Safety Lines

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Seizure of Boiler Relief Valves

The following article was extracted with the permission of the IChemE, from IChemE Loss Prevention Bulletin no. 141. The IChemE also market a database of accident reports — The Accident Database. ***Ed***

“Summary

While carrying out a statutory intermediate hot examination of a steam drum and superheater, which involved floating of the relief valves, it was found that whereas the superheater relief valve lifted at its set pressure, the two relief valves on the steam drum failed to lift.

Incident

The steam pressure was raised and the superheater relief valve floated successfully at its set pressure (45 barg). However, the relief valves on the steam drum failed to lift. The easing gear was utilised but this also failed to get the relief valves to lift. The boiler was shut down and the valves taken to the workshop for inspection.

Investigation

The records for the relief valves were checked and these showed that both relief valves had been successfully floated approximately one year prior to the incident. One of the relief valves was installed in the

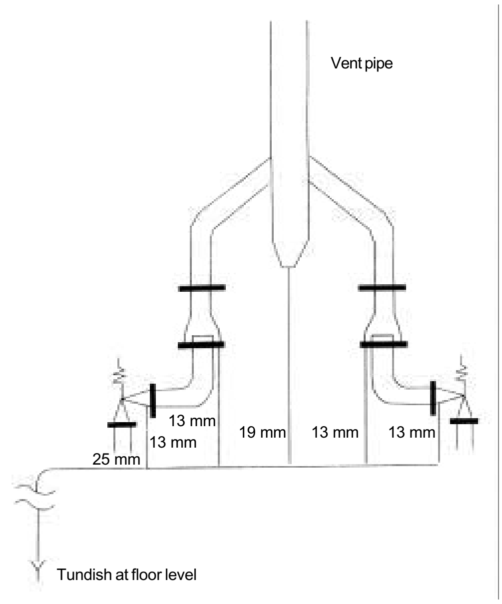

Figure 1. Typical relief valve drainage system.

relief valve test rig and the pressure raised to 55 barg but the valve failed to lift (set pressure 51 barg). The test was stopped and the valve stripped down. Inspection of the valve components revealed scaling and corrosion, and a build up of deposits around the valve, valve guide and seat. The valve had seized into the guide due to the deposits and the guide appeared to be seized onto the retaining ring lugs which were heavily scaled. The retaining ring had a corrosion groove around the outside of the seat. The other relief valve, when stripped, was found to be in similar condition.

Examination of the relief valve discharge pipework revealed that all the drains from the discharge side of the valves were connected to a common header which ran to a tundish some 24 m away — see figure 1. The drain lines were 13 mm and 19 mm nominal bore carbon steel and the header 25 mm nominal bore carbon steel. Blockages in individual drain lines could not be checked. Both relief valve outlet bends were badly scaled and corroded due to water standing in the extension pieces. These sections had already been renewed on other boilers. The extension pieces were badly scaled and full of deposits. The drain line was badly scaled reducing the bore from 13 mm to 6 mm. There were also indications on top of the boiler that condensate/water had been dripping from the relief valve discharge extension pieces.

In view of the findings, examination of the other boiler relief valves was instigated. It was found that in all cases the relief valve drain lines were blocked. As a result it was decided to float the relief valves on the other boilers using the easing gear.

All the steam superheater relief valves were checked for blockages but were found to be clear. Because of the proximity of the tundishes to the boilers the operating personnel never checked the relief valve drains, and these drains were never checked for obstructions or washed out at boiler surveys.

Conclusions

- The relief valves failed to lift due to blockages in the discharge pipework draining system which led to corrosion and scaling of the valves.
- The outlet lines and vent were badly scaled internally such that when the relief valves were floated, debris and scale fell back into the expansion pieces and valve outlets. This debris could then block the drain lines.
- Water/condensate collected on the outlet side of the valves where evaporation caused the build up of scale and precipitation of deposits rendering the valve inoperable.

Recommendations

- The relief valve drains on all boilers should be modified to provide individual short lines of adequate size to a tundish within approximately three feet of the item being drained. Checking/washing through of the drain lines and the tundish lines should be included in future boiler surveys.
- Formal checking of drains/tundishes by operating personnel should be introduced.
- The relief valve vent lines should be renewed at the earliest opportunity and given a protective coating to reduce scaling. Other installations should be examined and if similar problems exist, modifications should be carried out to correct them.

Author's Note

There have been a large number of instances where relief valves have failed to operate as intended because of a blockage downstream. This often occurs when the material discharged can itself lead to blockage such as reactor contents etc. Often when the relief valve discharge pipework is site run, support pipework may become an obstacle and pipework configuration altered from that designed. This can lead to possible areas for restrictions. Therefore, when carrying out HAZOPs do not assume that, because there are relief valves/ bursting discs installed, the system is protected. Always ensure that the discharge side is correct.

