SAFETY NEWSLETTER

No. 128
FOLLOWING THE RULES TOO LITERALLY

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An Engineer’s Casebook — Pressure Vessel Orders and Modifications

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

128/1 DO WE SOMETIMES INTERPRET THE RULES TOO LITERALLY?

The various recommendations we make, on other matters as well as safety, have to be simplified into rules or guidelines for use by non-experts who want to know what they should or should not do, preferably in an easily-remembered form.

It is important to bear in mind the underlying reasoning behind the various rules and guidelines, not interpret them in too literal or mechanical a fashion and, in particular, not apply them to circumstances which were not thought of by those who wrote them.

For example, along Hadrian's Wall, milecastles with gateways were constructed every mile even when there was a near-precipitous drop outside the gate. Presumably the "design rules" were written in Rome by someone who did not foresee this possibility, perhaps the Emperor Hadrian himself, and stated that a gateway had to be constructed every mile. The men on the job then felt they had to construct them whether they were any use or not.
(D J Breeze and B Dobson, "Hadrian's Wall", Penguin Books, 1978, page 38).

(*Note for overseas readers*: Hadrian's Wall was built by the Romans to separate England from the wild and less civilised area now known as Scotland. It was not a defensive wall like the wall around a castle — the Romans fought their battles in the open — but an administrative boundary, to control movement between the two countries. Some people, on both sides of the border, wish it had not fallen into disuse.)

Do we ever install similar unnecessary equipment or unnecessary procedures, like the builders of Hadrian's Wall? Perhaps we do. Here are some examples. As two of them concern electrical equipment, it may be useful first to remind ourselves that electrical equipment installed in hazardous areas has to be of approved types. Hazardous areas are classified Zone 1 if a flammable atmosphere is likely to occur during normal operation or Zone 2 if a flammable atmosphere is not likely to occur during normal operation and, if it occurs, will exist for only a short time, Different types of equipment are used in the two zones. (See "Electrical Installations in Flammable Atmospheres", ICI Engineering Codes and Regulations, Group C, Volume 1.5). A useful 'rule of thumb' for distinguishing Zone 1 and Zone 2 areas is that a Zone 2 area is one in which gas will be present for less than ten hours per year. Zone 2 equipment will not spark in normal use but may spark if there is a fault, typically once in a hundred years.

Most plants are mainly Zone 2 with small Zone 1 areas.

1. In most plants, vehicles are not allowed to enter Zone 2 areas without special permission. On one plant the boundary of the Zone 2 area was drawn down the middle of the road. Interpreting the rules literally, this meant that vehicles could travel up the road whenever they wished, but had to get permission from the plant supervisor before they could come back. Zone 2 areas cannot, of course, be determined with such accuracy that we can distinguish between one side of a plant road and the other. The boundary should be moved so that all the road or none of the road is in the Zone 2 area.

2. A man will occasionally enter a Zone 1 area taking with him portable electrical equipment such as a radio or personal monitor. Does this mean that the portable equipment must be suitable for use in Zone 1 areas?

The answer is No, because a man is unlikely to enter a Zone 1 area when a leak is present. Men should never enter a cloud of flammable gas, though occasionally they may be tempted to do so, to isolate a leak. Even so, the amount of time they spend inside a cloud of flammable gas will never be more than a few minutes every few years and far less than 10 hours per year. The chance of the leak coinciding with a fault on the electrical equipment is thus extremely small and the portable equipment can be of a type suitable for use in Zone 2 areas.

Occasionally taking Zone 2 radios or personal monitors into Zone 1 areas is thus less hazardous than using fixed Zone 2 electrical equipment in Zone 2 areas. However, when the Codes were written nobody considered the special problems of equipment attached to men and the Codes make no provision for it.

