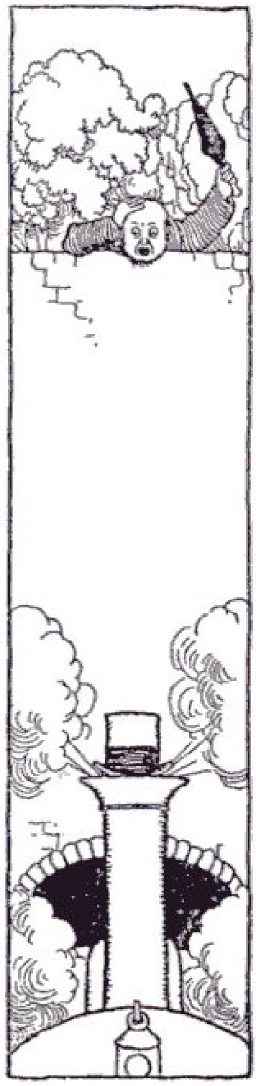
SAFETY NEWSLETTER

No. 135
SOME LESS OBVIOUS HAZARDS



Newsletter 133 described some obvious hazards.

This Newsletter describes some that are not obvious, the hazards of

135/1	**mixing water and hot oil**
135/2	**plugging tubes**
135/3	**resting a grinder on a pipeline**
135/4	**hollow pistons**
135/5	**a temporary modification**
135/6	**filling drums**
135/7	**Three Mile Island**
135/8	**statistics**
135/9	**loos**

An Engineer’s Casebook — Back seat bushings and valve glands.

A Simple example of removing a hazard by changing the design.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

135/1 MIXING WATER AND HOT OIL

Earlier Newsletters (110/1, 107/1, 90/p17, 67/1, 50/11c, 47/8, 42/8, 9/8 and 3/10) have described accidents which occurred because water was mixed with hot oil, above 100° C. The water turned to steam so quickly that the oil was blown out of the plant. Onlookers thought that explosions had occurred. They were explosions — rapid releases of energy — but physical rather than chemical in origin.

Another Company have now described another incident. Some paraffin which had been used for cleaning was left in a bucket. There was water under the paraffin. Some hot equipment set fire to cleaning rags and the fire spread to the paraffin in the bucket.

To put out the fire, a man threw a shovelfull of wet scale into the bucket. The water became mixed with the oil, turned to steam and blew the oil over the man who was standing 5 feet away. He died from his burns.

Never mix water and hot oil.

Do not use flammable solvents for cleaning. Use a non-flammable solvent such as Genklene.

Do not carry flammable liquids in buckets. Use a closed can.

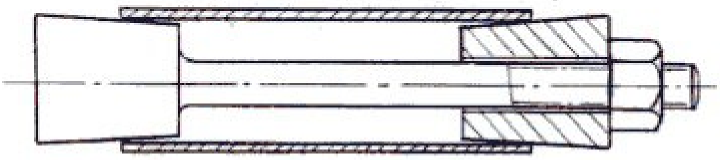
135/2 PLUGGED TUBES IN HEAT EXCHANGERS

Tube bundles often suffer from the odd leaking tube. It is common practice to plug off leaking tubes in order to prolong the useful life of the bundle. Traditionally, taper plugs have been hammered into each end of the leaking tube and sometimes the plugs have been given a sealing weld run. If the bundle is eventually taken out of service for retubing, shell-side fluid can be left in plugged tubes and can give rise to hazards when the plugs are removed. Before such bundles are sent away from the plant, plugged tubes should be vented as part of the preparation for retubing. Recently a fitter was sprayed with process fluid while he was grinding a welded plug. No injury resulted because he was wearing a full face visor. Other accidents which have occurred while removing plugs were described in Newsletters 85/3 and 45/5. In one of these incidents a plug flew out and travelled over 300 m. Hydrogen had been formed by reaction between water and the aluminium tube.