Editorial comment: In this case, the operators made the appropriate professional response by considering a common mode failure by checking the operation of the relief valves on similar duty."

Year 2000 and the Millennium Bug

Engineering Safety has had brought to their attention a potential Y2K problem which is less obvious than those in computers where dates are routinely processed.

This exists in mechanisms which rely on small microprocessor-based computer systems, all of which have some form of computer programme embedded in them. Often these processors utilise date-based routines to control and ensure safe operating environments and equipment operating controls.

Equipment with embedded systems require special treatment because:

- The systems can be difficult to locate and identify because they are hidden inside a piece of equipment.
- They cannot usually be modified by the user.
- They are likely to be involved in the majority of cases where the millennium bug can cause safety issues.

The first point is particularly relevant. Generally, embedded systems will consist of some form of microprocessor or digital electronics, often with a timer, and are enclosed within modern instruments, controllers and pieces of industrial machinery.

Also, the programme held within such systems is not normally accessible for modification by the user, so it may not be obvious that an embedded system is in place and if it is, changing it may be difficult.

Embedded systems fall into one of two broad categories — those that control discrete components and those that co-ordinate the activity of other components.

Discrete embedded systems contribute to safety by measuring operating parameters such as temperature, pressure, speed, rotation and vibration. More sophisticated systems contribute to safety by building vibration profiles, measuring cracks and erosion or undertaking trend analyses on rates of change or temperature and pressure.

Controllers contribute to safety by measuring and checking plant conditions before taking actions, which could have safety implications, such as opening or closing valves, stopping or starting machinery.

Often computers centralised within the factory, or elsewhere, contribute to safety by gathering data from local instruments, other controllers and discrete embedded systems. This information is made available to operators, giving them an overview of plant conditions and providing facilities by which they can safely take control actions.

A variation on these are safety protection systems, such as fire control or emergency shutdown systems, which contribute to safety by taking decisive action to make plant safe when it is considered to be in a dangerous condition.

Safety protection systems also inform plant personnel of hazards, allowing evacuation of hazardous areas.

Of course, it should be remembered that safety could be compromised by the failure of an embedded system not directly related to processes with the plant. Such embedded systems include those that control or monitor:

- inert gas
- waste or effluent disposal
- waste heat disposal
- communications, such as phone radio and intercom
- fire/smoke detection
- energy supply
- refrigerator/heating systems
- air treatment plants
- emergency power.

One of the insidious aspects of the millennium bug is that the use of a date may not be obvious. Part of the challenge is that many of the microprocessors used in control equipment are generic in nature. They contain multiple functions, only some of which may be used in a particular application. One of these functions is usually a date function. **But, even if there is no need for the system to use the date function, the incorrect operation of this function as a result of the millennium bug may impact on the entire operation of the unit.**

Plastic Pipe for Pressure Applications

Engineering Safety has had enquiries about the acceptability of non-metallic pipe and fittings for compressed air piping systems.

Non-metallic piping systems are acceptable for compressed air providing the piping materials and fittings comply with AS 1460, ~~AS/NZS 1477~~, AS/NZS 4129 and AS/NZS 4130 and design complies with AS 4041 (ASME B31.3 option).

Energy and Chemical Plant Operation Computer-Based Training Package

Engineering Safety advises readers that a new computer-based training package is available for the training of energy and chemical plant operators. It has been developed as a joint venture between the Petrochemical Industry Training Organisation and Training Resources Development.

The package targets both experienced and inexperienced operators working in an energy and chemical environment such as boiler operation, hydrocarbon processing, power generation, forestry, dairy and meat processing. It also includes modules relevant for staff involved with hazardous environments including chemical handling, personnel protective equipment, knowledge of legislation, etc.

The complete package trains for National Certificates in Energy and Chemical Plant Operation (Level 2 and 4) with optional steam strands. A number of unit standards (areas of knowledge and skill) combine to make up these qualifications.

(National Certificates in Energy and Chemical plant operation, with the appropriate modules including the steam strand, replace the Stationary Engine Drivers certificates, the last examination for which was held in November this year.)

A manual is provided covering each course, and training support is available through regular visits to the trainee's workplace by the training provider.

Following completion of a module or set of modules official assessment is provided which, if successful, enables the trainee to gain a credit against the relevant unit standard.

