials for hinge or gimbal hardware, or other sliding parts, shall be chosen to minimize galling of the contacting parts.

5.2 *Manufacture:*

5.2.1 Expansion joints shall be designed and fabricated in accordance with requirements set forth in the ordering data and the EJMA Standards.

5.2.2 Nonstandard flanges shall be designed and fabricated in accordance with Appendix 2 of Section VIII, Division 1, of the ASME Code. Flanges machined from plate shall not be used at pressures exceeding 150 psi (1034 kPa) and temperatures exceeding 450 °F (232 °C). Hubbed flanges machined from plate or bar stock shall meet the requirements of Appendix 2, Paragraph 2-2(d) of Section VIII, Division 1, of the ASME Code.

5.2.3 All welding shall be accomplished in accordance with ANSI B31.1.

5.2.4 Welding personnel and welding procedures shall be qualified in accordance with the applicable sections of Section IX of the ASME Code.

5.2.5 All fabrication details not covered by the referenced codes and standards shall be taken from the appropriate ANSI standard. If no standard applies, accepted industry practice shall govern.

5.2.6 The bellows shall be of tested and proven convolution geometry.

6. Other Requirements

6.1 The details of design, material supply, fabrication, and testing of the complete product are the responsibility of the manufacturer unless specific details are requested by the purchaser.

6.2 The specified normal operating movements (axial, lateral, and angular) shall be available concurrently. The specified lateral and angular movements shall be available on either side of the expansion joint centerline.

6.3 Internal sleeves, external covers, and all attached hardware shall be constructed so as not to interfere with adjacent parts when the joint is in the fully deflected position.

6.4 Universal expansion joints shall be designed and fabricated to be self-supporting and not require any external structure for the support of the center pipe spool piece and its contents.

6.5 Internally pressurized expansion joints to be installed in systems above 150 °F (66 °C) shall have an external cover. When external mechanical damage is possible, a cover shall be fabricated to protect the joint and personnel.

6.6 Internal sleeves shall be installed in internally pressurized expansion joints when the fluid velocity of the system, where the expansion joint is to be installed, is greater than the values listed in Section C-3.1 of the EJMA Standards and where the flow velocity exceeds 75 % of the velocity calculated using Section C-3.1.4 of the EJMA Standards.