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The GRIME

February / March 2011
Newsletter

Keep The Basics Of Water And Steam Physics In Mind

One of the most basic fundamentals of boiler operation that any operator should remember is that water flashes to steam at 212°F.

Failure to keep this rule in mind can lead to tragedy. Another basic law of physics of importance to this trade: when water flashes to steam, it will always attempt to increase to 1700 times its original volume.

In the following case study, a repair crew in a large powerhouse was attempting to replace the piping between the main steam stop and the non-return valves on a high pressure boiler. The boiler was in battery with three other boilers. The main steam valve next to the boiler was leaking steam, according to the workers, but they did not consider it to be problematic at the time.

The first circumferential root pass and while it was only one fifth of the total thickness, it created a pressure containment vessel. The crew left the job for the weekend. Throughout the following two days, the leaky steam valve continued to leak steam into the new spool piece which had a short drain valve that was closed. The steam condensed and the hot water accumulated in the spool pieces and the drain valve line.

The workers returned to the job on Monday and did not think to open the short drain valve to ensure that the area was free of water before they started to weld. The welder finished the circumferential weld next to the non-return valve with four additional passes. During that process, the condensed water was reheated and flashed into steam. The steam was enclosed within the spool piece which meant it could not expand to 1700 times its original volume and built up a great deal of pressure. The workers, unaware of this tremendous pressure build-up, began to weld the second pass at the other end of the spool piece.

The welding arc was in excess of 10,000°F and the molten weld puddle was nearly 2,800°F and the heat affected zone ranged from approximately 1200°F to just below the temperature of the molten steel. All of these factors explain how this flashing of steam and pressure build-up occurred.

The tragedy occurred when the welder was about two-thirds of the way around the pipe for the second pass. As expected, the weld and adjoining metal blew outward with alarming speed and shock. The weld root pass and the section of the molten second pass exploded and struck the welder in the neck and chest containing molten metal mixed with steam and caused severe injuries. The welder's assistant was hit directly in the face and eyes causing blindness. Both workers sustained serious injuries that were a high price to pay for what should have been a minor repair job.

Tragedies such as these can be averted. Awareness of the danger is the best defense. Keep these guidelines in mind:

- Never weld on any pressure retaining surface which contains unvented liquids that can be pressurized.
- When welding on a vessel containing either a liquid or gas vapor, always remember that stress values of the metal in the weld and heat affected zones are low due to the high temperatures, therefore, the weld strength will contain virtually no internal pressures.
- Before beginning any welding, always check to see if anything might be contained by or on the opposite surfaces. Welding on containers holding unknown substances can be extremely dangerous.
- Always use proper welding procedures qualified in accordance with ASME Code Section IX.
- Always use welders that have demonstrated their proficiency and have passed a performance qualification test in accordance with ASME Code Section IX.

Information for this tip was taken from The National Board of Boiler and Pressure Vessel Inspectors. More information can be found at www.nationalboard.org.

Creep Can Lead To Failure Of High Temperature Components

Creep - (Krēp) <1 is the distortion or warping components in a boiler due to high temperatures and constant stress.

The end of useful service life of the high-temperature components in a boiler, like the superheater and reheater tubes and headers, is usually a failure by a creep or stress-rupture mechanism. An understanding of high temperature materials behavior is beneficial in evaluating failures in these types of systems.

Failures involving creep are usually easy to identify due to the deformation that occurs. Failures may appear ductile or brittle. Cracking may be either trans granular or inter granular. While creep testing is done at constant temperature and constant load actual components may experience damage at various temperatures and loading conditions.

Depending on the type of metal, creep can occur at various temperatures:

- **Carbon steel = 800°F**
- **Carbon + 1/2 Molybdenum = 850°F**
- **1¼ Chromium – ½ Molybdenum = 950°F**
- **2¼ Chromium – 1 Molybdenum = 1000°F**
- **Stainless steel = 1050°F**

The first two stages of creep will not leave any micro structural evidence damage. The first evidence of damage will appear as individual voids or pores often in the junction of three or more grains at nonmetallic inclusions. These voids or pores grow in size and connect and form long cracks until failure occurs. The final rupture occurs by a tensile overload when effective wall thickness is too thin to contain the steam pressure.

Creep failures are expected for superheaters and reheaters when operating at design conditions but even a slight deviation from the appropriate parameters can cause early failures. In individual tubes, steam temperature will always vary slightly and the design should allow for some variability. However, if the range of temperatures is larger than accounted for, the highest temperature tubes will fail sooner than expected.

