

Corrosion-Fatigue Failures of Riser Tube Bends

Purpose

This Plant Service Bulletin is a **SAFETY ALERT WARNING** that advises boiler owners and operators of the immediate need to inspect riser and supply tube bends for evidence of corrosion fatigue damage on the inside of these bends and to undertake immediate replacement of damaged tubing.

Problem / Hazard

Corrosion fatigue damage has been found on the inside of bends in riser tubes. The damage appears as crack-like indications parallel to the tube axis, predominantly aligned along the neutral axes of these bends, and limited to the bend area. These “cracks” often initiate at internal pitting attack locations and then propagate through the tube wall. In time, pinhole leaks occur that could steam wash and damage nearby tubing and boiler parts. In addition, the leaking tube could catastrophically rupture as a window blowout, ripping along the inside diameter (ID) cracking at the neutral axes. Anyone in the area during such an event could be severely burned or killed.

Background

Previous plant service bulletins, PSB-2 and PSB-29, detail the potential for internal corrosion damage of boiler components. They addressed damage that was found to principally occur in horizontal runs of downcomers, supply tube and riser tube pressure part connections. Damage also occurs in boiler waterwall tubing in areas of high restraint, such as adjacent to attachment welds, boiler corners, or at windbox attachment areas. Recent riser tube failures have occurred in pipe and tube bends between the boiler waterwall headers and the steam drum, and away from any nearby welded structural restraints.

Conditions known to contribute to corrosion-fatigue damage include:

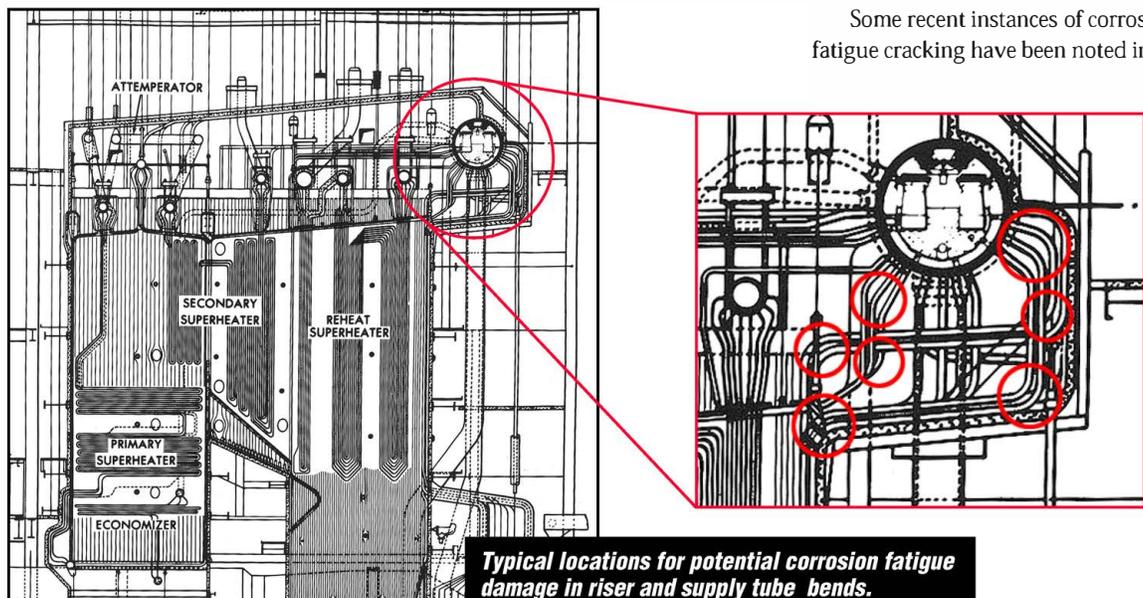
- Poor water chemistry control, such as periods of high dissolved oxygen or pH excursions in the boiler water.
- Very long service time; recent failures have occurred after nearly 40 years of service in original tubing.

- Cycling conditions, particularly repeated boiler start-ups and shut-downs, that lead to flexing of the riser tube bends; this flexing, which is elastic, creates cyclic stresses that are highest at the neutral axis of these bends.

Exposure of water-wetted surfaces to cyclic stress for very long periods of time may lead to the development of internal cracking in the bend areas. Crack initiation and propagation rates can be further aggravated by upset water conditions, especially if combined with repeated acid cleaning operations. Cracking can lead to tube failure, with potential for personal injury and death. In one case, a riser tube rupture pressurized a penthouse that subsequently ruptured casing and injured a nearby worker.

Although the recent cases have been limited to riser tubing in the upper areas of boilers, it is possible that any water containing tube or pipe bend subjected to flexing while in service may also be susceptible to damage by corrosion fatigue and in even shorter times than experienced to date.

Some recent instances of corrosion fatigue cracking have been noted in the



Typical locations for potential corrosion fatigue damage in riser and supply tube bends.



Photo shows catastrophic tube rupture that is possible with corrosion fatigue.

straight, membraned roof tubes of a boiler. These instances appear to be associated with the type of internal corrosion-fatigue damage that is described in PSB-29, and points out the importance of regular and diligent inspection of the internal surfaces of areas known to be susceptible to this time dependant, damage mechanism.

Inspection

The most effective method of detecting corrosion fatigue damage is ID videoprobe inspection, though this method does not allow for direct determination of crack depth. Other non-destructive methods can also be employed, such as radiographic examination and angle-beam ultrasonic inspection, but these methods require the development of procedure and acceptance criteria.

Recommendations for Immediate Action

1. Review boiler arrangement drawings for areas that would be susceptible to pipe and tube flexing during boiler cycling. Pay attention to areas between generally inflexible and rigid penthouse components and the boiler proper. Target these locations first and prioritize those areas as most susceptible to damaging corrosion fatigue.
2. Thoroughly inspect bend areas in riser and supply piping, such as those described above.
3. Review waterside operating history to determine if oxygen, pH or chemical cleaning excursions have occurred. Such excursions would

increase the probability that corrosion-fatigue damage has occurred.

4. Review pressure part failure history that may indicate increasing susceptibility to corrosion-fatigue failures and revise tube inspection procedures and frequencies accordingly.
5. Replace any tubing that shows any evidence of cracking as soon as possible.

B&W Support

Contact B&W Field Engineering Services through your local district service office for assistance in your investigation and inspection efforts to identify and locate corrosion fatigue damaged tubing and to obtain copies of PSB-2 and PSB-29. B&W can be particularly helpful in evaluating the specific boiler details and determining areas of greatest risk to target for further inspection and study. B&W also possesses unique and effective non-destructive capabilities that may uncover ID cracking problems.

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