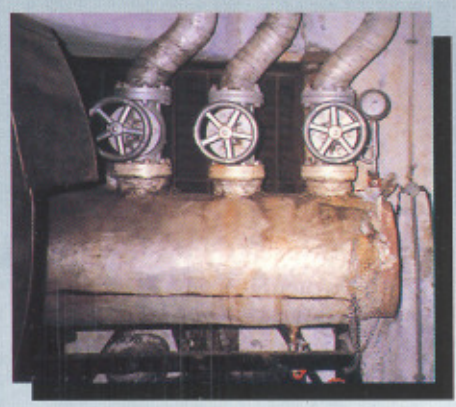
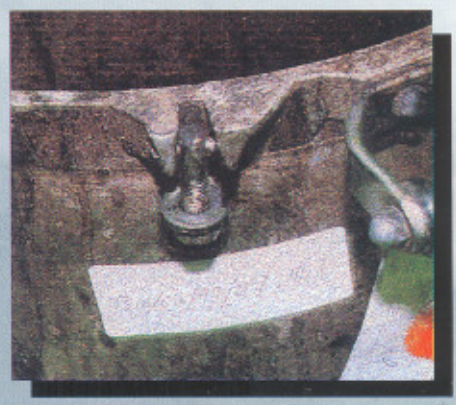
Brief Accident Cases of Boilers and Pressure Vessels in Hong Kong





Safety at work

Occupational Safety and Health Branch
Labour Department

Brief Accident Cases of Boilers and Pressure Vessels in Hong Kong

This guidebook is prepared by the
Occupational Safety and Health Branch
Labour Department

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INTRODUCTION

This brief of boilers and pressure vessels accidents in Hong Kong sets in plain terms to identify the possible causes of each accident and to make recommendations for prevention of its recurrence. This brief revealed that loss of lives and damage to properties could be the result of the safety procedures for operation and maintenance of pressure equipment had been ignored. It may serve as a reminder to the equipment owners and operators for avoiding the recurrence of similar accidents in boilers and pressure vessels.

Case 1
EXPLOSION OF A PRESSURE COOKER RESULTING IN INJURY OF A BABY AND DAMAGE IN THE STORE-ROOM

Summary

A pressure cooker installed on the mezzanine floor in a herbal tea house exploded in 1997. The explosion caused extensive damage to the store-room and the fallen broken glass injured a baby girl in the waiting area. The pressure cooker was left unattended on the stove under fire at the time of the accident. The safety valve of the pressure cooker had been replaced with a stop valve. The excess pressure accumulated inside the pressure cooker resulted in the explosion.

Circumstances

The owner used the pressure cooker to brew the herbal tea for commercial purpose. He put the herbal medicine into the pressure cooker which was half full of water. He then closed the lid, tightened the securing bolts, shut off the stop valve (which was used to replace the original safety valve) and changed the firing rate to medium after the content started boiling. He then left the pressure cooker unattended until the explosion occurred.

Observation

1. The lid was found buckled and cracked. The lip seal rim of the lid was broken and the handle on the lid was deformed.
2. The pressure gauge was damaged and the stop valve was found missing.
3. The bottom of the pressure cooker was cracked and six axle screws for the securing bolts were fractured.
4. The pressure cooker was used to boil herbal tea for commercial purpose, therefore it fell under the control of Boilers and Pressure Vessels Ordinance. The pressure cooker was classified as a special purpose boiler.
5. The working pressure was estimated to be over 450 kPa based on the results of investigation.
6. The pressure cooker safety valve had been replaced with a common stop valve. The relief valve was removed and plugged with bolt and nut. If the above safety fittings had not been removed, the excessive steam pressure inside the pressure cooker should have been released and explosion could be avoided.
7. The explosion caused extensive damage in the store-room above the shop and the fallen broken glass slightly injured a baby girl in the waiting area.
8. The operating instructions were written in English only. The owner could not read English and he operated the pressure cooker based on the verbal instructions given by the pressure cooker salesman.

Legal Implication

The owner of the special purpose boiler could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section l5 (A):
   The owner of a new boiler shall, not later than 30 days preceding the day on which he intends to put the same into use, apply to the Authority in the prescribed form for registration of the same under this Ordinance.
2. Section 22 (1):
   Every boiler and its auxiliary equipment shall be properly maintained.
3. Section 24 (1):
   Upon completion of the installation of a new boiler and before the boiler is put into use, the boiler and its auxiliary equipment shall be examined by an appointed examiner (boiler inspector).
4. Section 49 (7):
   No boiler shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate boilers of the class or type in question.

Recommendation

1. Register any boiler and auxiliaries with the Boilers and Pressure Vessels Authority and have a Certificate of Fitness issued by an Appointed Examiner.
2. Engage Competent Person(s) to operate the boiler and auxiliaries.
3. Do not tamper with the pressure parts of the boiler without the prior approval of the Boilers and Pressure Vessels Authority.

Photo 1.1 The hole for safety valve was punctured

Photo 1.2 Crack on the bottom

Photo 1.3 Hole for relief valve was fitted with bolt and nut

Photo 1.4 Broken lip seal rim of the lid

Photo 1.5 Axle screw and securing bolt

Photo 1.6 Sheared axle screw

Case 2
OVERLOADING OF ELECTRICAL WIRING RESULTING IN A FIRE THAT DAMAGED THE BOILER CONTROL PANEL COMPLETELY

Summary

In 1995 a fire caused by short-circuited or overloaded electrical wiring damaged the boiler electrical control panel completely. The fire was put out by the competent person and no casually was reported.

Circumstances

A fire broke out in a boiler control panel inside the boiler room of a clothing factory. Three hours after the boiler attendant lighted off the fire-tube boiler, smoke was found escaping from the boiler room. The boiler attendant found that the boiler control panel was on fire. He immediately closed the boiler fuel oil supply valve and isolated the electrical supply to the boiler electrical control panel. He then put out the fire with a portable fire extinguisher.

Observation

1. The pressure switch was the initial source of the fire as concluded from the result of investigation.
2. The mercury glass bulb of the pressure switch was shattered due to short-circuit or overload and this caused the fire inside the electric control panel.

Legal Implication

The owner of a boiler could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):

   Every boiler and its auxiliary equipment shall be properly maintained.

Recommendation

1. Issue circulars to the owners and boiler operators warning them of the potential fire hazard in the pressure controllers inside the control panels.
2. Issue circulars to the Appointed Examiners alerting them of the concerned areas.

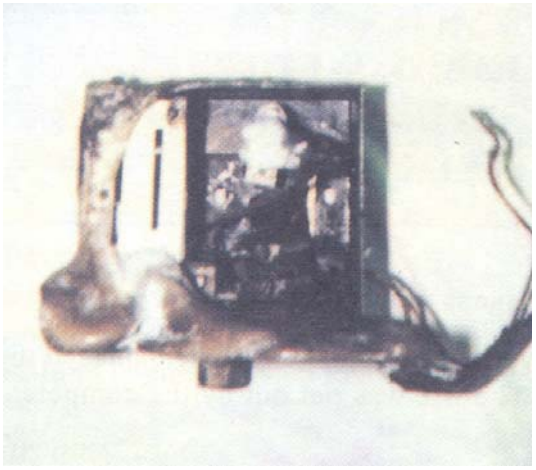


Photo 2.1 Burnt pressure switch

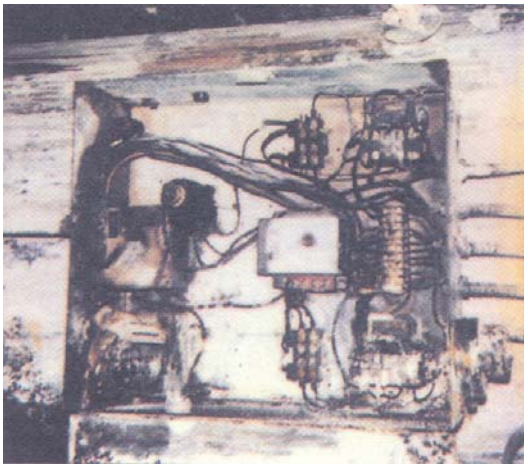


Photo 2.2 Damaged control panel

Case 3
THE EXPLOSION OF A CAULDRON DAMAGING THE SURROUNDINGS EXTENSIVELY

Summary

An explosion of cauldron occurred in 1995 was due to the operational errors made by improperly trained workers. The cauldron was designed by the owner himself. The safety valve malfunctioned at the time of the accident.

Circumstances

The cauldron involved was used in the production of watercress honey. Upon adding the requisite raw materials, the cauldron was heated by a LPG stove. After boiling the mixture for about five hours, seeing that there was still no steam coming out of the ball valve, the operator replaced the LPG stove with another one of greater capacity. Shortly afterwards, the cauldron exploded with plenty of steam spurting out and caused extensive damage to the premises. Fortunately, no one was injured.

Observation

After investigation, the pressure inside the cauldron prior to the explosion was estimated to be 770 kPa above atmospheric pressure. The safety valve was found malfunctioning. The explosion was due to improper operation and poor maintenance of the safety valve. Since the cauldron can be hermetically sealed, steam would be generated inside the cauldron on application of heat. The cauldron was equipped with safety valve and pressure gauge and hence it was classified as a special purpose boiler.

Legal Implication

The owner of the cauldron (special purpose boiler) could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 15 (A):
   The owner of a new boiler shall, not later than 30 days preceding the day on which he intends to put the same into use, apply to the Authority in the prescribed form for registration of the same under this Ordinance.
2. Section 24 (1):
   Upon completion of the installation of a new boiler and before the boiler is put into use, the boiler and its auxiliary equipment shall be examined by an Appointed Examiner (Boiler Inspector).
3. Section 49 (7):
   No boiler shall be operated except under the direct supervision of a Competent Person whose certificate of competency certifies that he is competent to operate boilers of the class or type in question.

Recommendation

1. Register any boiler and auxiliaries with the Boilers and Pressure Vessels Authority and have a Certificate of Fitness issued by an Appointed Examiner.
2. Engage Competent Person(s) to operate the boiler and auxiliaries.
3. Every boiler should be properly maintained.

