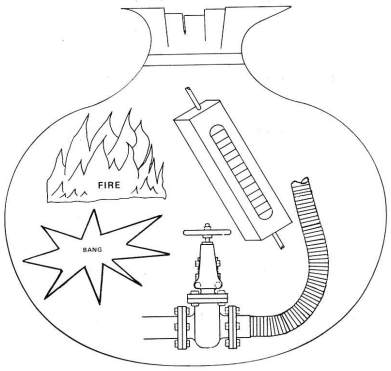
SAFETY NEWSLETTER

No. 140
A MIXED BAG



140/1 Again — maintenance started on plant which was not isolated.

140/2 Again — a hose disconnected before blowing off the pressure.

140/3 Hot water — a dangerous liquid.

140/4 Another sight-glass failure — and the precautions to take.

140/5 Two incidents with thermosheaths.

140/6 Off-specification product manufactured for ten hours.

140/7 Powder disturbed by fire hoses — 1930 and 1980.

140/8 Two fires and two explosions.

140/9 Do we build safe plants because the Law makes us, or because we want to?

An Engineer's Casebook — Overhaul of relief valves

Hazard Analysis and Hazard and Operability Studies

ICI
IMPERIAL CHEMICAL INDUSTRIES LIMITED
PETROCHEMICALS DIVISION

140/1 PIPELINES GIVEN TO MAINTENANCE BEFORE ISOLATION

One afternoon a supervisor (in another Division) closed a valve and locked it shut ready for a maintenance job the next morning.

During the night the line was required. As no clearance certificate had been issued, the night-shift operator unlocked the valve.

In the morning the supervisor issued a clearance certificate for work on the line **without checking that the valve was still locked.**

Fortunately, the fitter who was working on the line realised it was up to pressure as soon as he started to break the first joint.

Isolations should be made or checked immediately before issuing clearance certificates.

Never unlock a locked valve without asking why it is locked.

In a similar incident in Petrochemicals Division a fitter broke into a cooling water line while it was up to pressure. He got away with a soaking.

A clearance certificate was issued for the repair of steam and process leaks on a vacuum ejector and condenser. The process supervisor who issued the clearance did not realise that work had to be done on the water lines so he did not isolate them. The maintenance supervisor thought that the clearance allowed work to be done on any part of the equipment, including the water lines.

Before a clearance is issued, process and maintenance supervisors should discuss in detail the work that has to be done and visit the site. A discussion several days before is not sufficient.

Clearance certificates should make it clear what jobs can and cannot be done.

Reminder: Many fatal accidents have occurred because equipment under maintenance was not properly isolated. See Newsletters 137/4, 93/1, 91/2, 68/6, 57/5, 48/6, 11/2 and 6/1.

140/2 ANOTHER MAN SPLASHED WHILE REMOVING A HOSE

Some accidents occur with distressing regularity! Once again a man has been injured because he disconnected a nitrogen hose without blowing off the pressure inside it. He could not do so as there was no blow-off cock.

The man wore goggles but the trapped pressure caused the hose to whip out of his hands and splash another man who was standing nearby.

Unfortunately, the hose had been isolated at the nitrogen end first and so was full of liquid.

Have you checked your hose points recently to make sure they are fitted with blow-offs?

Do you isolate the process end of a hose first?

140/3 HOT WATER — A DANGEROUS LIQUID

Newsletter 137/3 described nitrogen as our most dangerous gas: One of our most dangerous liquids is hot water. Newsletter 113/1 reported that five men were killed in another company when a plastic hot water tank split along a seam. In the Division, 8 years ago, several men were badly scalded when a steam main burst as the result of water hammer (Newsletter 43/4).

Now the RoSPA Bulletin for May 1980 has described another incident. A man, going to make some

tea, caught his sleeve on the tap of an electric water heater. The heater fell on its side and two gallons of boiling water was emptied over him. He died in hospital five days later.