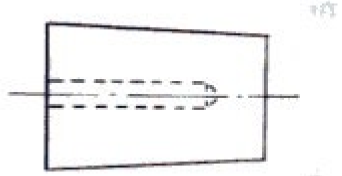
It is therefore good practice to prevent process fluids or water accumulating inside plugged tubes. This can be done by cutting through the tube wall behind the tubeplate. Special tools are available and if this is done at one end only, the tube remains in position. Cutting through the tube before plugging is standard practice in Wilton Central Workshops. However, it should not be done if the tube has been holed as the result of vibration arising from high cross-flow velocity as cutting will then leave a loose end which might damage other tubes by impact.

If tubes cannot be cut, the use of a mechanical plug rather than the traditional taper plug will allow pressure to be released under controlled conditions on the plant; see sketch A.

Although the use of taper plugs should be discouraged, if they are used they should be manufactured with a central predrilled pilot hole. This eases the problem of drilling through on the plant to vent the tube and also centralises the drill used to remove the tube; see sketch B.



(A) Mechanical plug



(B) Taper plug with pilot

135/3 AN LPG PIPELINE NEARLY LEAKED

A new pipeline was being installed alongside some existing ones. A portable hand-held compressed air grinder was left resting in the space between two lines. The handle had been left in the 'on' position so when the air compressor was started the grinder started to turn and ground away part of an LPG line. Fortunately, the grinder was seen and removed before it had ground a hole in the line, but the wall thickness was reduced from 0.28 inch to 0.21 inch.

Do not leave equipment on live lines.

Make sure that portable tools are switched off *at the tool* before connecting to the mains supply, or making the mains supply live.

Reminder: Other hazards of grinders were described in Newsletter 35/5 — sparks from them can ignite leaks and/or oil-soaked ground.

135/4 THE HAZARDS OF HOLLOW PISTONS

A reader reminds us that many compressors are fitted with hollow pistons and that this should be borne in mind before hot work is permitted.

Sometimes the pistons are fitted with breather holes. Any gas inside the piston can diffuse out and burn or, if there is air and vapour inside the piston, an explosion could occur.

However, the worst incidents seem to have occurred on pistons that are not fitted with breather holes. Newsletter 59/6 described an incident that occurred when a man was drilling a hole in the hollow piston of a steam engine. When the drill penetrated the shell a flame 3 feet long shot out and injured him. The outside of the piston had corroded and the hydrogen had diffused through the inside. Hydrogen produced by corrosion is formed as atomic hydrogen which can diffuse through metal.

A similar incident occurred in one of our overseas companies. Welding had to be carried out on the hollow aluminium piston of a compressor. It was realised that there might be some gas inside and it was decided to vent the piston by drilling a hole through it. As the electric drill broke through into the inside, gas escaped and caught fire and the man holding the drill suffered second degree burns to his hands.

In another incident, in another company, a man was heating a hollow aluminium piston without first drilling a vent hole in it. The piston exploded, killing the man. In this case tests on a similar piston showed that the gas was propane. The piston had been used to compress propane and some of the gas is believed to have diffused through the casting which must have been slightly porous.

Reminder: Newsletters 59/6 and 61/7(5) described some other incidents which occurred because hydrogen produced by corrosion turned up in unexpected places.

135/5 A TEMPORARY MODIFICATION WITH SERIOUS SIDE-EFFECTS

An incident at the Hunterston Nuclear Power Station in Scotland in 1977 shows the importance of thoroughly probing temporary modifications in order to see if they could have unwanted side-effects.

The nuclear reactor is cooled by carbon dioxide gas and the hot gas is then used to raise steam. There was a leak of carbon dioxide into the demineralised water system due to a defect in a seal cooling system; in order to reduce the leak, sea water — at a higher pressure — was temporarily connected into the demineralised water system.

When the plant was shut down and the pressure of the carbon dioxide reduced, 6 000 gallons of sea water passed through the leak into the carbon dioxide system and deposited salt in various parts of it.