Photo 3.1 Damaged strainer of the cauldron

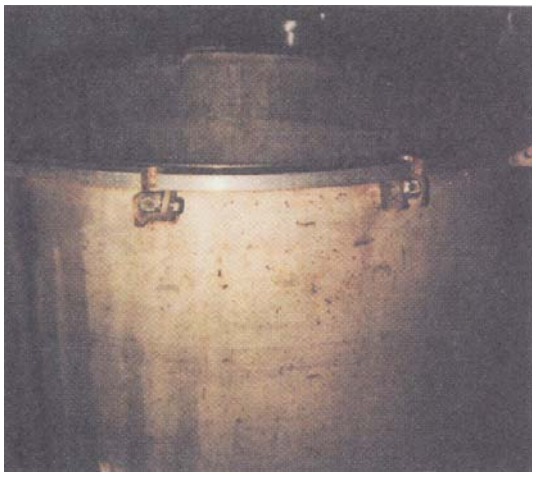


Photo 3.2 Fracture securing bolts and bush holdings

Photo 3.3 Damaged lid with fittings

Photo 3.4 Damaged lid with fittings removed

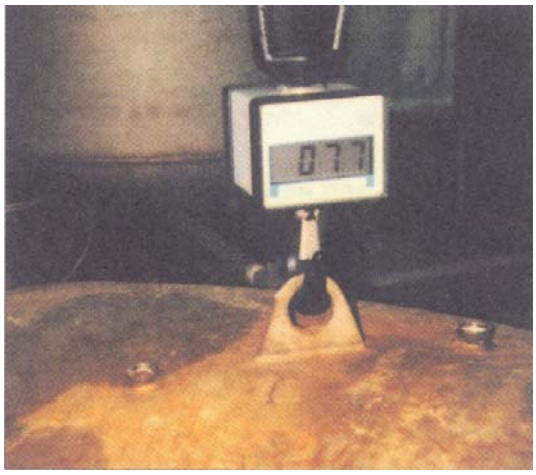


Photo 3.5 The cauldron lid was weighed to establish the bursting pressure

Photo 3.6 LPG stove

Case 4
A BOILER FIRE CAUSED BY A LEAKY FUEL OIL PIPE RESULTING IN BURNT INJURY OF A BOILER OPERATOR

Summary

The leakage of a diesel oil pipe caused a fire on the boiler in 1991. The leakage was observed when the boiler fuel was switched from heavy oil to diesel oil as required by the Environmental Protection Department. The fire was put out shortly after the arrival of the Fire Services.

Circumstances

The boiler operator noticed that smoke came out from the boiler room and the boiler was on fire; he stopped the fuel pump and shut off the fuel supply valve. Fire Services Department was called upon to put out the fire. The damage to the boiler was minimal.

Observation

1. Small leakage of fuel oil was observed since the boiler fuel was changed from heavy oil to diesel oil.
2. The damage was minimal and was confined to the fuel burning gear and the associated control panel.
3. The cause of fire could not be established. However, the fuel oil leakage might be a contributing factor.

Legal Implication

The owner of boilers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation

1. Maintain every boiler and its auxiliary equipment properly.
2. Any fuel oil leakage should be rectified immediately.

Photo 4.1 Damaged burner gear

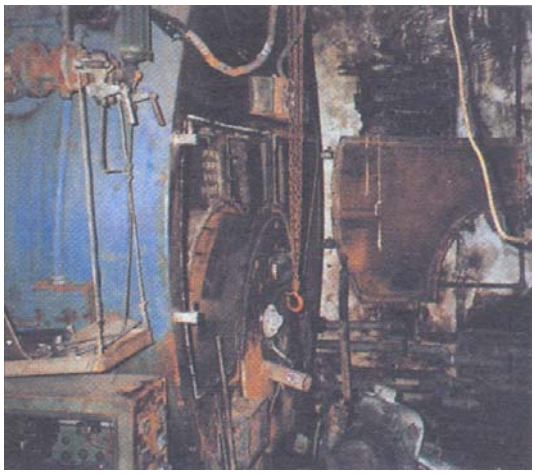


Photo 4.2 View of incident site

Case 5
A FIRE CAUSED BY BOILER FUEL SPLASHING ON THE HOT SURFACE RESULTING IN BURNT INJURY OF A BOILER OPERATOR

Summary
In 1991, a fuel return valve bonnet slipped off from the crossed-thread valve casing. The diesel oil spilled on the boiler hot surface was ignited. The fire flashed over the boiler operator's right forearm and right face resulting in minor burnt injury. The damage to the boiler was minimal.

Circumstances
The fire was due to a failed valve in the fuel return line. Fuel oil was found leaking at the jointing between the valve bonnet and the valve casing. The boiler operator tried to tighten the bonnet to stop the leak. The bonnet slipped and jumped off from its position exposing the valve casing internal to atmosphere. Fuel oil under pressure splashed onto the hot surface and was ignited. The boiler operator left the boiler room and closed the metal door behind. The diesel oil supply was shut off immediately. The damage to the boiler was not serious but the boiler operator sustained minor burnt injury.

Observation
The bonnet had been over-tightened to stop the fuel leakage stripping screw thread between the valve bonnet and the valve casing without noticed by the boiler operator. When the boiler operator further tightened the bonnet, it failed to engage to the valve casing and was pushed out from the valve casing by the fuel oil under pressure.

Legal Implication
The owner of boilers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation
1. Maintain every boiler and pressure vessel and its auxiliary equipment properly.
2. Replace any defective fuel valve immediately.

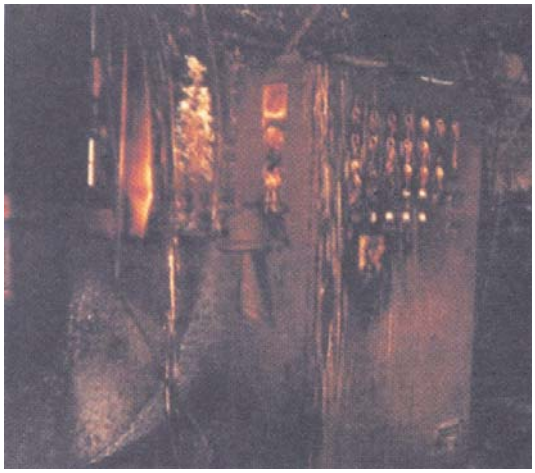


Photo 5.1 Damage to boiler

Photo 5.2 Damage to boiler and fuel oil system

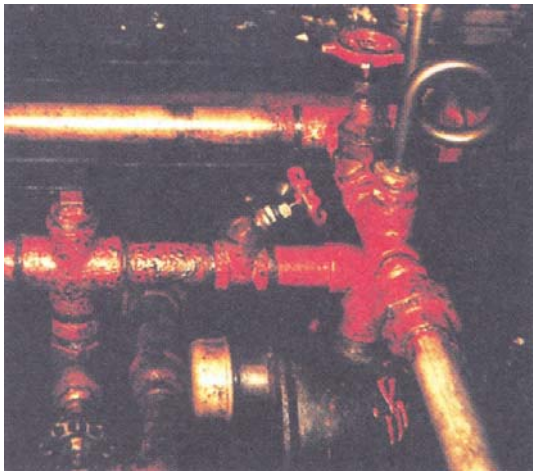


Photo 5.3 Fuel return valve in position

Case 6
STEAM AND HOT WATER RUSHED OUT FROM THE CRACK-OPENED COVER OF STEAM KIER RESULTING IN SERIOUS SCALD OF THE BOILER OPERATOR

Summary

In 1990, steam and hot water rushed out from the slackened cover of a steam kier (steam receiver) and scalded the victim who died later in hospital. The deceased was not properly trained and not being supervised by the Competent Person at the time of accident.

Circumstances

The micro-processor for automatic operation control of the steam kier had been removed for repair and the steam kier was left on manual operation. The worker unlocked the kier cover after opening the exhaust valve at the end of the process. The steam and hot water rushing out from the slackened cover scalded the victim and he later died in hospital.

Observation

1. There were two Competent Persons holding the relevant certificates of competency.
2. The victim working on the steam kier on his own at the time of accident did not possess a certificate of competency.
3. The seal on the safety valve of the steam kier was missing. The temperature interlock set-point on the dial thermometer was set to 7°C above the maximum temperature setting of 85°C.
4. There was a very large amount of hot water left inside the steam kier at the end of the run.
5. A properly set safety valve should blow at a pressure of 450 kPa but it did not blow at a testing pressure of 700 kPa after the accident.
6. The temperature indicated on the defective dial thermometer was 12°C lower than the actual measuring temperature.

Legal Implication

The owner of steam receivers (steam kiers) could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 4 (1)(a):
   There shall be a suitable reducing valve or other suitable automatic appliance to prevent the maximum permissible working pressure of the steam receiver being exceeded.
2. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

3. Section 49 (7):
   No steam receiver shall be operated except under the direct supervision of a Competent Person whose certificate of competency certifies that he is competent to operate the type of steam receiver in question.

Recommendation

1. Employ sufficient Competent Person(s) to operate the steam receivers (steam kiers).
2. Provide training and assistance to the employees to obtain the relevant certificates of competency.
3. Maintain every steam kier and its auxiliary equipment properly.

Photo 6.1 Kier cover is being unlocked

Photo 6.2 Interlock exhaust valve in its closed position

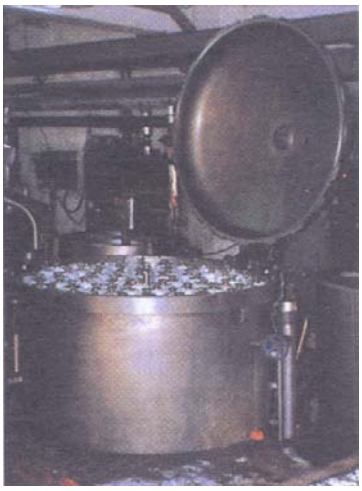


Photo 6.3 The kier in open position

Photo 6.4 Seal for safety valve was missing

Photo 6.5 Pneumatic overflow valve at the kier cover

Photo 6.6 Manual overflow valve

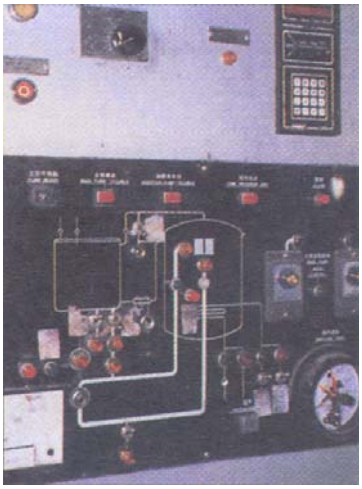


Photo 6.7 Control panel with dial thermometer (set point of 92°C)

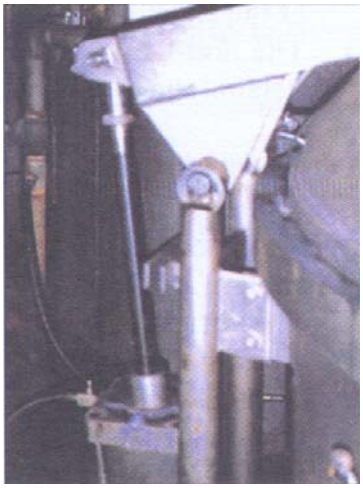


Photo 6.8 Pneumatic actuator for lifting the kier cover

Case 7
FATAL ACCIDENT CAUSED BY THE BURST OPENING OF A STEAM MANIFOLD END PLATE

Summary

The end plate of a steam manifold burst open in 1990 and caused serious head injury to a worker who died later in hospital. The defective steam manifold and the boilers which supplied steam had not been examined by any Appointed Examiner (Boiler Inspector).

Circumstances

Two vertical automatic water-tube boi1ers supplied steam to five washing machines through a steam manifold. The end plate which weighed 4.5kg was blown out and hit a worker's head. The end plate continued to slide on the floor seven metres away due to its inertia. The worker was sent to hospital and died later.

Observation

1. The preparation of the welding edge and welding workmanship of the steam manifold end plate were poor.
2. Incomplete root penetration in the welding joint of the steam manifold end plate was found. This welding defect together with the improper operation of the steam plant and auxiliaries might have resulted in the failure of the joint in the manifold. Water hammer might damage the end plate if the steam manifold was not properly drained.
3. The manifold was mounted two metres above ground in the workplace.
4. The boilers had not been registered with the Boilers and Pressure Vessels Authority and therefore none of the boilers, auxiliaries and piping were examined and tested by any Appointed Examiner to verify that they are safe to be operated at the working pressure.
5. The boilers were being operated without the direct supervision of Competent Person(s) and without valid Certificates of Fitness.