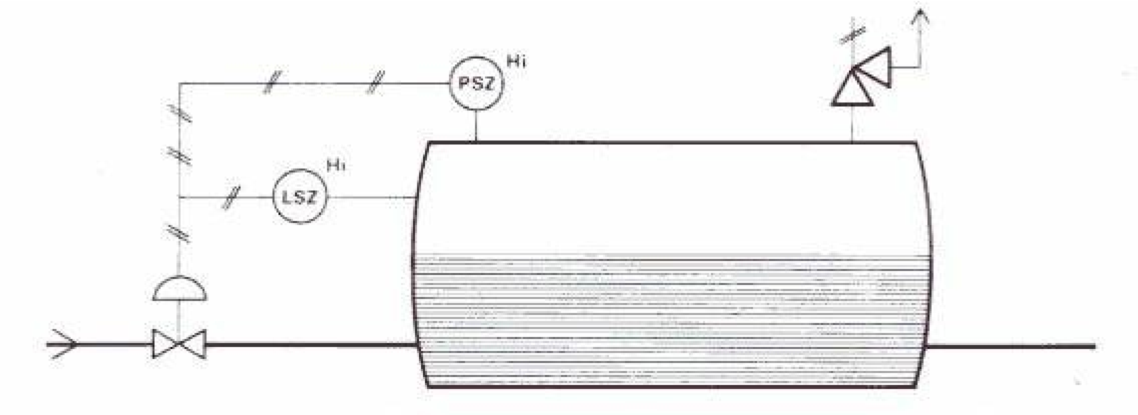
3. In areas where unconfined vapour cloud explosions might occur, we now design occupied buildings to stand a certain degree of over-pressure (see Safety Note 77/13B). Internal walls are also designed to withstand an over-pressure. Should internal fittings be designed to withstand this over-pressure? If the design guides are taken literally then they would be, but, in practice this is not necessary because a small object in a building, unlike a wall, will be exposed to the same over-pressure on all sides.

Can you think of other occasions when we have interpreted the rules too literally?

128/2 ANOTHER INSTRUMENT WHICH CANNOT DO WHAT WE WANT IT TO DO

Newsletter 119 described some instruments which cannot do what we want them to do. Here is another example, brought to light, more than once, during hazard and operability studies.

A vessel is kept half full of liquid. There is a level controller (not shown) and in addition a high level trip isolates the inlet line if the level gets too high.



If the level controller and high level trip fail the relief valve will lift and discharge liquid to atmosphere, so a high pressure trip was installed as well.

If the space above the liquid contains nitrogen or other non-condensible gas the system will work. As the level rises the gas will be compressed and the pressure will gradually rise.

However, the vessel contains liquefied petroleum gas (LPG). As the level rises the vapour condenses and the pressure does **not** rise until the vessel is completely full of liquid. The pressure then rises rapidly, too rapidly for the high pressure trip to prevent the relief valve lifting.

The man who designed the system probably did not understand the difference between a non-condensible gas, such as air or nitrogen, and a vapour.

128/3 A MYSTERY SOLVED — HOW WATER GOT INTO THE IMPULSE LINES

Newsletter 101/1 described a fire which was worse than it might have been because the emergency blow-down system failed to work. The blow-down valves are operated by gas pressure, process gas being used, Some of the valves failed to operate because there was water in the impulse lines and it had frozen.

Two years before the fire an operability study had been carried out on the plant. The team were asked if water might be present in the process gas stream which supplies the impulse lines and they said “No”.

How the water got into the impulse lines remained a mystery — but the reason has now been discovered,

Occasionally the valves have to be operated during a shut-down, when no process gas is available. The maintenance team were asked to operate the valves but not, of course, told how to do so. They used water and a hydraulic test pump. None of those present at the operability study or at the enquiry into the fire (including the shop steward) knew that the valves had been operated in this way.

Operability studies and accident investigations are not infallible — they are only as good as the knowledge and experience of those present and it is necessary to ask the right people the right questions. It helps if those present cover a range of disciplines and levels but, on the other hand, the team must not be too big.

Gas from a cylinder is now used for operating the valves during a shut-down,

Can you think of any other examples of maintenance methods which may introduce unforeseen hazards?

128/4 FROST DAMAGE TO A PIPE WAS NOT DETECTED

A pipe-line is used only occasionally and after use it is flushed through with water. It had not been used for seven months. When it was used again 5 tonnes of oil were lost because the line has been split open by frost.

Little-used lines should be blown clear after use, not left full of water. When they are put back into use, they should be inspected to make sure they are not leaking.

128/5 AN ELECTRIC LIGHT CAN BURN A HOLE THROUGH A WOODEN PLANK

A portable floodlight was left face down on a staging and burned a hole right through it!

The light is of a type which is not certified for use in flammable areas but is frequently used during shutdowns when a plant has been cleared of flammable materials.

128/6 MORE WAYS TO SUCK IN TANKS

Earlier Newsletters (115/3 & supplement, 96/1 & 2,81/1, 78/8, 77/2, 47/5b, 42/1, 29/7 and 27/4) have described ways by which tanks have been sucked in. While Newsletter 115 was at the printers, a painter painted the flame trap on a small tank. The next day the tank was emptied and sucked in.