All modifications, temporary as well as permanent, should be thoroughly vetted for their effects and shutdown conditions should be considered as well as normal running. the procedure recommended in the Division was described in Newsletter 83 (and in Chemical Engineering Progress, November 1976, p 48). Other modifications which went wrong were described in Newsletters 127/3 and 5, 126/12, 118/2, 111, 103/5a, 100/2, 99/1, 97/6, 71/7, 67/7d and 63/7.

Reference: HSE Quarterly Statement on Nuclear Incidents, 77/4/4.

135/6 A PROBLEM ABOUT PRESSURES

A man had to export a liquid in drums to the tropics. He knew that liquids exert a vapour pressure which increases with temperature and that they expand on heating. The extremes in temperature which the drums would experience were 0°C and 30°C. He asked his physical chemistry colleagues (without telling them why, and they, mistakenly, did not ask) to measure the vapour pressure of the liquid at 0°C, 15°C and 30°C and to measure the expansion of the liquid from 0°C to 30° C. The results came back:

Temperature °C	0	15	30
Vapour pressure (psia)	3	6	12
Expansion (0°C to 30°C)	3%		

He therefore decided, to be on the safe side, that the drums would be filled to 90% of their volume to allow plenty of room for expansion, and that he would use drums with bursting pressures of twice the vapour pressure of the liquid at the highest temperature it would experience, ie 2 x 12 = 24 psia.

It was a cold day (0° C) when the drums were filled but he thought this had been allowed for in his margins for safety. He was very surprised to learn that all the drums burst when the ship arrived in the tropics.

Why did the drums burst?

Answer next month.

Reminder: Newsletters 76/5, 79/1 and 80/10 explained the difference between absolute and gauge pressures.

135/7 THREE MILE ISLAND

There is an excellent article by H W Lewis on the accident at this Nuclear Power Station in *Scientific American*, March 1980, Volume 242, No 3, p 33. When the relief valve on the cooling system lifted and failed to reseat, the operators did not understand what was happening. They thought there was too much water in the system, not too little, and they took several actions that made the problem worse.

> *"… the operators were dealing with a situation that had not been foreseen and for which they had no relevant training, It was at this point that actions were taken that, in retrospect, clearly seem to be inappropriate but for which the justification seemed adequate to the operators on the scene".*

> *"… the proliferation of possible scenarios soon exceeds the capability of any automatic system to sense the proper response, and human judgement comes into play. At this point human action may be curative, it may be ineffective or it may aggravate the problem. . ."*

As an old shift manager said to me 25 years ago,

> *"In this job you make a decision by yourself in 5 minutes at 4 a.m. The next day, the day staff spend 3 hours deciding that you made the wrong decision".*

Despite our efforts to foresee what may go wrong, situations that we did not foresee may arise and then we have to rely on the operator. However, when time is short and stress is high, men may fail to act correctly, may even act incorrectly. Therefore we should try to foresee all the ways in which things can go wrong and if the consequences are serious, we should, whenever possible, install fully automatic safeguards. Ultimate safeguards such as relief valves should be sized with Three Mile Island in mind. Suppose a relief valve lifts because a valve which should be closed is half open; in the stress of the moment the operator may open it fully.

An interesting detail at Three Mile Island is that a light on the panel showed the relief valve to be shut. However, this light indicated the position of the operating solenoid, not the main valve!

Always measure directly what you want to know, not some other property from which it can be inferred. See Newsletter 119.

135/8 OTHER MEN'S VIEWS No 19

"Suppose that 200 people are going to have 100 accidents. Obviously, there are not enough accidents to go around, so some will have an accident and some will not. Further, unless an accident immunizes one against another accident, someone who has had an accident is about as likely to have another as someone else is to have their first. The Poisson distribution, which describes the chance probabilities, predicts that 121 of these 200 people would have no accidents, 61 would have one accident, 15 would have two, and 3 would have three or more. Thus, by chance alone, 1.5 percent of the group would have 9 percent of the accidents, and 40 percent of the group would account for all the accidents.