There are several things to look for prior to creep failures:

1. **bulging or blisters in the tube,**
2. **thick-edged fractures often with very little obvious ductility,**
3. **longitudinal "stress cracks" in either or both ID and OD oxide scales,**
4. **external or internal oxide-scale thicknesses that suggest higher-than expected-temperatures, and**
5. **the microstructure has inter granular voids and cracks.**

Usually the very first sign of creep damage in a superheater or reheater tube is longitudinal cracks in the steam-side scale. As creep deformation expands the tube diameter, the brittle ID scale cannot follow the expansion. Cracks develop in an axial or longitudinal direction which is perpendicular to the principle hoop stress. With time, the tube continues to expand, and these cracks widen. This wide crack shortens the path from steam to steel; iron oxide forms preferentially at the tip of the crack, as there is less oxide thickness to protect the steel; and a cusp forms within the steel tube. The cusp acts as a notch or a stress raiser, reducing the local wall thickness. Creep voids form here, often before any other obvious grain-boundary damage appears elsewhere within the microstructure. With continued high-temperature operation, creep cracks grow from the cusp and ultimately weaken the cross section to the point where failure occurs.

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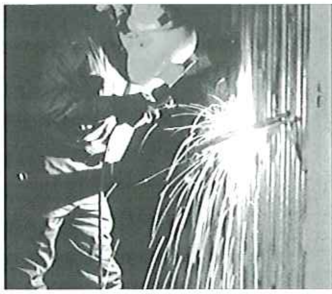

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Equipment List

All equipment listed is for sale or lease and is subject to availability

Unit	HP/PPH	Year	Manufacturer	Fuel	Type	Pressure	Controls
VE7	150,000	2008	Victory	Gas	Steam	250	IRI
VE8	150,000	2008	Victory	Gas	Steam	250	IRI
VE5	120,000	2008	Victory	Gas	Steam	250	IRI
VE6	120,000	2008	Victory	Gas	Steam	250	IRI
VE1	85,000	2008	Victory	Gas	Steam	350	IRI
VE2	85,000	2008	Victory	Gas	Steam	350	IRI
VE3	85,000	2008	Victory	Gas	Steam	350	IRI
VE9	79,280	2008	Victory	Gas	Steam	550/525SH	IRI
VE10	79,280	2008	Victory	Gas	Steam	550/525SH	IRI
VE11	79,280	2008	Victory	Gas	Steam	550/525SH	IRI
747	75,000	2000	B&W (Low NOx)	G/#2	Steam/SH	750/750	IRI
750	70,000	1996	Nebraska (Low NOx)	G/#2	Steam/SH	750/750	IRI
752	60,000	1980	B&W	G/#2	Steam	750/750	IRI
709	60,000	1979	Zurn (Low NOx)	G/#2	Steam	500	IRI
741	60,000	1979	Zurn	G/#2	Steam	550	IRI
SB79	40,000	1986	Cleaver Brooks	Gas	Steam	260	IRI
SB80	40,000	1986	Cleaver Brooks	Gas	Steam	260	IRI
615	40,000	1975	B&W	G/#2	Steam	325	IRI
SB29	1,200	1990	Johnston (Low NOx)	G/#2	Steam	200	IRI
496	800	1990	York-Shipley (Low NOx)	G/#2	Steam	200	IRI
634	800	1972	York-Shipley	G/#2	Steam	150	IRI
SB123	600	2008	York-Shipley	G/#2	Steam	150	UL/CSD1
SB63	500	1985	Superior	G/#2	Steam	150	IRI
SB18	300	1995	Clayton	G/#2	Steam	200	IRI
SB114	300	2008	Superior	G/#2	Steam	150	IRI
415	250	1980	Eclipse	#2 Oil	HT/HW	954	IRI
719	250	1987	Superior	G/#2	Steam	150	IRI
SB136	250XID	2010	York-Shipley	G/#2	Steam	150	UL/CSD1
SB144	175XID	2010	York-Shipley	G/#2	Steam	150	UL/CSD1
SB142	175XID	2010	York-Shipley	G/#2	Steam	150	UL/CSD1
SB125	150	2008	Superior	G/#2	Steam	150	UL/CSD1
SB76	150	2007	York Shipley (5 of these)	#2Oil	Steam	150	UL/CSD1
SB127	100XID	2009	York Shipley	G/#2	Steam	150	UL/CSD1
SB141	100XID	2010	York Shipley	G/#2	Steam	150	UL/CSD1
SB143	70	2010	York Shipley	G/#2	Steam	150	UL/CSD1
SB112	50	2008	Superior	G/#2	Steam	150	UL/CSD1
RB753	15	1986	Fulton	Electric	Steam	150	UL
SB65	15	2007	Fulton	Gas	Steam	150	UL