For further information on this training package please contact:

Richard Singleton
Training Resources Development
PO Box 88
PDC
Urenui
Taranaki
Phone/Fax: 06 752 3504 Email: rsingle@trd.co.nz

Waterhammer in Steam Pipework

The following article was supplied by Jim Elley, the Rotorua District Manager of M&I Safety Inspection Services Ltd. ***Ed***

The photograph below shows a three-inch cast iron valve body which has been shattered just below the bonnet through waterhammer effect.

The failure occurred when an operator opened the main steam stop valve in an adjacent area of the plant. This was done in the belief that any residual condensate would have been drained from the steam line by the trapping system. Unfortunately, the system had not drained and valve failure occurred when it was hit by a slug of water.

Fortunately, no one was injured and a procedure has been put in place that puts emphasis on draining and warming the system during the start up.

The following article on water hammer is an extract from Spirax Sarco technical reference guide Steam Distribution. *Copies of this guide are available from:*

Spirax Sarco
PO Box 76-160
Manukau City
Tel: 09 263 4205 Fax: 09 262 2475

Waterhammer and its Effects

Waterhammer may occur when condensate is pushed along a pipe by the steam instead of being drained away at the low points, and is suddenly stopped by impacting on an obstacle in the system. The build up of droplets of condensate along a length of steam pipework eventually forms a solid slug which will be carried at steam velocity along the pipework. Such velocities can be of 30 m/s or more. This slug of water is dense and incompressible and, when travelling at high velocity, has a considerable amount of kinetic energy.

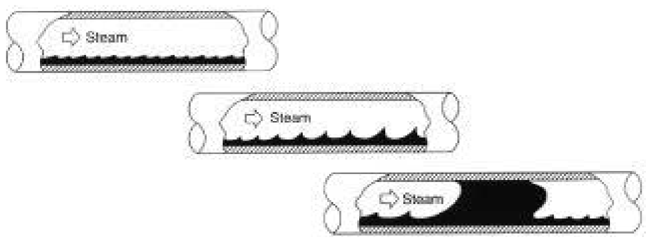

Figure 2. The formation of a 'solid' slug of water.

When obstructed, perhaps by a bend or tee in the pipe, the kinetic energy of the water is converted into pressure energy and a pressure shock is applied to the obstruction. (The laws of thermodynamics, state that energy cannot be created or destroyed, but is simply converted into a different form.) Commonly there is a banging noise, and perhaps movement of the pipe. In severe cases the fitting may fracture with almost explosive effect, with consequent loss of live steam at the fracture, providing a hazardous situation. Fortunately, waterhammer may be avoided if steps are taken to ensure that the condensate in the pipework is not allowed to collect along the pipework.

Avoiding waterhammer is a better alternative than attempting to contain it by choice of materials, and pressure ratings of equipment.

Common sources of waterhammer occur at low points in the pipework.

Such areas are:

- Sags in the line.
- Incorrect use of concentric reducers and strainers. For this reason it is better to fit strainers on their sides in steam lines.
- Inadequate drainage of steam lines.

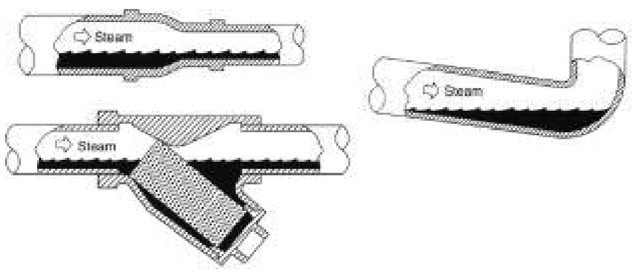

Figure 3. Potential sources of waterhammer trouble.

To minimise the possibility of waterhammer:

- Steam lines should be arranged with a gradual fall in the direction of flow, with drain points installed at regular intervals and at low points.
- Check valves should be fitted after all traps which would otherwise allow condensate to run back into the steam line or plant during shut down. Isolation valves should be opened slowly to allow any condensate which may be lying in the system to flow gently towards, and through, the drain traps before it is picked up by high velocity steam. This is especially important at start up.