Legal Implication

The owner of boilers and steam receivers could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 15A :
   The owner of a new boiler shall not later than 30 days preceding the day on which he intended to put the same into use, apply to the Authority in the prescribed form for registration of the same under the Boilers and Pressure Vessels Ordinance (Cap. 56).
2. Section 24 (1):
   Upon completion of the installation of a new boiler and before the same is put into use, the boiler and its auxiliary equipment shall be examined by an appointed examiner.

3. Section 41:
   Where a new boiler is being examined for the purposes of Section 24 (1), every pipe that will convey oils, steam or water under pressure to or from the boiler, as the case may be, shall be subjected by a Boiler Inspector to a hydraulic test.
4. Section 49 (1):
   No boiler or steam receiver shall be used or operated unless the boiler and its auxiliary equipment has been examined in accordance with this Ordinance and a certificate of fitness has been issued in respect thereof after that examination.
5. Section 49 (7):
   No boiler or steam receiver shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate all classes or types of boiler and steam receiver or that he is competent to operate boilers or steam receivers of the class or type in question.
6. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation

1. Register any boiler and auxiliaries with the Boilers and Pressure Vessels Authority and have a Certificate of Fitness issued by an Appointed Examiner.
2. Engage Competent Person(s) to operate the boiler and auxiliaries
3. Maintain every boiler and pressure vessel and its auxiliary equipment properly.

Photo 7.1 Blood stain of the victim at No.3 washing machine

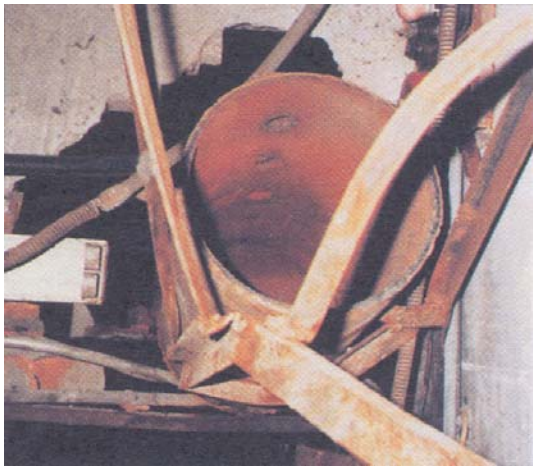


Photo 7.2 End View of the steam manifold

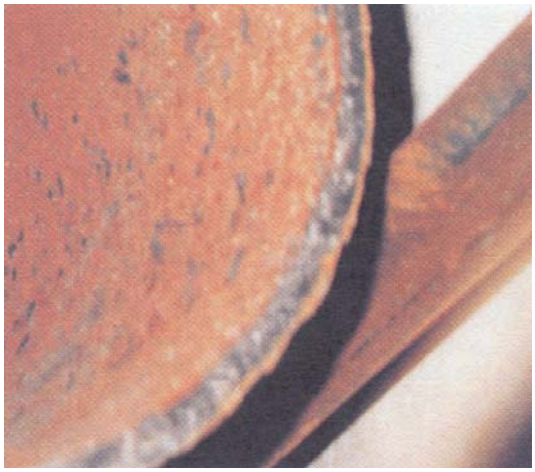


Photo 7.3 Close-up view to show the failed edge of the steam manifold

Photo 7.4 Detached end plate of the steam manifold

Photo 7.5 Weld on the other side of the steam manifold

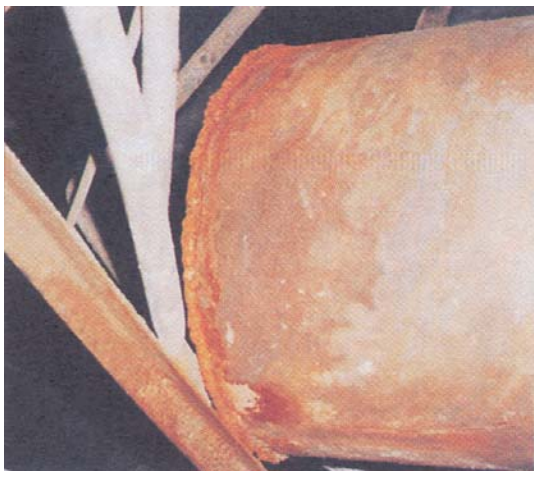


Photo 7.6 End view of the end plate on the other side of the steam manifold

Case 8
A WORKER BEING SCALDED BY STEAM FROM THE BURST STEAM MANIFOLD

Summary

A large volume of steam burst into a boiler room due to the failure of an end plate cover of a steam manifold and slightly scalded the face of a worker in 1990.

Circumstances

The Competent Person ran into the boiler room to shut off all the fuel valves when he had heard a big noise coming out from the boiler room. The end plate of a steam manifold failed and released a large volume of steam into the boiler room. He switched on the boiler room exhaust fan to extract the steam trapped inside the boiler room. A worker's face was slightly scalded by the steam when he opened the boiler room door.

Observation

1. No apparent damage was observed on two boilers.
2. The welding of the end plate to the manifold was of poor quality. The failed edge revealed welding defect of lack of root penetration.
3. When the steam manifold is subjected to steam pressure, the end plate of the manifold is being bulged outward slightly and very high stress is induced at the root of the welds. The failed steam manifold which was part of the auxiliary equipment of the boiler was not built to the required design standards.
4. The steam manifold had not been subjected to a hydraulic test and examined by the boiler inspector before it was put into use.

Legal Implication

The owner of boilers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 41:
   Where a new boiler or steam receiver is being examined for the purposes of Section 24 (1) or a new steam container is being examined for the purposes of Section 28 (2), every pipe that will convey oils, steam or water under pressure to or from the boiler, steam receiver or steam container, as the case may be, shall be subjected by a boiler inspector to a hydraulic test.

Recommendation

1. Engage a Boiler Inspector to examine the piping system (an auxiliary equipment) at the time the boilers are being examined.

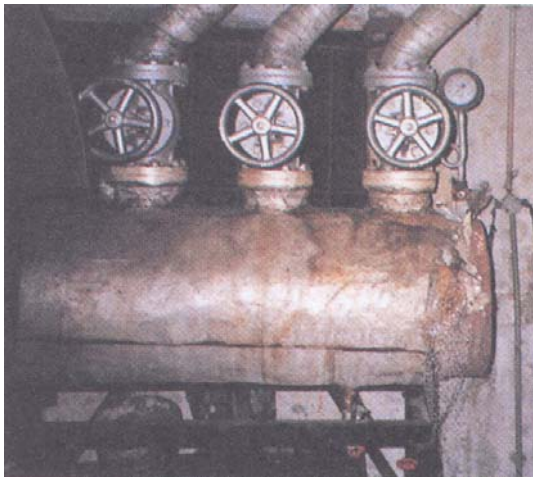


Photo 8.1 Steam Manifold

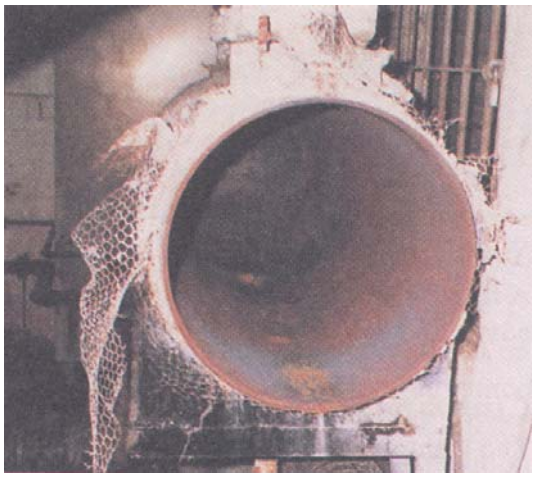


Photo 8.2 End View of the steam manifold

Photo 8.3 View of the edge of the steam manifold from bottom

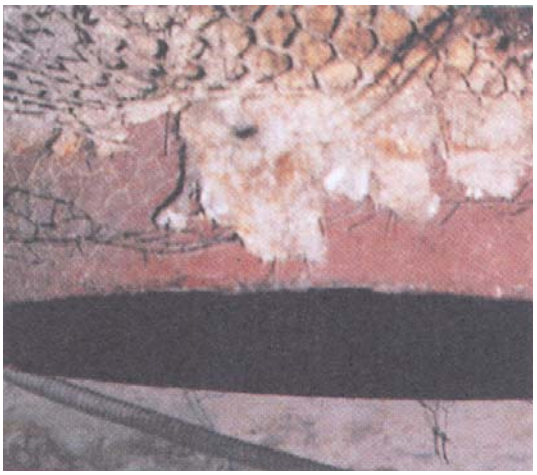


Photo 8.4 View of the edge of the steam manifold viewing from top

Case 9
IMPROPER OPERATION OF A STEAM KlER RESULTING IN CASUALTY

Summary

The steam receiver was in use when the accident occurred in 1989. During the rinsing process the worker opened the drain and vent valve and at the same time he opened the fresh water inlet valve to fill up the kier. The fresh water under pressure gradually filled up the kier and mixed with steam inside the steam receiver. Steam and hot water forced out from the partially tightened cover seriously scalded the worker who later died in hospital.

Circumstances

The operator failed to observe the usual safe working practice in steam kier operation. The receiver cover was partially locked by two locking bolts. Admission of fresh water with incorrect procedure during the rinsing process resulted in hot fluid being forced out from the partially tightened lid. The worker was seriously scalded by the hot fluid spilled over him.

Observation

1. The training provided to the operators of the steam kiers was not sufficient.
2. There was no Competent Person directly supervising the operation of steam kiers. The kier operation was practically in the hands of uncertified operators who possessed little knowledge and awareness of the operational safety and precautions.

Legal Implication

The owner of boilers and steam receivers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 49 (7):
   No steam receiver shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate steam receivers of the class or type in question.

Recommendation

1. Steam kiers should be properly maintained at all times, all safety devices should be fitted and regularly tested to ensure they are functioning properly.
2. Steam kiers should be operated under the direct supervision of competent persons of steam receivers.
3. Owners should provide adequate training to the operators for the safe operation of steam kiers.
4. Proper operating procedures and safety precautions should be conspicuously displayed and readily available in the vicinity of the steam kiers.

