PREVENTION OF BOILER ACCIDENTS

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When designing boilers great care has always to be exercised to guard against the possibility of a breakdown. This applies also to the design of the boiler-room plant, the selection of the materials to be used, and the fabrication of pressure parts and their test after assembly.

Stringent regulations governing the quality of the feed water to be used, the periodical cleaning, examinations, and tests of boilers go far to ensure freedom from a breakdown of pressure parts, but occasional failures have occurred. Many of these have been attributable to faulty operation and could have been prevented by the exercise of reasonable care and foresight. Thus it is that the boiler operator has a great responsibility.

Mr. S. D. Scorer recently remarked* in an article on " The Accident Potential of Steam Boiler Plant," that " a common conception of a steam boiler explosion is an event in which an apparently stable structure is suddenly disrupted, blasting and destroying all objects within reach of its violence. It is true that a few boiler explosions do actually approximate to a minor catastrophe, but, by comparison, most of them are mere incidents in which control is re-established in a few minutes."

EXAMPLES OF BOILER ACCIDENTS

Idle Boilers

One would imagine that an idle boiler would be safe enough from risk of accident, but this is not true. Mr. Scorer in his article records an incident where a Lancashire boiler had been standing out of use for nearly a week when a cleaner started to remove soot from the external flues. After raking out most of the soot he went into the side flues and stood in the space where the side flue joined the bottom flue while he sprayed water from a hose to keep down the dust. The water happened to fall on a pocket of red-hot dust and the cleaner was so badly scalded by the large volume of steam that immediately formed that he subsequently died.

Opening a Boiler

There are three major dangers to be guarded against when opening a boiler after a period of service. Firstly, there is the danger of residual pressure in the boiler. A glance at the pressure gauge which registers zero, or the cessation of flow from the blow-down valve is suggestive that all pressure has gone but the gauge may be faulty or the blow-down valve choked with deposit. The following incident will illustrate the need for special care when unsealing pressure vessels.

A water-pressure test, applied to a water-tube boiler in a destroyer on completion of retubing, revealed several leaky tubes and a bad leak from the safety-valve joint on the steam-drum pad piece. The work of remedying the leaks was immediately put in hand, the first move being to get rid of the water from

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the boiler. This was done in the usual way by connecting a low-pressure air supply, approximately 100 lb/sq. in., to the steam-drum to force the water overboard through the blow-down valve. In this case, for convenience, the air supply hose was connected to the pressure gauge pipe, the pressure gauge being disconnected but remaining in place. When the squad arrived to break and re-make the safety valve joint, they observed that the pressure gauge registered zero—which was not surprising since it was disconnected from the boiler—and the work of removing the nuts from the studs securing the valve was commenced. In the meantime the boiler remained under air pressure, and with all the nuts removed the valve still held tight. With the application of a couple of wedges between the joint, however, the valve shot into the air through the deck opening with a loud report followed by a rush of air. Fortunately the incident passed with no injuries to personnel.

Vacuum in Boilers

The second danger is that of a vacuum forming inside the boiler. If any hot water has been left in a boiler after blowing-down, and the boiler is allowed to cool with all openings closed, the condensation of the hot vapour may set up a partial vacuum. If someone now knocks in a door, the suction may force him against the boiler structure by the sudden inrush of air. Necks have been broken and severe internal injuries caused in this sort of accident.

Hot Empty Boilers

The third danger may arise when the occasion demands the opening of a boiler without delay after a period of steaming. With a boiler full of hot vapour the procedure for opening should always be to remove the top door first of all. Should the lower doors be opened first, the difference in the head of hot vapour inside the boiler and the outside atmosphere will cause a rush of hot vapour from the top door when this is knocked in, and may well lead to severe scalding of the individuals handling the door.

Prior to entering an empty boiler, precautions should be observed to ensure that it has been well ventilated and that the steam, feed, and blow-down arrangements have been isolated from all steaming boilers on the same range. Neglect of these simple precautions and failure to ensure that the isolation of the boiler is maintained have led to fatal accidents ; a case is known of a stoker inside a boiler of a cruiser being fatally injured when the supply of water for washing through was inadvertently passed through a feed heater.

EXAMINATION OF BOILERS

On each occasion a boiler is opened for internal examination careful attention should be given to the presence of grease, scale, and active corrosion. In addition, the following defects which are amongst those peculiar to the types of boilers mentioned should also receive close inspection :

Admiralty Three-Drum Boiler

Internally. (i) Pitting and cracking of bridge pieces between tube holes

(ii) Pitting and cracking in the radius of steam-drum end-plates

(iii) Surface examination of plates, particularly those provided for boilers manufactured during the war emergency period.