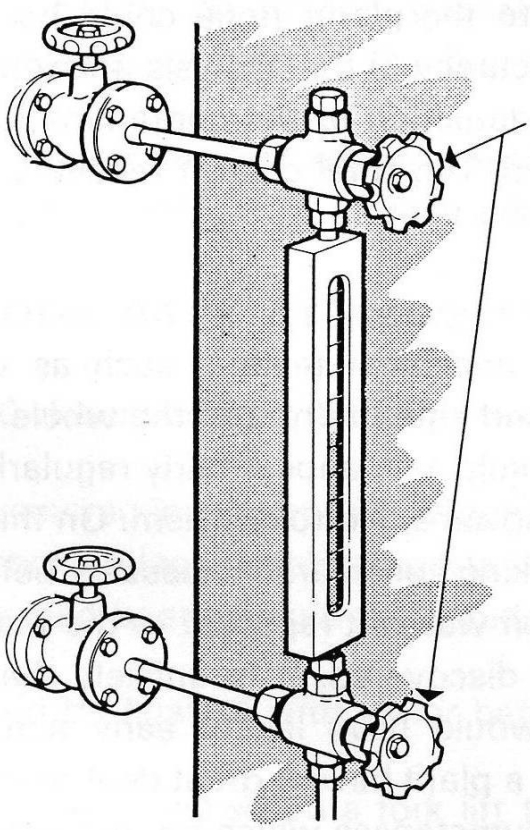
The water heater should have been fixed to the wall. Why wasn't it? Perhaps because no-one realised the contents were dangerous.

140/4 SIGHT-GLASSES

Safety Note 72/20 (copy on request) recommended that sight-glasses should not be used on equipment containing flashing flammable or toxic liquids, that is, flammable or toxic liquids under pressure at temperatures above their boiling points.

Fire Prevention for January 1980, page 37, reports a fire in a refinery which started when a sight-glass broke. Gas oil under pressure escaped and caught fire.

Level-glasses should be fitted with ball check cocks to prevent escape of liquid if the glass breaks (See Newsletters 34/5 and illustration below). Unfortunately, the balls are sometimes removed by people who do not know why they are there. The cocks must be fully open or they will not operate.



140/5 TWO INCIDENTS WITH THERMOSHEATHS

The first occurred in the Division. A thermosheath on a small atmospheric pressure tank corroded and leaked, wasting product worth £300. Similar sheaths on other tanks were found to be corroded.

Instead of replacing the sheaths, they were blanked off and new sheaths inserted through the tops of the vessels. If they corrode there will be no leakage.

The thermosheaths are now scheduled for examination during the normal inspections of the vessels.

The second incident occurred in another Company. A fitter, a man with 20 years experience, was asked to remove a temperature-measuring bulb out of a thermosheath on the oil line to a boiler. He found that the bulb was broken off inside the sheath and could not be removed. He therefore unscrewed the sheath. It blew out of the line and oil escaping at the rate of 1.5 m^3/min caught fire.

To isolate the oil supply an operator had to climb 5 m up the steelwork and crawl along pipelines to get to the valve!

The report recommends that:-

Valves required for emergency isolation should be readily accessible or remotely operated.

Thermosheaths should be secured by flanged joints, not screwed fittings. (This is already normal practice in Petrochemicals Division, though a few screwed fittings may slip through on packaged units.)

140/6 OFF-SPECIFICATION PRODUCT MANUFACTURED FOR TEN HOURS

A meter prover was used to check a flowmeter in a line carrying liquid A and then to check one in a line carrying liquid B. Due to a series of misunderstandings the prover was not washed out before the change of duty and a batch of B which had been analysed and passed for use became contaminated with 50 gallons of A.

The contaminated B was fed to the plant and the shift laboratory detected a high concentration of impurity in the plant product. The amount was so high, so far outside their previous experience, that they did not believe the result and spent 4½ hours analysing check samples and checking their apparatus and reagents, before reporting the analysis to the plant.

The plant, knowing that the purity of B had been checked before use, then spent 5½ hours looking for other ways in which the impurity could have got into the plant; none could be found, repeated laboratory checks removed earlier doubts about the accuracy of the analysis and ultimately the plant was shut-down. The delay of 10 hours between the detection of the contamination and the shut-down increased the make of impure product by a third. The total cost of recovery was £100 000.