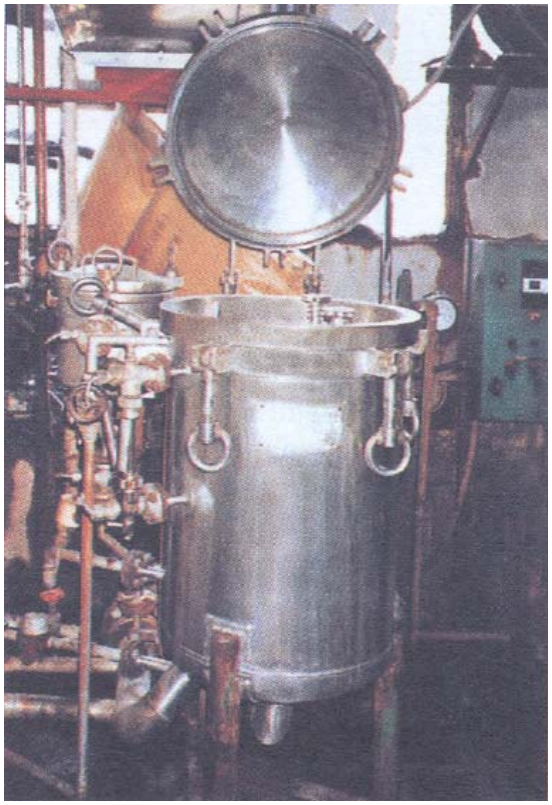


Photo 9.1 Outlook and piping of the steam kier

Photo 9.2 Reconstruction of accident on water spray pattern

Case 10
UNAUTHORIZED REPAIR ON BOILER PRESSURE PARTS MAKING IT UNSAFE FOR OPERATION

Summary

An incident of serious tube failure in a water-tube boiler was reported in 1989. The water-tube boiler was not being properly maintained and numerous unauthorized repairs had been carried out on the boiler pressure parts. Serious tube leaking was the final result and the boiler was unsafe to be further operated. There was no casualty or injury to workers.

Circumstances

Steam generated from the water-tube boilers was used for drying out the re-enforced concrete. Water was observed leaking from the right side of boiler. Immediate shut down and isolation of the hot boiler were not carried out subsequent to the serious boiler water leakage. The Competent Person went to increase the feed water flow and when he returned, the steam pressure had dropped to 500 kPa from 1,250 kPa. Then the boiler stopped automatically. He then selected the manual control for low firing and restarted the boiler. The boiler was left at low firing rate for ten minutes and the steam pressure could not be raised. Later on, he stopped the boiler and reported the case to the factory manager.

Observation

1. External and internal inspections were carried out after removal of the burner unit and the drum doors. Tube expansion ends to steam/water drums were found leaking at numerous locations.
2. One furnace roof tube was found burst with an opening of 60mm x 15mm.
3. Numerous unauthorized and poor repairs were evident in roof tube sections and membrane-wall sections.
4. Scales and slag were found flaking from the tube surfaces inside furnace.
5. Water drum internal was found covered with large amount of loose scales.
6. There were six pieces of defective tube section cutouts lying on open ground and these were evidence that the boiler had been repaired at numerous locations in the past.
7. The repairs on pressure parts were carried out by the Owner's contractor without any examination being carried out by the Appointed examiner after the repair. Such malpractice in repairing pressure parts of a boiler by owner was considered unsafe and unacceptable.
8. The boiler attendant failed to shut down and isolate the affected boiler, which had tube failure.
9. The boiler was considered unsafe for further operation.

Legal Implication

The owner of boilers could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.
2. Section 26 (1):
   Every boiler in respect of which extensive repairs have been carried out shall, together with its auxiliary equipment be examined by an appointed examiner before it is put into use again.

Recommendation

1. Repair on boiler pressure parts should be authorized and examined by the boiler inspector. The Boilers and Pressure Vessels Authority should be informed accordingly.
2. Safe working practice in the operation of a water tube boiler should be observed by the competent person.
3. Maintain every boiler and pressure vessel and its auxiliary equipment properly.

Case 11
EXPLOSION OF THE STEAM KIER RESULTING IN SERIOUS DAMAGE TO THE PREMISES AND A FATALITY

Summary

A scouring kier in a textile bleaching and dyeing factory exploded in 1988. The blast tore off the metal cover and smashed half of the plastic-roof shelter. The debris and cloths were scattered over a radius of fifty metres. The fire brigade found the deceased lying unconscious inside the kier. He was certified dead on arrival to hospital.

Circumstances

1. Scouring is a process to remove the impurities and dirt of the cloth before bleaching and dyeing. The cloth was being boiled in an alkaline solution under a pressure of 130 to 170 kPa for several hours. The scouring kier was 3.6 metres high with an opening of 1.37 metres on the top. Three scouring kiers were installed inside the covered rear yard. The locking arrangement of the kiers had been modified to seven hinged locking bolts.
2. Direct heating steam was used to raise the temperature and pressure inside the kier because the valve for indirect heating steam had been out of order for a few months. The amount of direct heating steam injected into the kier had to be adjusted five to six times over this six-hour process.
3. No other workers had ever seen the deceased since he took over the shift at 11 p.m. A loud explosive noise was heard by the boiler operator at about 4:30 a.m. He saw the pressure in the boilers was around 800 kPa. When noticing a large amount of steam vapour clustered over the kier platform, he immediately shut off the boiler and the main steam supply valve. The explosion was later confirmed to be the bursting of kier No.1. The top opening of the kier was exposed as the metal cover had been blown off twenty metres away. The firemen sprayed water to cool down the kier and the deceased's body was later found inside the kier. The deceased might have accidentally fallen into the kier through the top opening.

Observation

1. Three of the seven bayonet lugs of the cover and the lifting spindle were bent. Five cover locking bolts were sheared off in their cross-pins. The loading gear of the kier was torn away from the vertical pedestal column and thrown to the public car-park. The indirect heating steam piping and the seized valve were blown off and landed on a storage shed fifteen metres away.
2. Unauthorised modification was made to the kier cover.
3. No pressure reducing valve was installed in the steam supply line from the boiler to the steam kiers. The maximum permissible working pressure of the boiler is 820 kPa.

4. The failure of the indirect steam heating valve necessitated using the direct steam heating for maintaining both pressure and temperature in the process. Had the indirect steam heating valve been repaired and used, the steam pressure inside the kier could be greatly reduced.
5. No log book and operating instructions were available.

Legal Implication

The owner of boilers could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.
2. Section 49 (7):
   No boiler or steam receiver shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate all classes or types of boiler and steam receiver or that he is competent to operate boilers or steam receivers of the class or type in question.
3. Regulation 4 (1):
   Every steam receiver that is not so constructed and maintained as to withstand with safety the maximum permissible working pressure of the boiler to which it is connected or the maximum pressure that can be obtained in the pipe connecting the steam receiver with any other source of supply of steam shall be fitted with –
   (a) a suitable reducing valve or other suitable automatic appliance to prevent the maximum permissible working pressure of the steam receiver being exceeded;
   (b) a suitable spring-loaded valve that is capable of being sealed and is so adjusted as to permit the steam to escape as soon as the maximum permissible working pressure of the steam receiver is exceeded or suitable appliance for cutting off automatically the supply of steam as soon as that pressure is exceeded.

Recommendation

1. Do not tamper with the pressure parts of the boiler without the prior approval of the Boilers and Pressure Vessels Authority.
2. Engage Competent Person(s) to operate the steam receivers (steam kiers).
3. Suitable pressure reducing valve should be provided to prevent the maximum permissible working pressure of the kier and its auxiliary equipment being exceeded.
4. Safe operation procedures should be provided to the operators to ensure the steam kiers are being operated correctly and safely.
5. An effective logging or record-keeping system should be introduced for the operators on shift duties to avoid misunderstanding in verbal communication between shift workers.

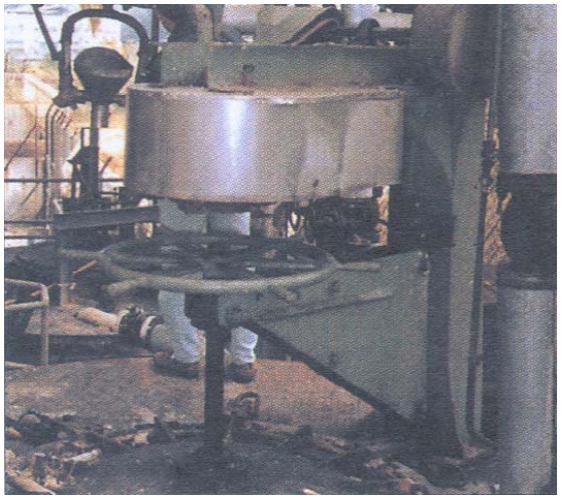


Photo 11.1 The metal cover, lifting gear and the mechanical piler

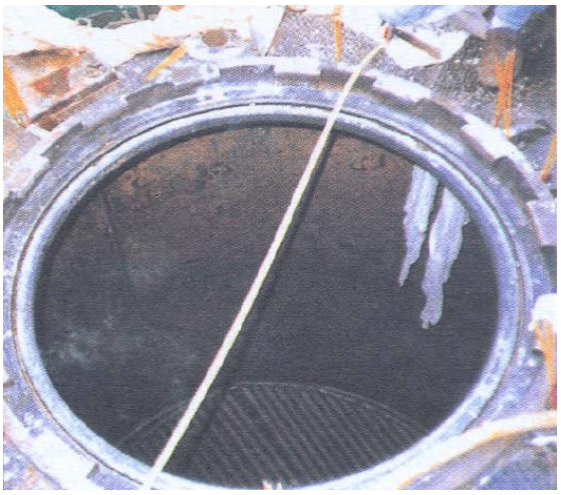


Photo 11.2 Close-up of the interior of the steam kier

Photo 11.3 The bent cover lugs of the kier cover

Photo 11.4 The bent lifting spindle of the kier cover

Photo 11.5 5 of the 7 cover locking bolts were sheared away

Photo 11.6 Full-width crack on flat base of the cast-iron pedestal column

Case 12
STEAM BLOWN OFF FROM THE STEAM PIPE TO THE STEAM IRON RESULTING IN MINOR SCALD INJURY OF A WORKER

Summary

In 1988 an incident occurred to an electrically heated steam boiler in which steam blown off at the end of the flexible steam pipe connecting to the steam iron scalded the right hand of the worker who was carrying out ironing at the time of the incident.

Circumstances

1. The damaged steam pipe was scrapped after the accident and no material evidence was available.
2. The material of the steam pipe was fatigued and this probably caused the accident.
3. The worker was sent to hospital for minor medical treatment.

Observation

1. The safety valves did not lift at the maximum permissible working pressure of the electric boilers. They lifted at 30% in excess of the maximum permissible working pressure.
2. The seals of the safety valves were intact.

Legal Implication

The owner of boilers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

The Appointed Examiner could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 45:
   Whenever, for the purposes of this Ordinance, an Appointed Examiner is carrying out an examination of a boiler, steam receiver or air receiver under pressure that will be specified in the certificate of fitness as its maximum permissible working pressure, he shall, by sealing or some other suitable methods, ensure that the safety valve is so adjusted as to prevent the boiler, steam receiver or air receiver, as the case may be, from being operated at a pressure greater than that pressure.

Recommendation

1. The Appointed Examiner should ensure the boilers and auxiliaries are in compliance with the Boilers and Pressure Vessels Ordinance during his examination of boilers.
2. The Appointed Examiner should ensure the correct setting of the safety valve for the purpose of issuing the Certificate of Fitness.
3. Every boiler and pressure vessel and its auxiliary equipment should be properly maintained.