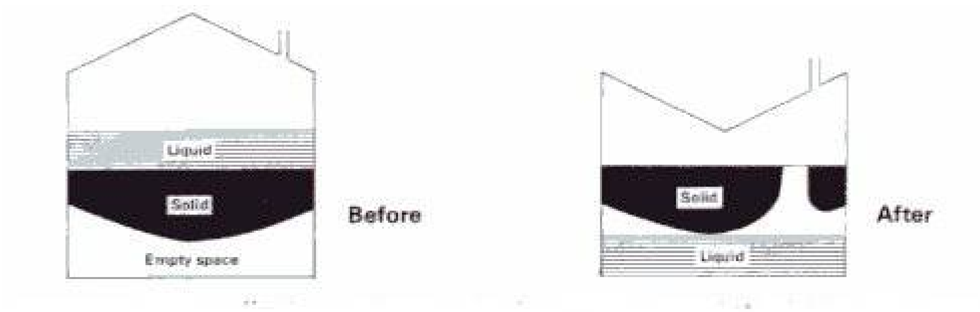
The report on the incident recommends:-

1. All painters should have a “teach-in” informing them of the duty of flame traps and telling them that they should not be painted.

2. After any work is carried out on a tank roof the process supervisor should check the flame traps before accepting back the clearance certificate.

3. All flame traps should be fitted with a label saying “Tank breather — do not obstruct”.

In another incident a solid layer formed in a storage tank. When some liquid was pumped out of the tank a space was left underneath the solid. Later, more liquid was added on top of the solid.



The solid gave way and the liquid on top rapidly drained through into the space below. It drained so rapidly that the vent pipe could not let in air quickly enough and the tank collapsed.

The report recommends changes in operating practice to prevent the formation of solids and, in addition, a larger vent.

128/7 OTHER MEN'S VIEWS No. 15

Suppose one carried out an analysis of the likely hazards of rush hour travel on the London underground, without the benefit of hindsight provided by the accident statistics accumulated by London Transport over a period of 80 years. Calculation could be based solely on such easily measured factors as number and layout of underground station platforms, speed and frequency of trains and accident statistics on stumbling and slipping. The level of probability thus obtained that 1, 10 or 100 of the ½ million or so commuters that use the London underground daily would accidentally find themselves beneath its wheels might turn out to be such as to demand nothing less than the wholesale installation of guard-rails or crush-barriers along the full length of station platforms, with automatically opening gates at appropriate intervals and automatic braking and inching mechanisms to bring trains to a halt at exactly the right position. At any rate this would be consistent with the policy of carefully guarding all moving parts from contact with man.

We have proof today, however, that such measures are unnecessary, as a result of the technically, though not sociologically, fortuitous fact that, until now, nobody appears to have raised any objections, or at least they were not heeded. Again, on the basis of this invaluable 80 years' experience, we are able to allow the new '125' trains to drive past passengers at speeds of over 100 mph with no more than a yellow line painted on the platform to protect them.

Or consider the petrol gauge in the tank of the modern motor car, a naked rheostat on which a bare contact is permitted to ride up and down with the level of the fuel and which is connected via the facia meter to the car battery. This arrangement does not comply with most of the requirements of the type of 'intrinsically safe' circuitry for flammable atmospheres perfected some 30 years ago and new *de rigueur* in all industrial, commercial and domestic installations in which petrol is used. Given the 'right' fault conditions it is possible to demonstrate experimentally that such a device can ignite petrol vapour in air.

Yet experience currently extending to 200 million motor cars throughout the world and going back over some 50 years (an 'experiment' on a truly gigantic scale!) has shown that the device, for the purpose it was intended, in a wide variety of conditions and with all kinds of faults, has performed no less safely than would have been the case with a much more elaborate and expensive device that conforms to the relevant European standard. This does not imply that we should replace level gauges in industrial oil tanks by cheap automobile gauges; what it does indicate is that calculation and experiment applied to some hazards could result in unnecessary elaborate solutions.

While the literature abounds with case histories of disasters ascribable to the inadequate application of technology, it is sometimes overlooked that history also presents us with a good deal of useful data which tend to show that some activities which by modern standards would appear *a priori* unsafe, turn out with hindsight to be perfectly acceptable.

Faced for the first time with any of the following, can anyone foretell what today's attitude towards their wholesale introduction would be: escalators, bicycles, pressure cookers, gas fires, razor blades, barbed wire, cigarette lighters, to name only a few common articles?

The history of the period between the onset of the industrial revolution and World War II has provided us with considerable evidence that some developments, which to the safety technologist of today appear to bear all the imprints of potential hazards, have subsequently turned out to be relatively harmless. Unfortunately, for various reasons, this is likely to remain a once-and-for-all never-to-be-repeated opportunity for the constructive application of hindsight. From it we can only suspect that similar overestimates of hazardous situations may occur in future which, while not as traumatic as an underestimate, could in the long run turn out to be equally debilitating.

While the suspicion should not detract from our continuing to identify hazards and develop counter-measures, it is worth keeping at the back of our minds as a salutary reminder that hazard assessment is still in its infancy and as a spur to hasten its adolescence.