If we assume that the 3 people who had three or more accidents were therefore accident prone, we would still have 91 percent of the accidents to account for. Calling those 3 people "accident prone" would be like calling a pair of dice "loaded" because they came up "snake-eyes" three times in a row. Dice *can* be biased, and some people may be more likely than others to have accidents or make errors in a given situation; but to prove such bias we must show that snake-eyes, accidents, or errors occur more often than we would expect by chance. The Poisson distribution describes the chance probabilities. Deviations from chance can be evaluated by common chi-square, analysis of variance, or correlation techniques."

From L V Rigby, "The Nature of Human Error", Sandia Laboratories, Report No SC-R- 70-4318, Sept 1970, presented at the 24th Annual Technical Conference of the American Society for Quality Control, May 1970, Pittsburgh, Pennsylvania.

135/9 UNUSUAL ACCIDENTS No 96
Exploding Loos — Cause Traced

A mysterious rash of fires and small explosions in people's bathrooms and lavatories, along a boulevard in Brownsville, Texas, has been solved. The cause was 40,000 gallons of petrol which had leaked into the sewerage system.

In some cases explosions occurred when petrol fumes were ignited by pilot lights in bathroom heaters. The local fire chief said: "We traced it to a petrol station where the leakage had occurred." Fire department official have now flushed out the sewerage pipes and told tenants their lavatories are now safe.

Daily Telegraph, 22 March 1980.

135/10 RECENT PUBLICATION

Safety Note 80/7, "The Law on Safety — Some Questions Answered", tries to answer a number of questions which experience shows are of interest to ICI staff, for example:

If I modify the plant after an accident, is this evidence that the original design was unsafe?

What should I do if a Factory Inspector asks me to do something which I think is unnecessary or even unsafe?

Am I expected to learn the lessons of accidents which have occurred somewhere else?

Can I be prosecuted if there is an accident on the plant on which I work or which I have designed?

For a copy of this Safety Note or for more information on any item in this Newsletter please 'phone ET (Ext. P.2845) or write to her at Wilton. If you do not see this Newsletter regularly and would like your own copy, please ask Mrs. T to add your name to the circulation list.

May 1980

An Engineer's Casebook No 35
BACK SEAT BUSHINGS AND VALVE GLANDS

Gate and globe valves manufactured in accordance with Petroleum Equipment Industry Standards have a back seating facility designed into them which enables the gland to be repacked whilst the valve is under pressure and the spindle raised to the fully open position. Valves to British Standard 3808, Wedge-gate Compact Valves up to 2 inches, BS 2995, Wedge-gate and Globe Valves up to 2 inches, BS 1414, Wedge-gate Valves up to 42 inches and BS 1873, Globe Valves all incorporate this feature.

In each case the valve spindle or stem has an integral end in the form of a button or tee head which is larger than the stem diameter to engage with the wedge or disc. A bevelled or spherical face machined on the back of this shoulder comes against a seating in the valve bonnet when the valve is wide open. In the small valve sizes the spindle makes a seal directly to a seat machined inside the valve bonnet. On the larger sizes it comes into contact with the back seat bushing in the bonnet at the bottom of the gland. The effect is to isolate the valve body from the gland when the valve spindle is opened as far as it will go. This takes the fluid pressure off the gland, provided that a tight seal is obtained, and after releasing any pressure which might be trapped under the gland follower and/or turns of packing, lantern ring etc. the gland packing may be supplemented or renewed.