Request a quote on-line at www.wareinc.com or call 800-228-8861

WARE buys used boilers

All equipment listed is for sale or lease and is subject to availability

Chillers

Unit	Size	Manufacturer	Voltage	Type	Year
RC-24	30 Ton	Mc Quay	480 v	3 ph	2000
RC-21	40 Ton	Mc Quay	480 v	3 ph	1999
RC-1	60 Ton	Mc Quay	480 v	3 ph	1995
RC-2	60 Ton	MC Quay	480 v	3 ph	1995
RC-13	60 Ton	Trane	200-230 v	3 ph	1989
RC-5	95 Ton	Mc Quay	480 v	3 ph	1995
DH-01	100 Ton	Trane	480 v	3 ph	2008
DH-02	100 Ton	Trane	480 v	3 ph	2008
RC-6	105 Ton	Mc Quay	480 v	3 ph	1995
RC-8	155 Ton	Mc Quay	480 v	3 ph	1995
RC-10	195 Ton	Mc Quay	480 v	3 ph	1995
RC-11	195 Ton	Mc Quay	480 v	3 ph	1995
RC -25	300 Ton	Mc Quay	480 v	3 ph	2003

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Unit	HP/PPH	Year	Manufacturer	Fuel	Type	Pressure	Controls
SSB1	50 hp	2011	York Shipley	G/#2	Steam	150	UL/CSD-1
SSB2	70 hp	2011	York Shipley	G/#2	Steam	150	UL/CSD-1
SSB3	100XID	2011	York Shipley	G/#2	Steam	150	UL/CSD-1
SSB4	150	2011	York Shipley	G/#2	Steam	150	UL/CSD-1
SSB5	175XID	2011	York Shipley	G/#2	Steam	150	UL/CSD-1
SSB6	250XID	2011	York Shipley	(Low NOx) G/#2	Steam	150	UL/CSD-1
SSB7	300XID	2011	York Shipley	(Low NOx) G/#2	Steam	150	UL/CSD-1
SSB8	400XID	2011	York Shipley	(Low NOx) G/#2	Steam	150	UL/CSD-1
SSB9	500XID	2011	York Shipley	(Low NOx) G/#2	Steam	150	UL/CSD-1
SSB10	600XID	2011	York Shipley	(Low NOx) G/#2	Steam	250	UL/CSD-1
SSB11	800XID	2011	York Shipley	(Low NOx) G/#2	Steam	250	UL/CSD-1

Reactivating Idle Boilers Requires Proper Safety Procedures

There are several safety precautions to follow when reactivating an idle boiler.

1. Check for signs of overheating in the exterior shell and/or insulation.

2. Watch the floor for puddles that can indicate water or steam leaking from any part of a pressurized system including the boiler, valves and piping.

3. Check for flue gas leaks. Look for black dust or soot around the sheet metal joints checking any part of boiler enclosure and breaching in particular in the connection to the stack. Also, check the boiler exhaust system reliability.

4. Inspect all of the controls looking for open panels, covers and sign of rewiring on the floor or bottom or panels in particular check jumper wires and locked shutoffs.

5. Examine all operating controls and safety devices to ensure proper operation. Watch at least three cycles of automatic op eration before independent operation.

6. Check to make certain all covers are installed on over-limit switches, temperature sensors and electrical controls.

7. Test all safety valves to confirm that all are installed with full-sized discharge piping properly supported and directed to a point of safe discharge. The set pressure of the safety valve must be equal to or less than boiler maximum acceptable working pressure and relieving capacity must be equal to or greater than boiler output.

8. Check all fuel sources for the capacity to shut off the vesel's fuel source.

Reactivating idle boilers continued from page 5

Reactivate idle boilers continued on page 4

9. Examine all temperature and pressure gages to ensure that each is operational and located for proper monitoring.

10. Eliminate all fire hazards from the boiler room.

11. Never use the boiler room for storage.

12. Check all combustion air openings for any obstructions.

13. Test all piping to ensure that there are proper supports and allowance for expansion and contraction.

14. Find the operating certificate and note the last date of inspection and expiration date and when the next inspection is due.

What happens when a boiler is not properly reactivated?

Reactivating an idle boiler without following properly safety precautions can cause problems for the boiler and safety of those in the building.

In the following case study, an old elementary school that had been closed down for several years was being reopened for a new use. The water tube boiler in the building had not been inspected since the shut down and the boiler was then placed into service without following the proper procedures.

The boiler experienced a runaway firing condition due to the safety shutoff gas valves being stuck. The boiler was also dry due to a malfunctioning low-water fuel shutoff and plugged piping. The resulting intense heat melted all the tubes in the boiler. The boiler had been seriously overheated causing the steam drum to grow lengthwise about eight inches, parting the insulation. This caused the "cherry red glow," a fireman reported.

If the boiler had been properly serviced and inspected before being placed in service, this incident could have been completely preventable. With the proper inspection, the inspector should have recommended that all controls and safety devices as well as the plugged low-water fuel shut-off piping should be replaced. In addition, the fuel train would have been upgraded to meet the current standards.