To quote from the report on the incident:

> “There are so many things to go wrong with analytical testing, such as wrongly labelled samples, layering, dirty bottles, faulty reagents and equipment and the whole range of human errors, that it is quite inevitable that erroneous results will appear fairly regularly. The analytical staff are aware of this, anxious not to mislead, and sensitive to criticism. On this occasion there was no error, but, as a result of the rigorous checking considered necessary before so unusual a result could be released, this gross contamination was not reported to the plant management concerned for some 4½ hours after it was first discovered. It is unlikely that such a report, qualified by uncertainties about its accuracy, would have led to early action by the plant management. But the people who are managing a plant have a great deal of information about production needs, other plant problems, and circumstances which might have given rise to an out-of-specification analysis, and the only safe course is to share with them, fully and promptly, any important analytical results.
>
> Any out-of-specification analytical result, however improbable, should therefore be reported to the plant supervisor concerned, after rapid checks for obvious errors. The laboratory supervisor should comment as he sees fit on the possibilities of error, and propose re-sampling and diagnostic actions, but he should bear strongly in mind the possible consequences of delaying the report if the analysis proves to be correct.”
>
> “Safety, economy and production are usually favoured by steady, uninterrupted plant operation.

The plant supervisor's reluctance to shut the plant down on learning of an extremely improbable analytical result was in line with training and tradition and his evaluation was endorsed at the time by the plant manager. Nevertheless it cannot be denied, with hindsight of course, that there was no pressure for production and the plant could have suspended manufacture with negligible cost and inconvenience until all doubt about the analysis had been removed. The importance of maintaining the purity of the product and the difficulty of removing contamination from it would have made this advisable."

Two other points came out of the incident.

Before equipment is connected to a plant, especially a running plant, someone should check that it is clean. We were fortunate that adding A to B merely put the product off-specification and did not cause a dangerous reaction.

Similarly, someone should check that equipment is clean before it leaves the plant. We have systems for checking that equipment sent for repair, modification, sale or scrap is clean (See Newsletter 85/2). Meter provers and other temporary equipment should also be proved clean.

140/7 FORGOTTEN ADVICE

Earlier Newsletters, particularly No 93, have described how experience becomes forgotten and has to be learned again. Here is another example.

In *Fire*, June 1980, p 23, there is a short account of a warehouse fire last March in which 3 000 tons of terephthalic acid powder was damaged or destroyed. The report states:

"Due to... the disturbance of the powder by jets, there was throughout the incident an aerial ignition, giving at the height of the blaze a fireball 70 m high."

The Quarterly Safety Summary, published by the Chemical Industries Association, recently completed 50 years publication. The first issue (Jan-March 1930) included this advice:

"Attention is drawn to dust hazards which arise during fire-fighting... from streams of water throwing up dust clouds when striking piles of powder."

140/8 A LOOK BACK AT NEWSLETTER 40 (April 1972)

Newsletter 40 described two fires and two explosions.

The first fire occurred in an empty floating roof tank, two weeks after cleaning. Some petrol came out of one of the hollow legs which supports the roof when it is off-float and was ignited by a welding-spark. The leg had been choked with sludge.

The legs should be flushed with water before welding.

The second fire occurred when a fork lift truck hit a valve and caused a leak. The whole unit was destroyed.

The first explosion occurred on an empty tank which was full of flammable vapour. Some vapour came out of an open man-hole on the side and caught fire. Air was sucked in through the vent on the roof and the tank blew up.

The second explosion occurred on a centrifuge because the nitrogen blanketing failed. There was no alarm on the nitrogen supply, no indication of the nitrogen flow and no regular analysis for oxygen.

One fire and one explosion occurred in ICI.

140/9 OTHER MEN'S VIEWS No 21

Many years ago, a wise jurist — Lord Moulton — said that there were three great domains of human action. The first is where our actions are limited or forbidden by law. Then there is the domain of free personal choice. But between those two lies the domain of "obedience to the unenforceable' where people do right although there is no one to make them do right but themselves. And the extent to which there is obedience to the unenforceable is the measure of true civilisation.

Obedience to the unenforceable means self-imposed restraint. It means a sense of right and wrong. It means asking not what can we do but what ought we to do.

This appeared in the Daily Telegraph for 7 August 1980 in an article by Robin Day on Television's responsibility, but Lord Moulton's views apply equally to safety.

Some things we are required to do (or not do) by Law. There is an area where it does not matter what we do. Then there is a very large area where we install equipment and operating procedures, so that people will not get hurt, though no law requires us to do so.

