

Welded Plate Elbows in High Temperature Applications

Purpose

Advise customers of the potential for steam leaks and rupture at the longitudinal weld joints in high temperature steam piping and make customers aware that they may have welded plate elbows installed in the high temperature components of their steam lines.

Problem

Recent failures have occurred in high temperature steam piping containing longitudinal weld seams. A few of these have been very serious, resulting in personnel injuries and fatalities. The information available from investigation of these failures, while incomplete, has suggested that one or more of these failures was caused by weld defects. Additional causes may have been due to higher stresses imposed by the variations in weldment surface geometry; lower strength of the weld metal; or lower strength of the heat-affected zone material. Evaluations by the ASME Boiler & Pressure Vessel Code are revealing that average weld metal creep strength of like compositions may fall below that of the equivalent base material property, when operating at high temperatures for long time periods. Therefore, even though there are no significant flaws detected in the welds, the lack of sufficient weld material strength may still lead to premature failure.

Longitudinal seams are more susceptible to failure because the stresses from the internal pressure are much higher for these seams than for circumferential ones.

Historically, B&W has supplied seamless steam piping and headers, including most pipe bends, for the high temperature elements in the boiler. However, due to the practical limitations in bending large-diameter, thick-walled pipe to tight radii, B&W has supplied some elbows of formed plate segments containing longitudinal weld seams. No known cases of leakage or failure have occurred in these products to date. However, the method and materials of construction and operating loads for these components bear enough similarities to longitudinally welded hot reheat piping, which did experience failures to warrant examination.

Warning

Failure of these pipe elbows could result in personnel injury, major property damage, and extended boiler outage.

Recommendations

1. Examine the steam piping of all boilers operating longer than ten years at steam temperatures above 975°F.
2. Identify all longitudinally welded pipe elbows in the high temperature steam lines (greater than 975°F) and examine for evidence of weld region degradation. B&W practice has been to use welded elbows for bends of radii equal to or less than 1.5D (where D equals pipe diameter). Bending of seamless pipe has been limited to no tighter than about 3D radius. Normally, B&W scope of supply will not include bends between 1.5D and 3D radii. Bends tighter than 2D can be assumed to be welded.
3. Remove insulation from all such bends, and carry out the following examinations:
 - 3.1 Magnetic particle or liquid penetrant method should be used particularly in the weld regions. An etching solution may be necessary to locate the weld seam, but eddy current methods are available that are also capable of finding the welds.
 - 3.2 Ultrasonic shear wave should be used to detect flaws along the weld fusion lines.
 - 3.3 Metallographic replication in the weld metal and heat-affected zones should be used to establish the degree of creep or creep-fatigue damage that may have occurred.

A thorough inspection is particularly important because subsurface flaw initiation and propagation can occur in these welds and progress to catastrophic failure with little warning. It is very important to examine the bend intrados (inside radius of the bend),

(continued on reverse side)

since the highest stresses usually occur at these locations.

On-line monitoring techniques can be utilized. In particular, acoustic monitors can be placed in the vicinity of, or on the elbow itself to continuously monitor for flaw initiation, growth, or leakage of steam.

Support

Contact Babcock & Wilcox Field Service Engineering with any questions that may arise. Our Field Engineering can offer assistance, such as non-destructive examination and replication, as well as on-line monitoring.

For more information in the U.S., call 1-800-BABCOCK (222-2625) or fax (216) 860-1886 (Barberton, Ohio). Outside the U.S., call (519) 621-2130 or fax (519) 621-2142 (Cambridge, Ontario, Canada). In Mexico, call (5) 208-1906 or fax (5) 533-5550. Or contact your nearest B&W sales or service office worldwide.

Akron (Wadsworth), Ohio
Ankara, Turkey
Atlanta, Georgia
Beijing, P.R.O. China
Birmingham, Alabama
Boston (Westborough), Massachusetts
Cambridge, Ontario, Canada
Charlotte, North Carolina
Cherry Hill, New Jersey
Chicago (Lisle), Illinois

Cincinnati, Ohio
Dallas, Texas
Denver (Lakewood), Colorado
Edmonton, Alberta, Canada
Halifax (Dartmouth), Nova Scotia, Canada
Houston, Texas
Jakarta, Indonesia
Kansas City, Missouri
Los Angeles (Los Alamitos), California
Melville, Saskatchewan, Canada

Mexico City, Mexico
Montreal, Quebec, Canada
New York, New York
Portland, Oregon (Vancouver, WA)
Pune, India
Saint John, New Brunswick, Canada
St. Petersburg, Florida
San Francisco (Vacaville), California
Vancouver (Richmond), British Columbia, Canada

The information contained herein is provided for general information purposes only, and is not intended or to be construed as a warranty, an offer, or any representation of contractual or other legal responsibility. Note: Deutsche Babcock AG and Babcock Energy Limited (U.K.), formerly licensees, are no longer affiliated with The Babcock & Wilcox Company.