

## PRESSURE BALANCED ELBOW EXAMPLE

Figure 1

**HOW THEY WORK** – A Pressure Balanced Elbow (PBE) or Tee (PBT) expansion joint is capable of absorbing axial and lateral movements while still cancelling out the system pressure thrust ( $P_t$ ). They do this by adding a third bellows on the back side of the elbow / tee which moves the typical location of the pressure thrust from the elbow to the balancing end plate. Thus, the elbow/tee is isolated from the piping on the left and can move freely.

**WHEN TO USE PBE/T's** – They are typically used in confined spaces where there is insufficient room for pipe loops, tied universal or other options.

WHEN NOT TO USE PBE/T's - Due to the addition of the third bellows and associated dummy legs and plates, the PBE/T are more expensive than a traditional tied universal and it is recommended that a tied universal option be tried first. Also, the balancing bellows creates several special considerations the primary one being accumulation of particulates. In this case, it is recommended that the unit be located in the vertical axis with the balancing end on top so that they are self draining. The second consideration is the operating temperature. The balancing bellows will operate at a significantly reduced temperature that could cause condensate / congeal problems. For these applications, a heating blanket over the balancing bellows may be required. **SPECIAL CONSIDERATINS** – PBE/T have several special considerations as follows:

1) When the line pipe is greater than 36" diameter, a reduced dummy leg pipe of approximately 75% of the line pipe should be used to avoid ovalizing the elbow and distorting the bellows.

2) The balancing bellows cavity should have a  $\frac{3}{4}$ " minimum drain port to allow the hydro test water to be drained.

3) Special care should be taken when designing two tied rod joints due to the potential for the end plate to become unstable and cause the bellows to squirm.

4) The squirm pressure of the balancing bellows should be carefully evaluated when considering the deadweight of the end plate assembly.

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SENIOR OPERATIONS LLC, DENIOR OPERATIONS LLC,	PATHWAY ENGINEERING BULLETIN		drawing no. PRESS BALANCED ELBOW / TEE	REV	<sup>sheet</sup> <b>2</b> OF 2
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**COMPUTER MODELING A PBE/T** – Figure 2 below depicts a typical PBE/T application where the line runs from one vessel to a second in a compact routing that would prevent a "normal" solution and dictates the use of a PBE/T. The example is based upon 24"nps pipe at 800° and stainless steel type 304 material at 150 psig. The expansion joint depicted by figure 1 has been used in the layout. A Caesar II model is available upon request. The following comments are applicable to this model:

- 1) The dummy leg runs from node 100 to 120. If you attempt to run it from the elbow centerline, node 110, you will generate erroneous results.
- 2) It is not necessary to model all four tie rod with the associated restraints which would generate an overly complex model. It is recommended that the tie rods be modeled as a single rigid element spanning from the balancing end plate, node 130, to the opposite tie rod plate, node 60. However, this end should be given a different node number, 1060, and then linked to the tie rod plate by restraints and connect nodes, 1060-60. In this case the Z, R<sub>x</sub> & R<sub>y</sub> restraints should be used to simulate the effect of four tie rods.
- 3) The modeling information for each bellows element should be entered into the auxiliary expansion joint input sheet. It is recommended that the lateral spring be left blank as the angular spring rate will be the dominate factor.