Very occasionally, I hear someone say, "Let's ask the Factory Inspectorate what they want" or even "Why should we do so if the Law doesn't tell us to do so?" The speakers should ponder Lord Moulton's views.

140/10 UNUSUAL ACCIDENTS No 100

As a man (in another Division) was dragging a wooden pallet across the ground it burst into flames 15 feet tall — like a big match.

Analysis of the remains showed that the pallet had been contaminated with sodium chlorate and probably with flammable liquids as well.

140/11 RECENT PUBLICATIONS

(a) *Vigilance*, the Journal of National Vulcan Engineering Insurance Group, Vol 3, No 12, consists entirely of coloured photographs of defective equipment found by their surveyors.

(b) Safety Note 80/11 contains the papers presented at a symposium on human error held in 1978. In one of the incidents described the operators failed to trip a plant in time to prevent an explosion because the computer was busy printing a long list of alarm conditions which confused them.

For a copy of (b) or for more information on any item in this Newsletter please phone P2845 or write to us at Wilton. If you do not see this Newsletter regularly and would like your own copy, please ask us to add your name to the circulation list.

October 1980

An Engineers' Casebook No. 40
OVERHAUL OF RELIEF VALVES

The cost of stripping, overhauling, reassembling and testing of relief valves is considerable and I have been asked if such work is absolutely necessary where valves are used on perfectly clean fluids such as air. Would not a lift test prove whether or not the valve still functioned correctly and was, therefore, good for a further period of service?

In the case of relief valves fitted to steam boilers and steam and air receivers the maximum interval between examination and test is stated in the Factories Act 1961. The Statutory requirements are that the safety valves should be 'properly maintained' and 'thoroughly examined' by a Competent Person at specified maximum intervals. The requirements for relief valves fitted to chemical or refinery type plant should be no less demanding for, in many cases, the hazard arising from failure is considerably greater.

For Statutory Equipment the meaning of 'thoroughly examined' is not spelt out in detail in the Factories Act; indeed it is left to the discretion of the Competent Person conducting the examination as to its extent and degree. Part of his competence is to detect defects or weaknesses which it is the purpose of the examination to discover and assess their importance in relation to the correct functioning of the valve.

To lift a relief valve in-situ, either by raising the fluid pressure or by means of an easing lever, if one is fitted, proves no more than at that point in time the valve functions. The value of such a test as a demonstration that the relief valve may be expected to function correctly during a further two or more years in service is minimal. This is because no data is obtained on the internal condition of the valve or as to how it has been affected by the previous period of service, internal or external corrosion, wear or galling from operation, build up of deposits etc.

Quantitative data collected from nearly 2000 relief valves installed on crude oil, aromatics and ethylene liquefaction plants, which were tested for set pressure in the condition as removed from service, showed that 5% did not lift at 110% of the original set pressure. In most cases the set pressure was the design pressure of the equipment being protected so that this equipment could potentially be in service at greater than 110% of design pressure, a higher pressure than the pressure vessel codes permit. Drift, dirt, galling, corrosion, 'striction' etc. were reasons why these valves had not lifted, all of which required a strip down of the valve to discover.