Case 13
HOT FLUID DISCHARGED FROM A STEAM KIER RESULTING IN SERIOUS INJURY OF A TECHNICIAN AND THE DEATH OF THE SUPERVISOR

Summary

In 1988 a fatal accident occurred in a factory. Modifications had been carried out on the kier with improper welding method to increase its loading capacity and hence affected the integrity and safety in operation of this kier. The failure of the mechanical interlocking device enabled the cover being left in partially open position and thus the cover could be opened under pressure. The supervisor and the technician failed to observe the safety working procedure by opening the cover whilst the kier was still under pressure. The technician was seriously scalded and the supervisor died later in the hospital.

Circumstances

The kier was programmed to lower fluid temperature from 100°C to 85°C with the pressure in the kier to be 400 kPa just after the main bleach process. The boiler operator noticed that the kier had cooling and discharging problems and he informed his supervisor. The supervisor brought along a technician to diagnose the fault but they could not identify the cause. Wrongly assuming that the overflow valve interlock had been opened and the fluid level inside the vessel had been lowered, they turned the hand wheel to crack open the cover of the kier. After a "clicking" noise was heard the cover sprang opened with a loud "bang". The supervisor escaped from the room covering with blood on his body, followed by the technician.

Observation

1. The lid of the kier cover was distorted and could not be completely closed onto its seat.
2. Scraping marks were found on the tapered sections of the lugs and gripping pins.
3. Cracks were found in way of the cover-operating actuator seating bracket.
4. Steam and hot water splashed in all directions and caused electrical faults in all electrical fittings in the vicinity.
5. The seal for the safety valve was found missing.
6. The mechanical safety interlocking plate was found too short to achieve its interlocking function.
7. All tack welds applied on each side of the gear plate attachment and on the securing bolts were cracked.
8. The water level control switches were not secured properly.
9. Two of the four cover positioning plates were found missing.
10. The failure of the mechanical interlocking device enabled the cover being left in partially open position and thus the cover could be opened under pressure.
11. The lack of water level indicator and the malfunctioned thermostat switch reduced the operational safety of the kier.
12. Modifications had been carried out on the kier to increase its loading capacity.

13. Quality of welds on the steam kier was poor and simple electrical arc welding was used by owner's workers on the stainless steel steam kier instead of the proper inert gas shield welding.
14. The workers failed to observe the safety working procedure in opening the cover whilst the kier was still under pressure.

Legal Implication

The owner of boilers and steam receivers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation

1. Any servicing on the boiler and its auxiliary equipment must be carried out by qualified personnel with good experience and professionalism.
2. Competent Person should be reminded to adhere to the safe working and operation procedures.
3. Engage adequate Competent Persons to operate the steam kiers.
4. Maintain every boiler and pressure vessel and its auxiliary equipment properly.

Photo 13.1 The kier (steam receiver)

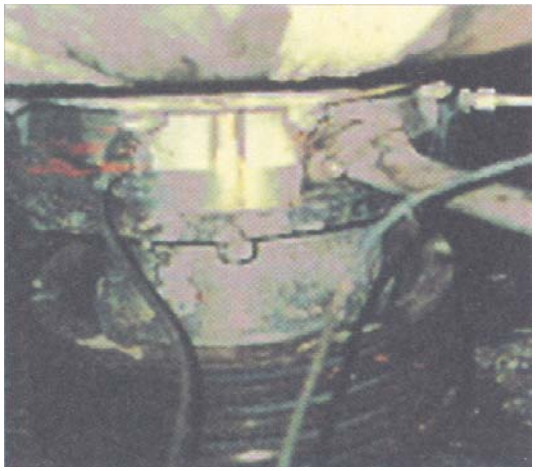


Photo 13.2 Bottom of the kier

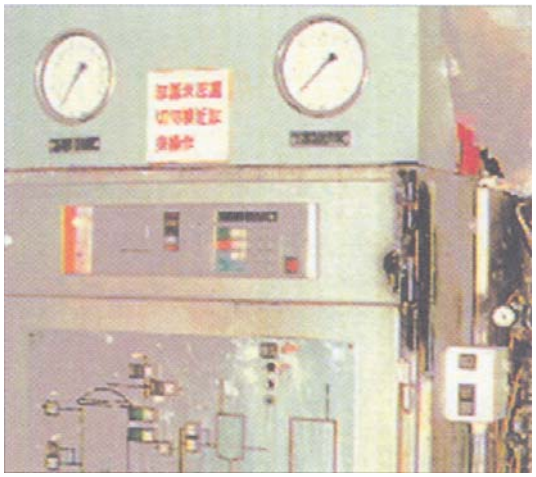


Photo 13.3 Control panel for the kier

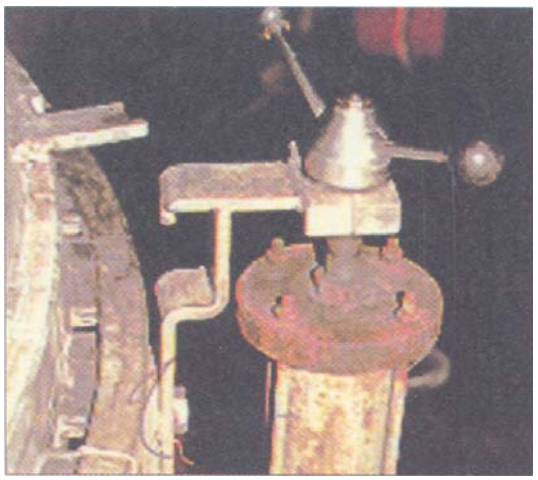


Photo 13.4 Overflow valve with interlocking device

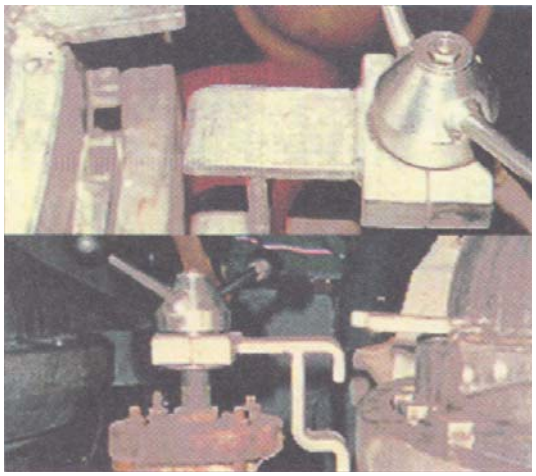


Photo 13.5 Locking pad is too short for locking

Photo 13.6 Broken level indicator, broken guide-pin and its bracket

Case 14
FIRE CAUSED BY THE RESIDUAL OIL BEING IGNITED BY SPARKS RESULTING IN DAMAGE TO THE BOILER FRONT AND BURNER

Summary

A fire broke out at the front end of a boiler in 1988. Flame and sparks were blown out from the lower part of the flanged joint where the fuel oil burning installation was mounted and ignited the residual fuel oil in the tray placed under the fuel burning installation. The fire was put out by the Fire Brigade.

Circumstances

The boiler was put on the automatic mode of control when the residual oil caught fire. When a worker was about to shut down the boiler after the shift, he saw flame and sparks being blown out from the lower part of the flanged joint between the front and of the boiler casing and the fuel burning installation. The flame ignited the residual fuel oil in the tray placed under the fuel burning installation. The flame was due to the ignition of fuel oil in the air trunk. The fuel oil appeared to have leaked from the defective joints of the fuel pipe to burner.

The boiler attendant tried to put out the fire but failed. The Fire Services Department was called upon to put out the fire.

Observation

1. The flame and sparks blown out from the flanged joint between the front end of the boiler casing and the fuel burning installation ignited the fuel in the tray placed under the fuel burning installation.
2. At the time of the accident, the boiler was not under the direct supervision of the boiler attendant.
3. The fire was only restricted to the local area around the fuel burning installation.
4. Fuel was seen inside the air trunk and on the air swirler.
5. No insulation or lagging was seen on most of the steam piping and steam valves.
6. The fuel oil piping around the boiler was very dirty.
7. Pressure gauge glass face plate was covered with soot.
8. The boiler room was very dirty and oily indicating housekeeping was poor.

Legal Implication

The owner of boilers could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.
2. Section 49 (7):
   No boiler or steam receiver shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate all classes or types of boiler and steam receiver or that he is competent to operate boilers or steam receivers of the class or type in question.

Recommendation

1. The boiler should be maintained properly and the air trunk, air swirler and burning installation should be kept clean and serviced regularly.
2. Soot and ash should be removed and boiler room should be kept in clean condition.
3. Oil tray is designed to catch any leaked oil. Any oil leakage should be rectified and oil tray should be cleaned frequently.
4. The boiler under steaming should not be left unattended.

Case 15
A BOILER EXPLOSION DUE TO IGNITION OF UNBURNT LPG RESULTING IN THE INJURY OF A BOILER ATTENDANT

Summary

In 1988 the furnace explosion occurred in a fire-tube boiler due to the accumulated LPG being ignited inside the furnace. The blast blew out the rear end cover, which injured the boiler attendant and hit on the oil burning unit of another steaming boiler. A warning letter was issued to the Competent Person for his failure to operate the boiler in accordance with safe operating procedures and thus create a hazardous situation.

Circumstances

Prior to explosion, the ignition and control systems were always malfunctioning. The boiler was therefore shut down for 45 days and the contractor was engaged to carry out repair of the ignition system. The boiler exploded due to the accumulation of LPG in the furnace, and the explosion blew out the rear end cover. The boiler attendant was injured and plant equipment was also damaged. The oil burning unit of the steaming boiler was slightly distorted and sagged. The end cover of the forced draught fan was broken. The fuel oil pipe union was fractured and a large quantity of fuel oil spread over the floor.

Observation

1. Liquefied Petroleum Gas (LPG) was used during start up of the boiler and heavy grade fuel oil was used for normal steaming.
2. The removal of the pressure reducing valve from the LPG supply line resulted in excessive amount of LPG being injected into the furnace during the testing of ignition.
3. The pilot burner was turned on but failed to ignite during the six successive manual and automatic tests.
4. Excessive amount of LPG accumulated in the furnace as a result of the unsuccessful trials of the ignition system.
5. Forced draught fan was left on but the air damper was closed and hence the furnace had not been purged.
6. The concentrated LPG and air mixture was being finally ignited. Fresh air was introduced into the furnace with the forced draught fan put on.
7. The LPG and air mixture was diluted to within the explosion limit and an explosion took place in the furnace.
8. The main cause of the explosion in the furnace was owing to the furnace not being purged thoroughly before every attempt of ignition.
9. The operator did not adhere to the safe working and operation procedures.
10. No damage or deformation on the furnace, pressure parts and structure of the boiler was found.

11. The oil burning installation was slightly distorted and sagged.
12. The furnace and smoke tubes were covered by a layer of carbon soot and scale.

Legal Implication

The owner of boilers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation

1. Servicing on the boiler and its auxiliary equipment must be carried out by qualified personnel with the relevant knowledge and experience of boiler operation.
2. Competent Person should be reminded to adhere to the safe working and operation procedures. Purge furnace thoroughly before every attempt of ignition.
3. Pressure reducing valve should not be removed from the LPG supply line.
4. The boiler and its auxiliaries should be properly maintained. Soot and other deposits should be removed from the furnace and the smoke tubes regularly during boiler inspection.