The cost to bring this boiler into compliance with safety standards was estimated to be between $2,500 - $3,000 but compared to the repairs or replacement if the boiler had been damaged, it is minimal, and especially considering a boiler incident could cause the loss of life.

Reviewing this incident, the following observations were made:

- The boiler was outfitted with only one low-water fuel shutoff – a combination low-water fuel shutoff and water feeder;
- The piping to the low-water fuel shut-off was plugged.
- Both safety shut-off valves in the main fuel gas train had failed in the open position. These are normally closed valves which must be energized to open, and when examined all power had been shut off.
- One of the safety shutoff gas valves was an obsolete diaphragm, weight-loaded valve, actuated by an electrical solenoid.

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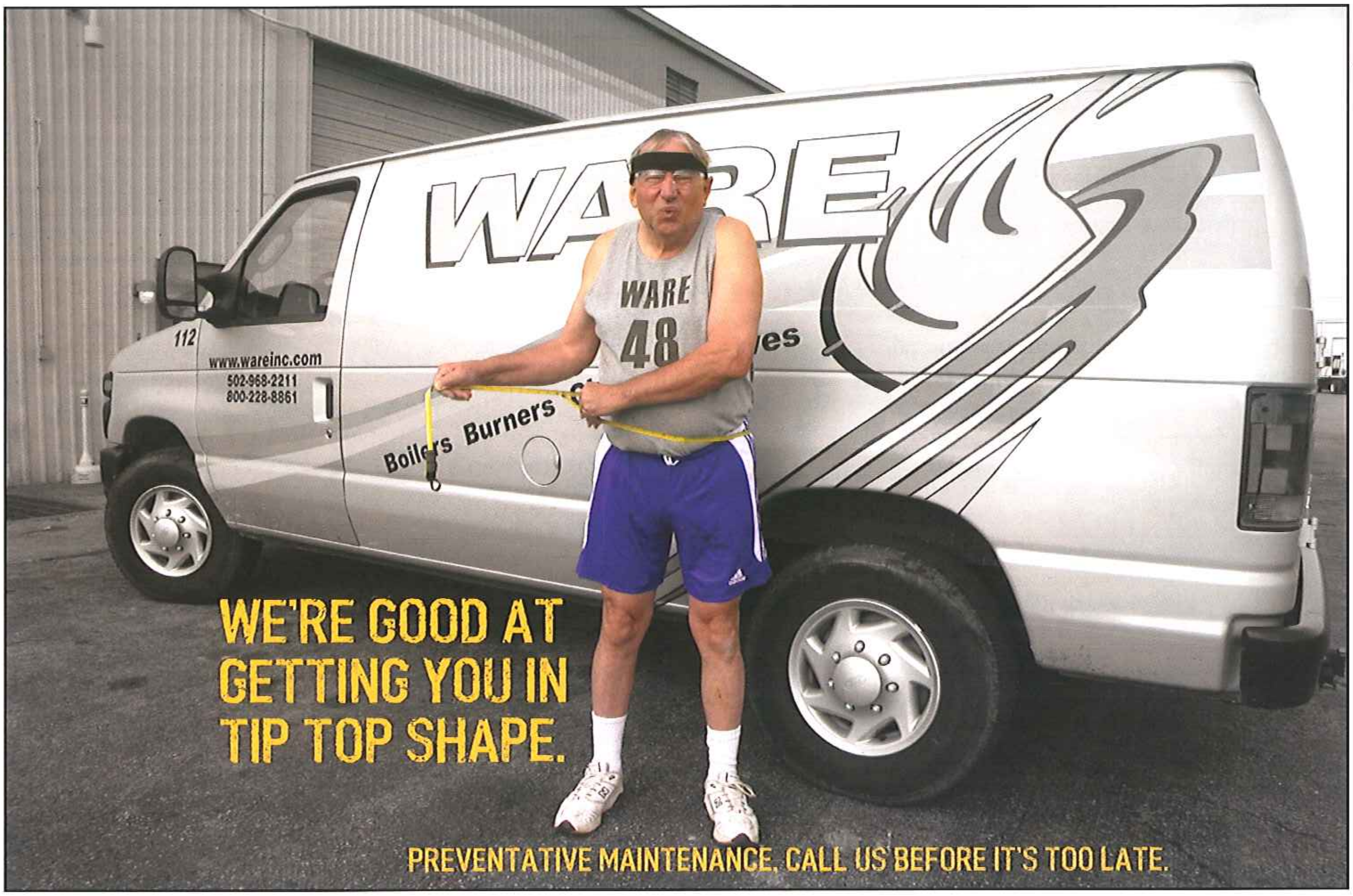

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