H S Eisner, Science & Public Policy, June 1979, p. 146.

Sometimes the hazards of new technology have been underestimated. The men who agreed that it was unnecessary for motor cars to be preceded by a man carrying a red flag did not realise the slaughter that would result. Other examples are described by Lawless (see Newsletters 111/5, 115/10 and 188/p6).

128/9 COMMENTS FROM READERS

The back page of Newsletter 125 (pictures from our Archives No.3) showed a picture of a relief valve tail pipe which bent when the relief valve lifted.

A reader has supplied some further information.

The tail pipe was not provided with a drain hole (or if one was provided it was too small), it filled with rainwater, and when the relief valve lifted the column of water hit the curved top of the tail pipe with great force. As well as checking that relief valve tail pipes are supported adequately we should also make sure that they are adequately drained.

128/10 UNUSUAL ACCIDENT No 90

A Wilton typist set fire to the varnish on one of her nails while lighting a cigarette.

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 her to add your name to the circulation list.

October 1979

An Engineer's Casebook No 28
PRESSURE VESSEL ORDERS AND MODIFICATIONS

Casebook No 18 in Newsletter 118 drew attention to the incomplete and hybrid application of design codes for the design and manufacture of unfired pressure vessels. Mention was made of the withdrawal of BS 1500 and BS 1515 leaving BS 5500 : 1976 'Unfired Fusion Welded Pressure Vessels' as the only current British pressure vessel Code.

Replacement vessels, which may often be required to be interchangeable with existing vessels designed to BS 1500 or 1515, must be designed to the new code. In most cases vessels designed to BS 5500 will be virtually identical to vessels to BS 1500 or BS 1515. Modifications to existing vessels built to the now obsolete Codes can continue to be engineered to the original rules provided that the modified vessel is at least equal to the BS 5500 requirement. When a new vessel is required, or significant modifications are proposed to an existing vessel, the Division Engineering Department should be consulted.

In many cases a British Standard does not entirely meet the Company's needs. BS 5500 is no exception and ICI Specification E365 has been issued as an Addendum to cover additional requirements when BS 5500 vessels are required for ICI. Amongst other things E365 specifies how various items in BS 5500, which are to be agreed between the purchaser and the manufacturer, are to be resolved.

The basis for calculating the allowable stress used in BS 5500 is similar to the so called 'higher design stresses' used in BS 1515 and is $^{2}/_{3}$ of minimum specified yield strength or $^{1}/_{2.35}$ of specified minimum tensile strength.

New features in BS 5500 include the introduction of an Inspecting Authority defined as 'the body or association acting on behalf of the purchaser which checks that the design, materials and construction comply with the standard'.

Also new is the concept of 'Construction Categories' by which the amount of non-destructive testing is related to the type and thickness of the material used. Materials are graded from MO for plain carbon steel, M1 for carbon-manganese steel up to M10 for 5%Cr ½%Mo followed by the austenitic chromium-nickel steels. Design stress is related to material and temperature and is the same value for categories 1 and 2. For category 3 allowable stresses at room temperature are about half those of 1 and 2. Inspection is visual only and it is unlikely that the Company will buy many pressure vessels to this category which is further restricted to carbon and carbon-manganese steels only, less than 16 mm thick or to austenitic steels less than 25 mm thick.

Category 1 applies to all materials permitted by the Code in any thickness and requires 100% NDT. Category 2 has a restricted range of permissible steels, limitations on maximum thickness and a slight restriction on minimum temperature, but requires less NDT. It should be suitable for almost all vessels which do not have to be Category 1 because of Code limitations on thickness and materials.

E H Frank

WHO'S WHO IN SAFETY

No 33 – M J P LE CORNU

Martin Le Cornu, Technical Assistant to the Company Safety Adviser, was born in Jersey, Channel Islands where he spent his formative years under the wartime German Occupation.

After a short spell in the Royal Navy he took an engineering degree at London University, and joined the North Thames Gas Board as a trainee plant manager. During his ten years in the gas industry, managing various 'town gas' production and ancilliary plants, he experienced the transformation from a predominantly coal-based industry, through oil to natural gas. He also learnt a thing or two about the flammability of feedstocks and end-products.

Martin joined ICI Plastics Division at Wilton in 1962 and after doing various jobs was appointed a member of the team which, in the period 1969-74, carried out technical safety audits of all the Division's Plants with the aim of avoiding another major incident similar to that which killed four men on the polythene plants in 1969. He later became an Assistant Division Safety Adviser and was promoted to his present position at Millbank in February this year.

Martin is married with a son and two daughters, aged between 28 and 19. His interests are caravanning, gardening, travel and contemplation — the latter as a defence against the rigours of London