Valves of Class 300 rating and above may have lantern rings fitted in the gland boxes. The standard arrangement is two turns of packing at the bottom of the gland, the lantern ring, five turns of packing on top followed by the gland follower or gland flange itself. When a lantern ring is fitted then a screwed plug may be provided on the stuffing box opposite the centre of the lantern ring. In theory this screwed plug can be used to check the effectiveness of any back seating isolation before repacking the gland. The lantern ring in conjunction with the screwed opening into the stuffing box can be used to pipe gland leakage away to some recovery system or more acceptable location though this is rarely done.

The Division policy is not to fit lantern rings and not to have stuffing boxes drilled, tapped and fitted with plugs except in very exceptional circumstances. It has to be admitted however that many valves are to be found on our plants with these features. In some cases screwed vent plugs have been welded up and this should be done where valves are on LPG or hazardous fluids. If lantern rings are found these should be replaced by additional turns of packing thereby giving a greater chance that gland leakage will be avoided.

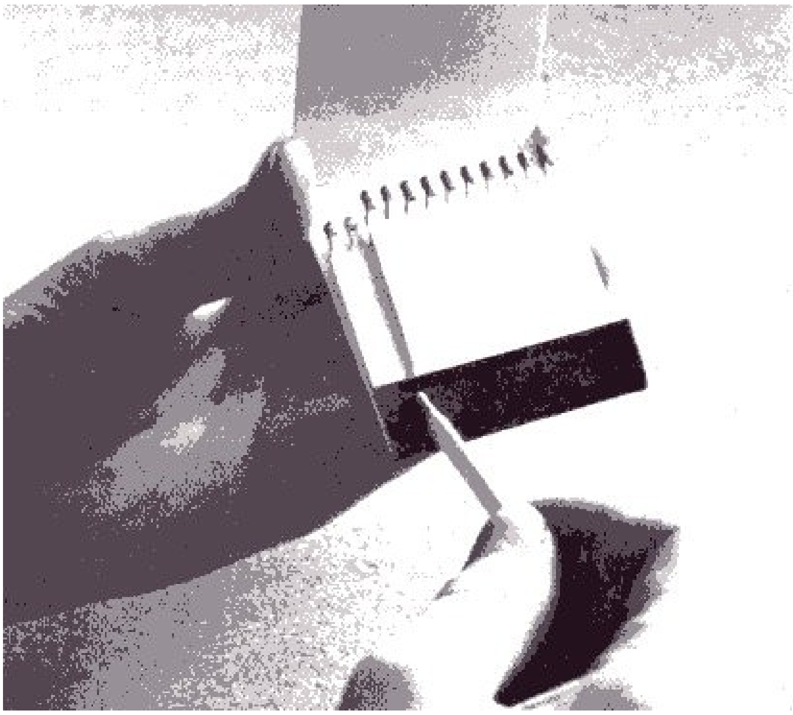
Valve spindles should not be opened fully against the back seat and left in that position whilst the valve is in service. This results in unnecessary strain on the bonnet bolting, encourages the bonnet joint to leak and masks any gland leak which may suddenly reveal itself when an attempt is made to close the valve. Spindles should be fully opened and then closed about one turn.

Under normal circumstances an effective isolation can be obtained using the back seating feature if it is considered necessary to attend to the gland packing whilst the valve is under pressure. The work can be done safely providing appropriate precautions are taken using an agreed procedure. Works have written permanent instructions for such work and these should be consulted.

Gland bolts should not be slackened off and attempts made to repack glands whilst any valve is closed in lines full of process fluid and/or under pressure. Under these circumstances the gland is open to the body space via the spindle to back seat bush clearance and there is no ready means of telling whether the valve disc or wedge is providing a positive isolation against its seat(s).

E H Frank

A SIMPLE EXAMPLE OF REMOVING A HAZARD BY CHANGING THE DESIGN INSTEAD OF ADDING SOMETHING ON



When lighting a match it is easy to set the rest of the book of matches alight.

Some people might say that the users should be instructed to close the cover before striking a match.

A better solution is shown below. The match is struck on the back of the book and it does not matter whether or not the cover is closed.

The good design costs no more than the poor design.