Photo 15.1 Blood stain of the injured worker

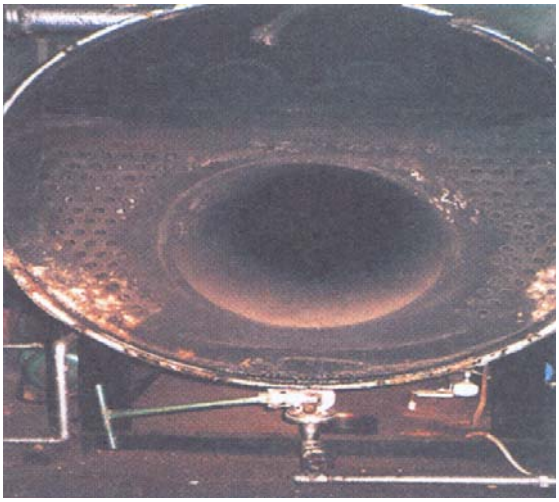


Photo 15.2 Rear end view of boiler

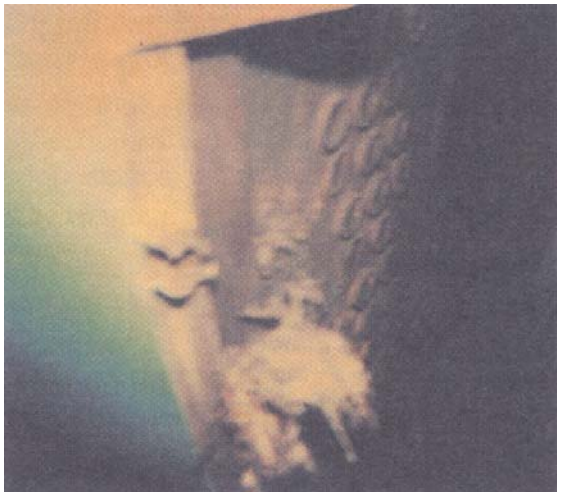


Photo 15.3 End view of the boiler showing one of the broken lugs

Photo 15.4 Blown off rear end cover with collapsed refractory

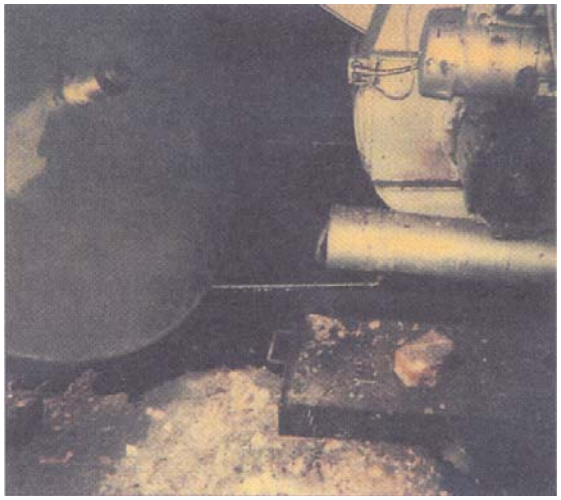


Photo 15.5 End cover of boiler and the damaged burning equipment

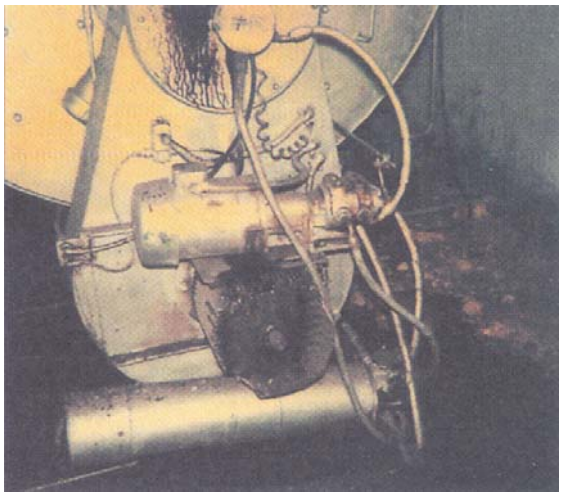


Photo 15.6 The damaged burning equipment

Case 16
BOILER EXPLOSION CAUSED BY IGNITION OF EXPLOSIVE MIXTURE IN THE REAR PASS OF THE BOILER RESULTING IN SEVERE DAMAGE TO THE BOILER

Summary

The fuel injected into the furnace through defective burners while testing the fuel control solenoid valve. This vaporised fuel was carried over to the rear pass of the boiler by the supplied air. The explosive mixture ignited and caused explosion and severe damage to the boiler in 1985.

Circumstances

Upon completion of the tests, the boiler was lighted off. Immediately following the firing of No.1 Bank burners, the flame condition was checked and hand signal was given to the boiler operator. The air draught was increased and explosion took place shortly afterwards.

Observation

1. The fuel admission into the boiler resulted from testing of solenoid valve and failure of burners was carried over to the rear pass of the boiler by the air. The fuel vapour and the air formed an explosive mixture and caused the explosion.
2. The supporting frame of the boiler was bent and the air trunks were torn open. The economizer and primary superheater had bulged. The boiler casing had shifted 7.6 cm to the rear of the boiler. The combustion side walls had bulged by 2 cm at mid height. Four short economizer tubes were fractured at the welded attachments.
3. Because of the misinterpretation of hand signal, the airflow was increased instead of shutting down the boiler.
4. The control system was over 20 years old and manual mode operation was used during the flashing up of boiler.
5. There was no flame monitoring device and hence constant surveillance was required.
6. Manning and supervision of boiler operation were not adequate and safety standards were not implemented. The management should be responsible for providing the necessary information, instruction, training and supervision to ensure safe operation.

Recommendation

1. Plans for adequate manning, proper instruction and supervision procedure should be developed and implemented for safe operation of boilers.
2. Effective communication and co-ordination required for safe operation of boilers should be included in the instructions to operators.
3. Flame monitoring system should be installed for reliable indication of the flame condition of each burner.

Case 17
SHORTAGE OF WATER IN A BOILER RESULTING IN THE COLLAPSE OF THE BOILER FURNACE

Summary

A boiler accident happened in a hotel in 1985. The furnace collapsed was due to the shortage of water in the boiler because of the malfunction of the feed water control unit.

Circumstances

The boiler water level controller malfunctioned because of the choked drain of water column. The furnace collapsed due to shortage of water in the boiler. The competent persons on duty failed to test the water gauge glass to ascertain the water level in the boiler and relied solely on the safety devices and alarms.

Observation

1. The competent person on duty did not carry out the test of the water gauge glass and the feed control unit.
2. The furnace collapsed due to the shortage of water in the boiler.
3. The sound of the audible alarm was very low and could not be heard even at a short distance away.
4. The two main steam stop valves were leaking.

Legal Implication

The owner of boilers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation

1. The boiler operators should regularly check on the water level in the boiler and avoid relying solely on other safety devices.
2. The boiler operators on duty should test the boiler control equipment whenever taking over their watches.
3. The equipment owner should maintain every boiler and pressure vessel and its auxiliary equipment properly.

Case 18
A FIRE CAUSED BY IGNITION OF FUEL OIL DRIPPING FROM THE BURNER NOZZLE RESULTING IN SERIOUS DAMAGE OF THE ELECTRICAL CABLES AND FAN MOTOR

Summary

Fuel oil dripped from the burner nozzle accumulated on the fan motor and on the floor caused a fire outbreak in 1984. Fan motor and electrical cables were severely damaged.

Circumstances

The night supervisor noticed that a fire had broken out at the under side of the forced draft fan. The power supply was cut off immediately. The worn fan motor bearing was overheated and the hot bearing ignited the oil residue. The fire spread over the boiler front. No Competent Person was employed in the night shift. The blower fan motor bearing was completely shattered and the shaft was severely damaged in this fire. All electrical cables had to be renewed.

Observation

1. The water level gauge glass was fouled internally and externally.
2. The relief valve of the fuel oil pump was found defective.
3. The door of the electrical switch gear box could not be closed because of the clumsy and poorly wired cables in the box.
4. The boiler feed pump was leaking at the gland and the boiler was not properly maintained.
5. The leak developed shortly after the Appointed Examiner had set the relief valve.

Legal Implication

The owner of boilers could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.
2. Section 49 (7):
   No boiler or steam receiver shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate all classes or types of boiler and steam receiver or that he is competent to operate boilers or steam receivers of the class or type in question.

Recommendation

1. Boilers should not be operated without the direct supervision of the Competent Person.
2. The boiler and its auxiliary equipment should be properly maintained.

Case 19
A BOILER EXPLOSION CAUSED BY THE SHORTAGE OF BOILER WATER RESULTING IN THE FURNACE BEING SEVERELY DAMAGED

Summary

A boiler explosion happened in 1976 was the result of severe shortage of boiler water. The tubes were overheated and the red-hot furnace bulged in.

Circumstances

The failure of the boiler safety devices resulted in the boiler being operated with severe shortage of boiler water. The tubes and furnace top were overheated to red-hot. The furnace bulged in and finally ruptured under the steam pressure.

Observation

1. The explosion was caused by severe shortage of boiler water. Most of the heating surface was not covered with water and overheated to red-hot temperature.
2. The furnace bulged in and finally ruptured.
3. The failure of feed water controller and low water alarm and trip were the main causes to initiate such explosion. The lever and link rod of the float for the low water level alarm were seized up. Scale deposited in the float chamber, steam and water pipes making the level controller and low water cutoff device failed to protect the boiler.
4. The safety devices were not tested by the boiler inspector during the statutory examination of the boiler.

Legal Implication

The owner of boilers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22(1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation

1. The Boiler Inspector should test all alarms and safety protection devices at the time of final inspection after the steam is raised.
2. The boiler operator should test alarms and safety devices regularly and properly maintain the control equipment.

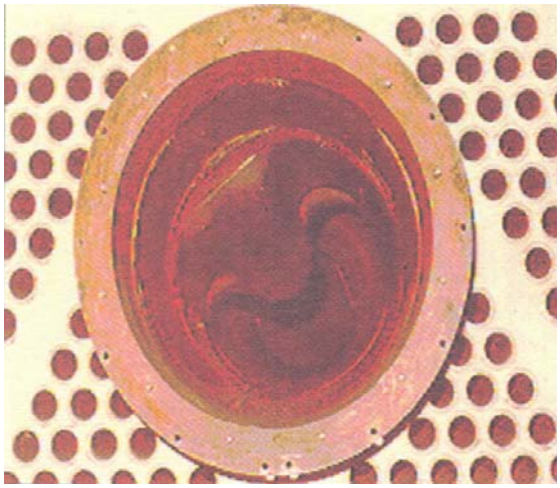
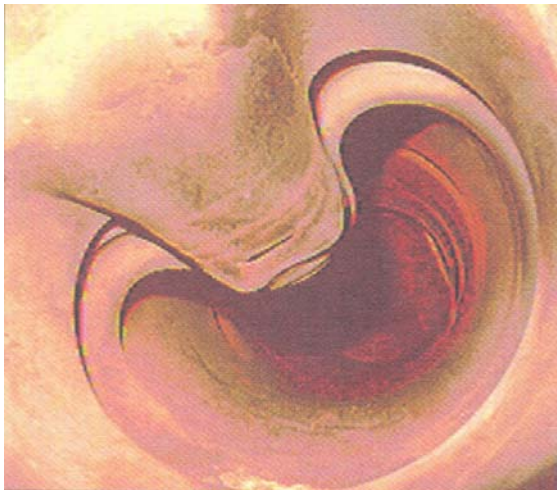


Photo 19.1 Damage to boiler furnace

Photo 19.2 White deposits were lodged on the water level gauge glass



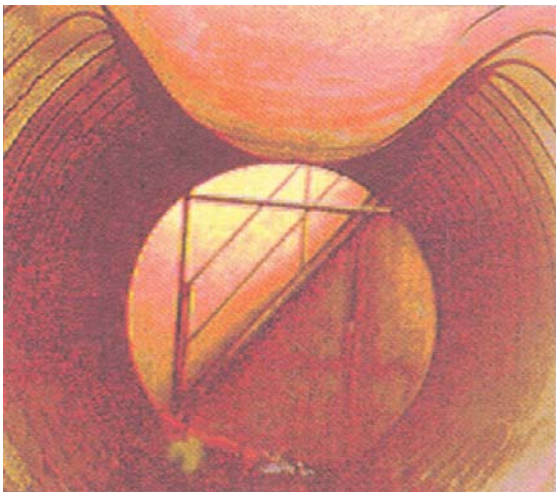


Photo 19.3 and Photo 19.4 Furnace bulged in (view from both ends)

Case 20
SHORTAGE OF BOILER WATER RESULTING IN THE COLLAPSE AND RUPTURE OF THE BOILER FURNACE

Summary

The boiler explosion occurred in 1976 in a hotel. The furnace collapsed and ruptured due to the malfunction of the feed water control unit which was caused by the shortage of water in the boiler.