Documents and Standards for Use with the Draft Pressure Equipment Cranes and Passenger Ropeways Regulations

STANDARDS				**ES.Docs**
Pressure Equipment				
AS/NZS 1200	AS 3788	AS 3920.1	BS 6759	
Pressure Vessels				**Pressure Vessels**
AS 1210	AS 1210 Supp No. 1	AS 4458	AS/NZS 1596	
ASME VIII, Div. 1 & 2	ASME X	AS 2971	BS 470	ES.Doc 003
BS 1101	BS 3970 Parts 1-6	BS EN 286 Parts 1-4	BS 4814	ES.Doc 004
BS 4994	BS 5169	BS 3274	BS 5500	ES.Doc 013
BS 7201	NZS/BS 853	NZS 5418	NZS 5235 Parts 1-2	ES.Doc 020
TEMA	UL1450	NZS/BS 5045 Parts 1-3		
Approved Code of Practice for Design, Operation, Maintenance and Servicing of Pressure Equipment (pending)				
Boilers				**Boilers**
AS 1228	AS2593	ASMEI	BS 855	ES.Doc 009
BS 1113	BS 759	BS 2486	BS 2790	ES.Doc 012
NZS 5351				ES.Doc 021
Approved Code of Practice for the Design, Safe Operation, Maintenance and Servicing of Boilers				
Pipework				**Pipework**
ANSI B31.1	ANSI B31.3	ANSI B31.5	AS 4041	ES.Doc 001
NZS/BS 806				
Welding				**Welding**
BS EN 287	BS EN 288	ASME IX	AS 3992	ES.Doc 007
Cranes				**Cranes**
NZS/BS 302	BS 327	BS 357	BS 466	ES.Doc 006
BS 1757	BS 2452	NZS/BS 2573, Parts 1 & 2	BS 2799	ES.Doc 008
BS 5744	BS 7121, Part 1 & Part 2	BS 7262		ES.Doc 018
NZS 1545 (BS 2853)	ISO 4309			ES.Doc 019
Crane Safety Manual for Operators/Users (Power Crane Association of NZ Inc.) (pending)				
Approved Code of Practice for Cranes And Lifting Appliances (OSH, Department of Labour) (pending)				
Passenger Ropeways	CAN/CSA - 298 - 96			
Approved Code of Practice for Passenger Ropeways in New Zealand (in print)				
General				**General**
NZS 4203	ANSI/NB - 23	Dangerous Goods (Class 2 - Gases) Regulations		ES.Doc 011 ES.Doc 014 ES.Doc 015
Transportable Equipment				**Transportable Equipment**
IMDG Code	NZS 5418			ES.Doc 016 ES.Doc 020
Rotating Equipment				**Rotating Equipment**
BS EN 60045- 1	BS 752	BS 5968	API Standard 611	
ANSI/ASME PTC 6	ANSI/ASME PTC 6-1	BS EN 60953-2		ES.Doc 017
Quality Management Systems				
AS/NZS ISO 9001	AS/NZS ISO 9002	AS/NZS ISO 8402		
ISO-IEC Guide 25	ISO Guide 39	EN 45004		
Hyperbaric Chambers				
CSA Z275 -1 - 93	ASME PVHO -11990			

Update

Pressure Equipment, Cranes and Passenger Ropeways Regulations

Industry consultation has been completed and final processing of the Regulations is with the Parliamentary Counsel Office.

Approved Code of Practice for the Design, Operation, Maintenance and Servicing of Pressure Equipment

A draft is now virtually complete and will be installed on the OSH internet home page for information. A meeting of the technical committee responsible for this code has been arranged for 21 December. Following any modifications required by the committee, a final draft should be issued to industry for comment.

Approved Code of Practice for the Design, Safe Operation, Maintenance and Servicing of Boilers

Modifications to the current code have been prepared by the technical committee responsible for this work. A draft of the amended code has been produced and given to industry for comment. Other persons with an interest in this code may obtain a copy from Engineering Safety. Closing date for comments is, 29 January 1999.

Approved Code of Practice for Passenger Ropeways in New Zealand

This code of practice has been completed and approved by the Minister for Enterprise and Commerce. Printing has been arranged and this code should be available for purchase from your local OSH office in the near future.

Approved Code of Practice for the Design, Manufacture, Supply, Safe Operation, Maintenance and Inspection of Cranes

The draft is complete apart from one section on inspection and this will be installed on the OSH internet* home page for information. A meeting of the technical committee responsible for this code is scheduled for 16 December. It is anticipated that the final draft will be completed soon after this meeting and sent out to industry for comment.

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*OSH internet address: www.osh.dol.govt.nz

Merry Christmas

We wish all our readers a merry Christmas and a happy New Year.

The Engineering Safety office will be closed between the 25th December and 4th January inclusive.

It is also likely that staffing levels in early January will be minimal. If you anticipate requiring any assistance during this period we recommend that you contact us before the 24th December 1998.

Readers are reminded that *Safety Lines is* now published quarterly and that the first edition in the new year is due out at the end of March.

Safety Lines is a publication of the Engineering Safety Unit of the Occupational Safety and Health Service, Department of Labour, PO Box 3705, Wellington.

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