Externally. (i) Overheated and distorted boiler and superheater tubes

(ii) Wastage of tubes adjacent to the water-drums, and to a lesser extent

the steam drums, due to the access of water from overhead valves and joints and defective rainwater catchments

(iii) Excessive deposits

(iv) Wastage of superheater tubes adjacent to headers.

Cylindrical Marine Boilers

Internally. (i) General pitting of tubes with necking adjacent to the combustion-chamber tube-plate

(ii) Necking and fracture of water-space stays particularly the marginal stays and those fitted towards the bottom of the combustion chambers

(iii) Grooving in the flange of the Gourlay end, *i.e.*, the reduced egg-shaped section at the back-end of the furnaces

(iv) Connected pitting, grooving and cracking in the radius of the flange at the bottom of front and back end plates of the boiler.

Externally. (i) Distortion of furnaces and bulging of combustion-chamber back and wrapper plates

(ii) Lap cracks from rivet holes to caulking edge of seams in combustion chambers

(iii) Local wastage of plate due to long standing perpetual leakage from riveted seams in combustion chambers and at the bottom of front and back circumferential seams of the shell plate.

Vertical Cross-Tube Boilers

(i) Wastage due to leakage from the riveted seam connecting the uptake tube to the crown plate of boiler

(ii) Wastage of shell plate in the vicinity of handhole doors, particularly in the case of boilers fitted to cranes, where access for tightening the doors when the boiler is warm after lighting up is restricted by the presence of a coal bunker

(iii) Wastage of shell extension forming the ashpit due to the presence of damp ashes.

(iv) Wastage over crown of the top cross-tube immediately beneath the uptake tube in boilers where rain water gains access to the funnel and uptake tube.

Stay and Smoke-Tube Failures

Detection of fractured water-space stays is frequently not easy, particularly when the position of failure of a stay occurs flush with the surface of the plate or, in the case of loco-type boilers, where close visual inspection is not possible. It is therefore essential that on every occasion boilers with internal combustion chambers are water-pressure tested, deflection meters should be fitted to register the compression and expansion that occurs under pressure. Deflections up to a maximum of $\frac{3}{32}$ in may be regarded as normal provided no permanent set remains on release of the pressure. Any undue deflections or permanent set may be the result of weak areas and an investigation of the cause should be made.

Should a smoke-tube failure occur in a cylindrical boiler and the circumstances are such that replacement is not readily possible, the normal practice is to fit a tube stopper. This arrangement allows the boiler to be made available in a very short time but the repair should be regarded as a temporary measure and the tube renewed at the earliest opportunity. The bar of the tube stopper

will satisfactorily withstand the stress imposed when new, but corrosion of the bar can develop unobserved and the effective cross-sectional area may be reduced until no margin of safety remains.

Lagging

Periodical removal of sections of lagging and brickwork setting, where applicable, should be carried out to expose seams and plate surfaces ; areas selected should be where damp conditions are known or are likely to occur.

Manhole Joints

Excessive clearance between the flange of the manhole and spigot of the door has been the cause of many fatal accidents caused by the blow out of the asbestos joint. On opening a boiler the manhole doors are often placed to one side and their condition is not verified until the time comes for closing the boiler. This delay is usually due to the presence of electric and pneumatic leads passing through the manhole and the inconvenience which would be caused to cleaners by the removal of the leads to check the fit of the doors.

The fitting of double joints or an extra-thick commercial type asbestos joints to overcome defective door-facings may increase the total effective clearance of the door spigot and is bad practice and dangerous. Where defective door-facings exist they should be faired. Doors should be correctly centred in the manhole orifice and the asbestos joint should comply with the Admiralty specification.

Cleanliness

Accidents to water-tube boilers have been caused by tools, waste, and the like having been left in the boilers. The internal cleaning of a boiler should be compared with a surgical operation and similar care should be applied to the closing of a boiler to ensure that no foreign bodies are left inside.

Having regard to the great number of boilers in operation with the fleet and shore establishments, the incidence of pressure part failures due to material weakness is very small and is undoubtedly due to a rigid adherence to the regulations that govern the periodical cleaning, examination and test of the boilers, and the care exercised in carrying them out.

The interval between internal cleaning and inspection of boilers in naval ships has been increased with the introduction of the Navy system of feed-water treatment ; this measure somewhat coincides with the fitting of wholly-welded steam drums and with ships joining the Fleet with boilers working at higher pressures and steam temperatures than hitherto. It is therefore imperative that if the availability of the boilers envisaged by the use of feed-water treatment is to be realized, reliability must be maintained. To achieve this, the examinations and tests of boilers should be no less critical or thorough than ever before.