Circumstances

The boiler explosion and collapse of furnace was the result of shortage of boiler water. The failure of the automatic water level control was because of lack of proper boiler maintenance.

Observation

1. The boiler was inspected a few days preceding the incident by an Appointed Examiner. However, the control equipment was not examined nor tested after the steam was raised.
2. The competent person on duty did not carry out the test of the water gauge glass and the feed water control unit. He was relying too heavily on the automatic control device.
3. Because of the shortage of water in the boiler the furnace collapsed and ruptured.

Legal Implication

The owner of boilers could be found in breach of the following provision of the Boiler and Pressure Vessels Ordinance:

1. Section 22(1):
   Every boiler and pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation

1. Boiler operators should regularly check on the water level in the boiler and avoid relying solely on the safety devices.
2. Boiler operators on duty should test the boiler control equipment in their watches.
3. Equipment Owner should maintain every boiler and pressure vessel and its auxiliary equipment properly.
4. Boiler Inspectors should thoroughly examine the safety devices and equipment at each statutory examination of boiler. The alarms, equipment and devices must be tested after the steam is raised.

Case 21
EXPLOSION OF AN AIR RECEIVER RESULTING IN THE DEATH OF ONE PERSON AND INJURY OF FOUR OTHERS

Summary

The worker was not aware of the danger of mixing oxygen and compressed air with oil which formed a highly explosive mixture. This mixture was ignited by hot gases resulting in an explosion that killed one person and injured four others in 1971.

Circumstances

An air receiver was used to start the diesel engine servicing a mobile crane. The diesel engine failed to start after repair. A cylinder containing oxygen at 1.4 MPa was connected in the system to start the engine. The oil accumulated in the system from the air compressor plant mixed with the oxygen and formed a dangerous mixture. The mixture was ignited by the hot gases leaking through the starting air valve and caused the explosion. The force of explosion ripped open the air receiver at the longitudinal seam, blew off the dished end plate to 150 metres away and tore away the air receiver from its seat. Immediately after the explosion, fire engulfed everything combustible in the vicinity.

Observation

1. A routine maintenance of the air compressor plant had been neglected with the result that lubricating accumulated in the system.
2. The worker, being ignorant of the effect of oil on pure oxygen, connected the oxygen supply at 1.4 MPa to the starting air system.
3. The relief valve fitted in the air receiver could not relieve the rapid build-up of pressure due to explosion.
4. The force of explosion was extremely large that tore down the air receiver into pieces and set everything in the vicinity on fire.

Legal Implication

The owner of boilers could be found in breach of the following provision of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every pressure vessel and its auxiliary equipment shall be properly maintained.

Recommendation

1. Air receiver must not be charged with gas other than air. The use of oxygen is particularly dangerous.
2. The oil and water should be removed from the air system through the regular and effective draining of the air receiver.
3. Regular examination and maintenance of the compressor and its auxiliary equipment are necessary.

Case 22
THERMAL OIL LEAKAGE SCALDED AN OPERATOR AND CAUGHT FIRE WHEN IT SPRAYED ONTO THE HOT SURFACE

Summary

In 1994 leakage of the thermal oil from the pressure gauge connection at the discharge side of the thermal oil circulation pump sprayed onto the hot surface and caught fire. The operator was scalded by the hot thermal oil as he attempted to shut off the isolating valve for the pressure gauge but failed. Fire Brigade was called upon to put out the fire.

Circumstances

The thermal oil heater was inspected and registered twenty-three days before the accident. The safety valve that was supplied by the Appointed Examiner's company was found leaking shortly after a major repair. The operator was asked to adjust the spring tension on the safety valve to stop the leak but he refused to do so. The safety valve was then removed and the thermal oil heater was put back to operation. It was suspected that the vibration of circulation pump might have caused the oil leakage.

Observation

1. There was no safety valve fitted on the thermal oil heater that caught fire.
2. There was no save-all located underneath the circulating pump.
3. The whole boiler room was badly damaged and blackened. All auxiliary equipment and electrical wiring were seriously damaged. There was a through crack on the shell of the thermal oil heater.
4. The thermal oil heater was being operated without a safety valve.
5. The Appointed Examiner did not carry out the inspection thoroughly. His technical assistant carried out part of the inspection for him.

Legal Implication

The owner of the special purpose boiler could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 63:
   Provisions as to notification of accidents and defects in boilers and pressure vessels
   (1) Where –
   (a) an accident occurs in or to a boiler or pressure vessel or its auxiliary equipment; or
   (b) the owner of a boiler or pressure vessel becomes aware of any defect therein or in its auxiliary equipment that is likely to cause danger to life or damage to property,
   the owner of the boiler or pressure vessel shall forthwith cause the use and operation thereof to be stopped and shall, as soon as practicable and in any event within 24 hours, notify the Authority of the accident or defect, as the case may be,

and where applicable, shall, at the same time, send to the Authority the latest certificate of fitness issued in respect of the boiler or pressure vessel.

2. Section 22 (1):
   Every boiler and its auxiliary equipment shall be properly maintained.
3. Section 24 (1):
   Upon completion of the installation of a new boiler and before the boiler is put into use, the boiler and its auxiliary equipment shall be examined by an appointed examiner.
4. Section 49 (7):
   No boiler shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate boilers of the class or type in question.

Recommendation

1. Engage Competent Person(s) to operate the boiler and auxiliaries.
2. Do not tamper with the setting or remove safety valve from a thermal oil heater in operation.
3. Report any accident to the Boilers and Pressure Vessels Authority within 24 hours.

Photo 22.1 Connection for pressure gauge that was removed for investigation

Photo 22.2 Through crack on the shell of the thermal oil heater

Photo 22.3 No save-all was fitted underneath the circulating pump

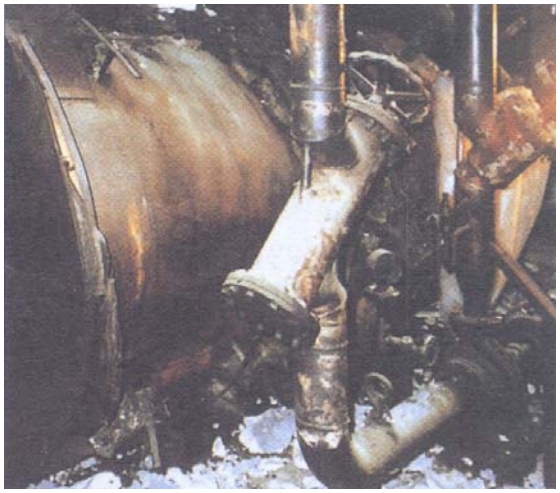


Photo 22.4 Whole boiler room was badly damaged

Case 23
A FURNACE BLOWBACK ACCIDENT RESULTING IN THE INJURY OF TWO WORKERS

Summary

A furnace blowback accident occurred in 1993 that injured two workers. One worker suffered from minor burns and the other worker sustained serious face burns. The burner unit was severely damaged. Only one Competent Person was employed to direct supervise the operation of two fire-tube boilers and five steam receivers over a factory floor area of 4,000m^2 for day and night shifts.

Circumstances

1. Two workers went to the boiler room to check what was happening after a boiler alarm was heard.
2. These two workers were injured by the furnace blowback.
3. There was no competent person at the day shift.
4. Six workers were changing clothes inside the boiler room at the time of accident.

Observation

1. The furnace blowback was the result of insufficient purge of the furnace to clear out the excess fuel accumulated in the furnace with air before ignition.
2. One worker suffered from minor burns and the other suffered from serious face burns with blistering on his face.
3. The burner unit sustained severe damage.
4. The vicinity of the burner unit was blackened by the blownback hot gases.
5. The air diffuser was full of accumulations of carbon deposits, which indicated poor combustion condition of the boiler.
6. The burner tip was found wet with fuel oil, which indicated the burner tip was leaking.
7. The refractory in the furnace was found in a very poor condition. The front end fire bricks were broken as a result of high fluctuating temperature under flame impingement.
8. There was a build-up of melted refractory materials solidified at the bottom of the combustion crown.
9. The boiler room was used as a changing room and was extremely dirty.

Legal Implication

The owner of the special purpose boiler could be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 22 (1):
   Every boiler and its auxiliary equipment shall be properly maintained.
2. Section 49 (7):
   No boiler shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate boilers of the class or type in question.

Recommendation

1. Engage sufficient Competent Persons to operate the boiler and auxiliaries in any shifts.
2. The boiler room should not be used as a staff changing room and should be kept tidy and clean at all times.

