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INSTALLATION

The necessary steps for installing all expansion joints shall be pre-planned. The installers shall be made aware of these steps as well as the installation instructions furnished by the manufacturer. The most critical phases of the expansion joint installation are as follows.

- Care shall be exercised to prevent any damage to the thin bellows section, such as dents, scores, arc strikes and weld spatter.
- No movement of the expansion joint (compression, extension, offset, rotation and especially torsion) due to piping misalignment, for example, shall be imposed which has not been anticipated and designed into the movement capability of the expansion joint. If such movements are imposed, they can result in system malfunction, damage to the bellows or other components in the system. Specifically, cycle life can be substantially reduced, forces imposed on adjacent equipment may exceed their design limits, internal sleeve clearances may be adversely affected, and the pressure capacity and stability of the bellows may be reduced.
- Any field pre-positioning shall be performed in accordance with specific instructions which include both the direction and magnitude of the movement.
- Anchors, guides and pipe supports shall be installed in strict accordance with the piping system drawings. Any field variances from planned installation may affect proper functioning of the expansion joint and must be brought to the attention of a competent design authority for resolution.
- The expansion joint, if provided with internal sleeves, shall be installed with the proper orientation with respect to flow direction.
- After the anchors or other fixed points are in place and the piping is properly supported and guided, the expansion joint shipping devices should normally be removed in order to allow the expansion joint to compensate for changes in ambient temperature during the remainder of the construction phase.

POST INSTALLATION INSPECTION PRIOR TO SYSTEM PRESSURE TEST

A careful inspection of the entire piping system shall be made with particular emphasis on the following.

- Are the anchors, guides and supports installed in accordance with the system drawings?
- Is the proper expansion joint in the proper location?
- Are the expansion joint flow direction and positioning correct?
- Have all the expansion joint shipping devices been removed?
- Are all guides, pipe supports and the expansion joints free to permit pipe movement?
- If the system has been designed for a gas, and is to be tested with water, have provisions been made for proper support of the additional dead weight load on the piping and expansion joint? Some water may remain in the bellows convolutions after the test. If this is detrimental to the bellows or system operation, means shall be provided to remove such water.
- Has any expansion joint been damaged during handling and installation?
- Is any expansion joint misaligned? This can be determined by measuring the expansion joints' overall length, inspection of the convolution geometry, and checking clearances at critical points on the expansion joint and at other points in the system.
- Are the bellows and other movable portions of expansion joint free of foreign material?

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INSPECTION DURING AND IMMEDIATELY AFTER SYSTEM PRESSURE TESTS

WARNING: EXTREME CARE MUST BE EXERCISED WHILE INSPECTING ANY PRESSURIZED SYSTEM OR COMPONENT.

A visual inspection of the system shall include checking for the following.

- Evidence of leakage or loss of pressure.
- Distortion or yielding of anchors, expansion joint hardware, the bellows and other piping components.
- Any unanticipated movement of the piping due to pressure.
- Evidence of instability (squirm) in the bellows.
- The guides, expansion joints and other moveable parts of the system shall be inspected for evidence of binding.
- Any evidence of abnormality or damage shall be reviewed and evaluated by competent design authority.

PERIODIC INSERVICE INSPECTION

WARNING: EXTREME CARE MUST BE EXERCISED WHILE INSPECTING ANY PRESSURIZED SYSTEM OR COMPONENT.

Immediately after placing the system in operation, a visual inspection shall be conducted to insure that the thermal expansion is being absorbed by the expansion joints in the manner for which they were designed.

The bellows shall be inspected for evidence of unanticipated vibration.

A program of periodic inspection shall be planned by the system designer and conducted throughout the operating life of the system. The frequency of these inspections will be determined by the service and environmental conditions involved. These inspections should include the items noted previously as well as an examination for signs of external corrosion, loosening of threaded fasteners and deterioration of anchors, guides and other hardware. **IT MUST BE UNDERSTOOD THAT THIS INSPECTION PROGRAM, WITHOUT ANY OTHER BACKUP INFORMATION, CANNOT GIVE EVIDENCE OF DAMAGE DUE TO FATIGUE, STRESS CORROSION OR GENERAL INTERNAL CORROSION. THESE CAN BE THE CAUSE OF SUDDEN FAILURES AND GENERALLY OCCUR WITHOUT ANY VISIBLE OR AUDIBLE WARNING.** Where the critical nature of the system warrants, it may be necessary to devise means for minimizing the probability of this type failure, including periodic preventative replacement of critical system components.

Where any inspection reveals evidence of malfunction, damage or deterioration, this shall be reviewed by competent design authority for resolution.

SYSTEM OPERATION

A record shall be maintained of any changes in system operating conditions (i.e. pressure, temperature, thermal cycling, water treatment) and piping modifications. Any such change shall be reviewed by competent design authority to determine its effect on the performance of the anchor, guides and expansion joints.

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TYPICAL CAUSES OF EXPANSION JOINT FAILURE

Bellows expansion joints which have been properly designed and manufactured for specified piping system conditions have given many years of satisfactory service. Failures, of course, have occurred which are of concern both to users and to reputable expansion joint manufacturers. Failures can occur for many reasons, but experience has shown that certain causes of failure fall into fairly distinct categories. The following list, which shows some typical causes but is by no means all-inclusive, is presented with the intent that, as knowledge of the causes of failure becomes more widespread, action can be taken to prevent or minimize these occurrences.

- Shipping and handling damage. Examples: Denting or gouging of bellows from being struck by hard objects (tools, chain falls, forklifts, adjacent structures, etc.); improper stacking for shipping or storage; insufficient protection from weather or other adverse environmental conditions.
- Improper installation and insufficient protection
- during and after installation.
- Examples: Joints with internal liners installed in the reverse direction with respect to flow; installing an expansion joint in a location other than as prescribed by the installation drawings; premature removal of shipping devices; springing of bellows to make up for piping misalignment; insufficient protection from mechanical damage due to work in the surrounding area; insufficient protection of bellows during nearby welding operations and failure to remove shipping devices before placing system in operation.
- Improper anchoring, guiding and supporting of the system.
- Anchor failure in service.
- Bellows corrosion, both internal and external.
- System over-pressure (in-service or hydrotest). Bellows vibration (mechanical or flow induced resulting in high cycle fatigue).
- Excessive bellows deflection (axial, lateral, angular deflections greater than design values).
- Torsion.
- Bellows erosion.
- Packing of particulate matter in the bellows convolutions which inhibits proper movement of the bellows.