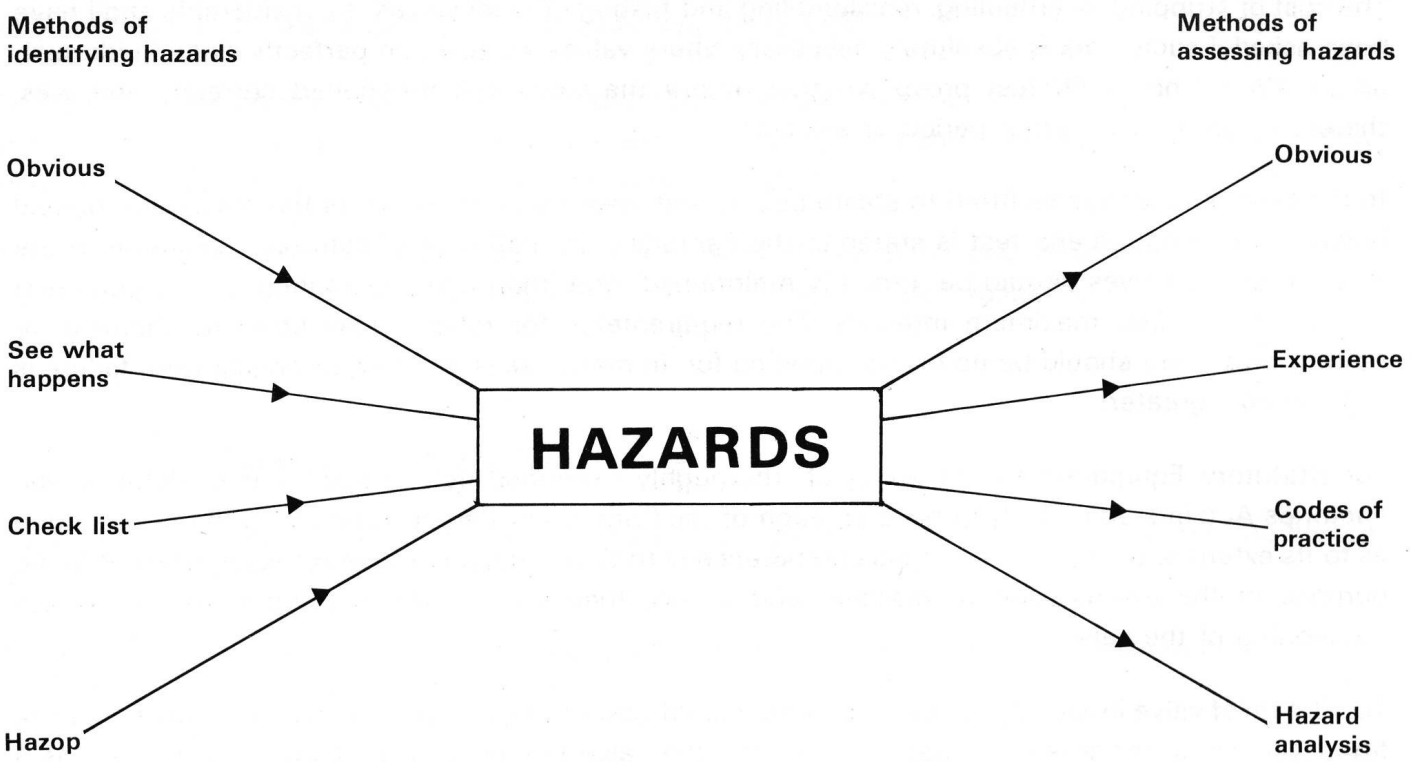
It is considered unwise to allow process vessel relief valves to continue in-situ for a further period of service based on a function test alone. Clause 4.10.2 of the ICI Code on Pressurised Systems, Group B Vol 1.4, has been amended to give more positive guidance and now reads:-

All fittings on pressure vessels or piping systems upon which the safe operation of the equipment depends shall be examined, and where appropriate tested for correct functioning, at the time of the equipment examination or more frequently. The Competent Person shall satisfy himself that any examination is sufficiently thorough as to detect any weakness in the relief valve or alarm and trip system which might prevent it functioning correctly whilst in service. This will normally require that all parts be exposed to be examined, replaced or refurbished as judged necessary, the equipment re-assembled and tested once again for correct function.

E H Frank

HAZARD ANALYSIS AND HAZARD AND OPERABILITY STUDIES

The two are often confused. The diagram may help to make the difference clear.



The left-hand side shows various methods of identifying hazards, of finding out what hazards are present.

Some hazards are obvious.

The traditional method of identifying hazards was to build the plant and see what happens — '"every dog is allowed one bite". Until it bit someone, we could say that we did not know it would. This method is no longer satisfactory now that we keep dogs as big as Flixborough.

Check-lists are sometimes used to identify hazards but items not on the list may be missed. We therefore prefer 'hazard and operability studies' or HAZOPS, as they are sometimes called. A series of guide words are used to encourage free-ranging thinking about what might go wrong.

The right-hand side of the diagram shows various methods of assessing hazards, of deciding what to do about them. Sometimes this is obvious; sometimes experience or codes of practice tell us what to do; sometimes we try to work out the probability of an accident; this is called hazard analysis.

HAZOP should be applied to all parts of all projects (unless we are copying an existing design which has been proved satisfactory) — we need to know all our problems. Hazard analysis, however, should be used selectively. There is neither the need, the data, nor the resources to attempt to quantify every problem.