Photo 23.1 The damaged and blacken burner unit

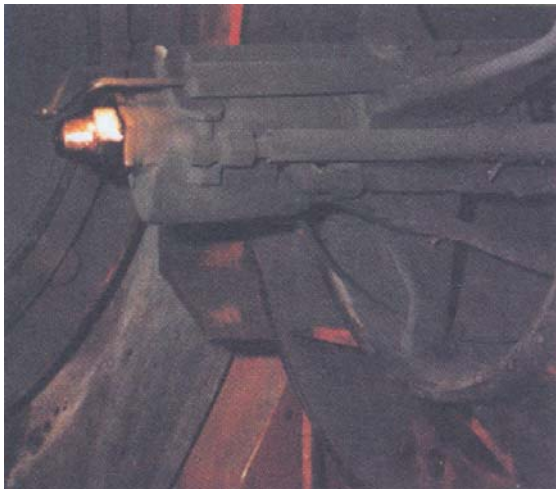


Photo 23.2 The leaky burner tips and air diffuser with carbon deposits

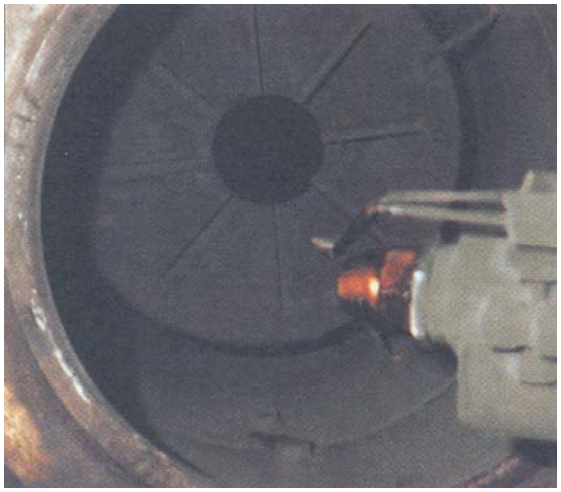


Photo 23.3 Air diffuser and wet burner tip

Photo 23.4 Damaged furnace refractory

Photo 23.5 Built-up slag at combustion crown

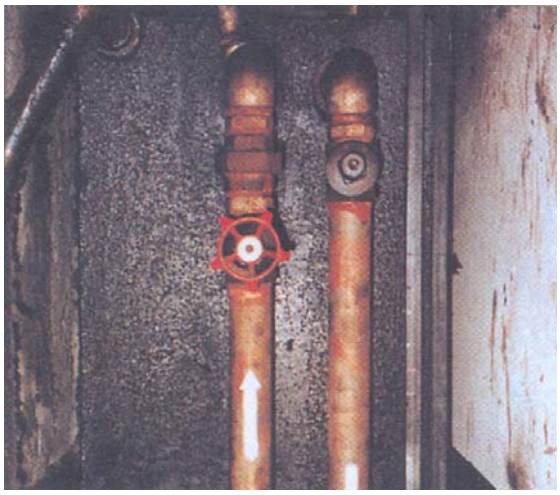


Photo 23.6 Fuel oil tank with supply & return fuel pipes

Case 24
BURSTING OF BLOW-DOWN TANK RESULTING IN THE INJURY OF A COMPETENT PERSON

Summary

In 1993 a boiler blow-down cooling tank burst up. The hot water rushed out from the tank and scalded a Competent Person. The poor welding of the tank top failed when the tank was under pressure. The capacity of the tank is too small to hold the boiler blow-down water with the boiler blow-down cock fully opened for several minutes.

Circumstances

1. The boiler was blown-down for five minutes every morning.
2. The boiler pressure at the time of blowing-down was 700 kPa.
3. When the boiler was being blown-down, the competent person went to check the blow-down tank to see if it was full.
4. The blow-down tank burst up and the hot water splashed onto the competent person's body and scalded him.

Observation

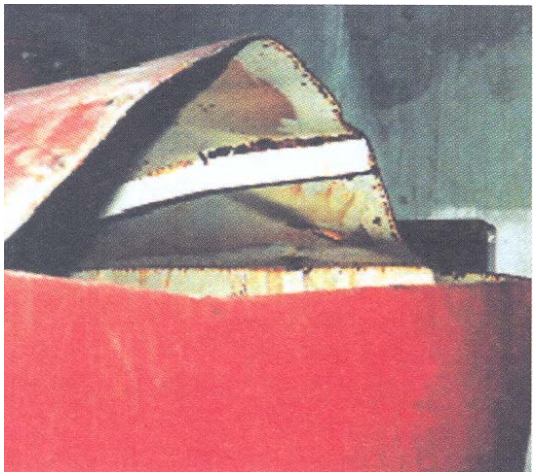
1. The blow-down tank was significantly deformed and opened up at the top on one side.
2. The welding of the tank was poor. There was no root penetration of the welding.
3. The construction and installation of the tank were substandard.
4. The blow-down tank was hydraulically tested to a pressure of 200 kPa as reported by the Appointed Examiner.
5. The capacity of the tank and the size of the vent pipe were not designed to hold the boiler blow-down water with the boiler blow-down cock fully opened.
6. The boiler was left unattended while the blow-down cock was fully opened.

Recommendation

1. The Appointed Examiner should ensure that the boiler auxiliaries were constructed and installed according to the recognised standards before issuing the Certificate of Fitness.
2. Any modifications made to the boiler and its auxiliaries should be examined by Appointed Examiner before they are put back to use.

Photo 24.1 The blow-down tank was deformed and opened up

Photo 24.2 Cooling coil inside the blow-down tank



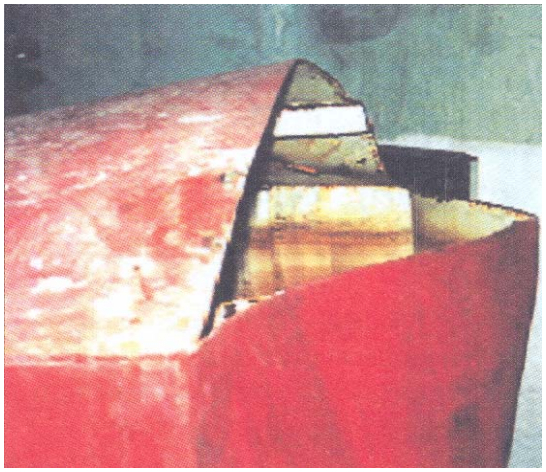


Photo 24.3 and 24.4 The blow-down tank was deformed and opened up

Photo 24.5 Inadequate stiffeners were installed inside the poorly constructed blow-down tank

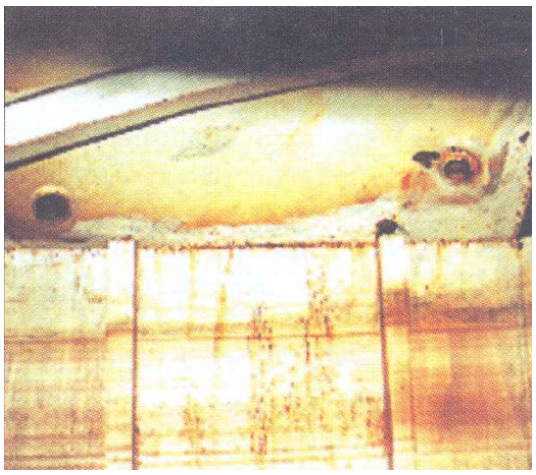


Photo 24.6 Deformed stiffeners inside the blow-down tank

Case 25
AN ACCIDENT INVOLVING THE SPLASH OF CONTENTS INSIDE AN UNREGISTERED AUTOCLAVE

Summary

A serious accident involving an autoclave was reported in 2002. After the door of an unregistered autoclave was unduly forced open, the contents inside the pressurised autoclave splashed out and injured two staff members. They were sent to hospital for medical treatment.

Circumstances

The autoclave was loaded with a number of glass containers which were being sterilised. Upon finishing the sterilisation process, the autoclave door was found stuck with traces of water seeping through the door gasket. A female quality control technician at the scene asked a male assistant quality control manager for assistance. After the autoclave door was forced open, hot liquid and steam as well as fragments of the glass containers splashed out of the autoclave. Both staff members sustained scald and cut injuries. They were hospitalised for medical treatment.

Observation

1. The autoclave had not been registered and no safety interlocking device was available to prevent the autoclave door from being opened under pressure;
2. Both victims had not received proper training;
3. Warning notices were not posted at the scene of accident;
4. The staff failed to observe and follow safety measures and instructions properly; and
5. The staff did not use suitable personal protective equipment at the time of accident.

Legal Implication

The owner of the autoclave may be found in breach of the following provisions of the Boilers and Pressure Vessels Ordinance:

1. Section 13:

   The owner of a new boiler shall, not less than 30 days before the day on which he intends to put the boiler into use, deliver to the Authority-

   (1) one copy of the maker's certificate and one copy of the certificate of inspection during construction issued in respect of the boiler or pressure vessel by a recognised inspection body; or

   (2) documentary evidence, to the satisfaction of the Authority, that the boiler or pressure vessel complies with a recognised engineering standard or code in respect of –

(a) the welders employed and welding procedures used in the construction and erection of and, if repairs have been carried out, in the repairs to, the boiler or pressure vessel;
(b) heat treatment before and after welding;
(c) tests and inspections carried out on the boiler or pressure vessel; and
(d) any other relevant technical details that the Authority may, by notice in writing, specify; or

(3) where the owner can deliver neither the documents referred to in paragraph (a) nor the documents referred to in paragraph (b), details of the design and methods of construction, inspection and testing of the boiler or pressure vessel and its auxiliary equipment.

2. Section 15(A):
The owner of a new boiler shall, not later than 30 days preceding the day on which he intends to put the same into use, apply to the Authority in the prescribed form for registration of the same under this Ordinance.

3. Section 49(1):
No boiler or pressure vessel and its auxiliary equipment shall be used or operated unless it has been examined in accordance with this Ordinance and a certificate of fitness has been issued in respect thereof after that examination.

4. Section 49(7):
No boiler shall be operated except under the direct supervision of a competent person whose certificate of competency certifies that he is competent to operate boilers of the class or type in question.

Recommendation

1. Autoclaves must be operated by persons who are fully conversant with the safety requirements for autoclaves.
2. Warning signs and notices should be posted near autoclaves.
3. Safe operating instructions and precautions must be strictly observed and followed.
4. Suitable personal protective equipment should be used during the operation of autoclaves.

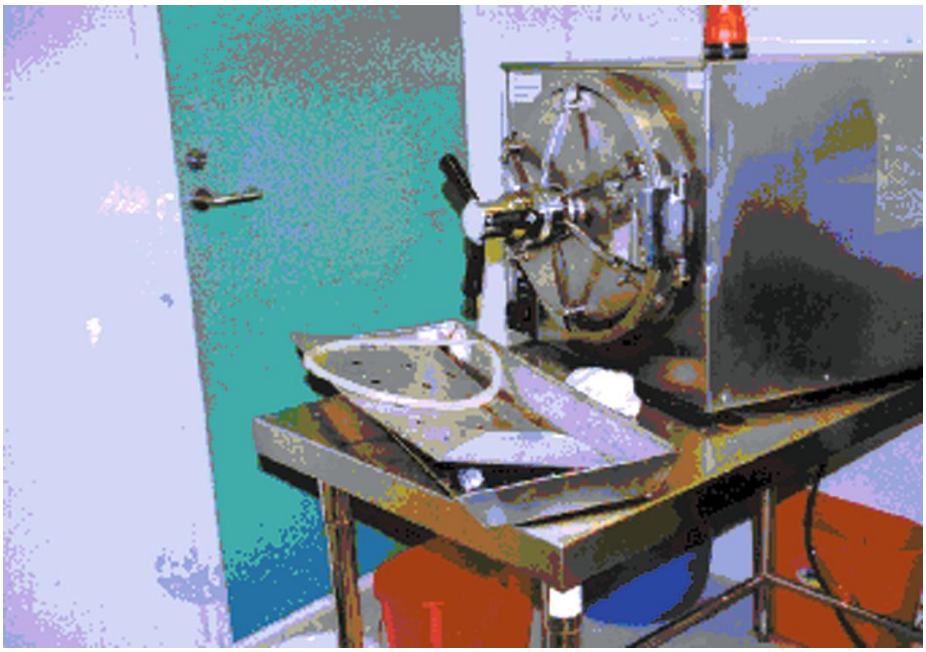


Photo 25.1 Autoclave door without pressure safety interlocking device

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