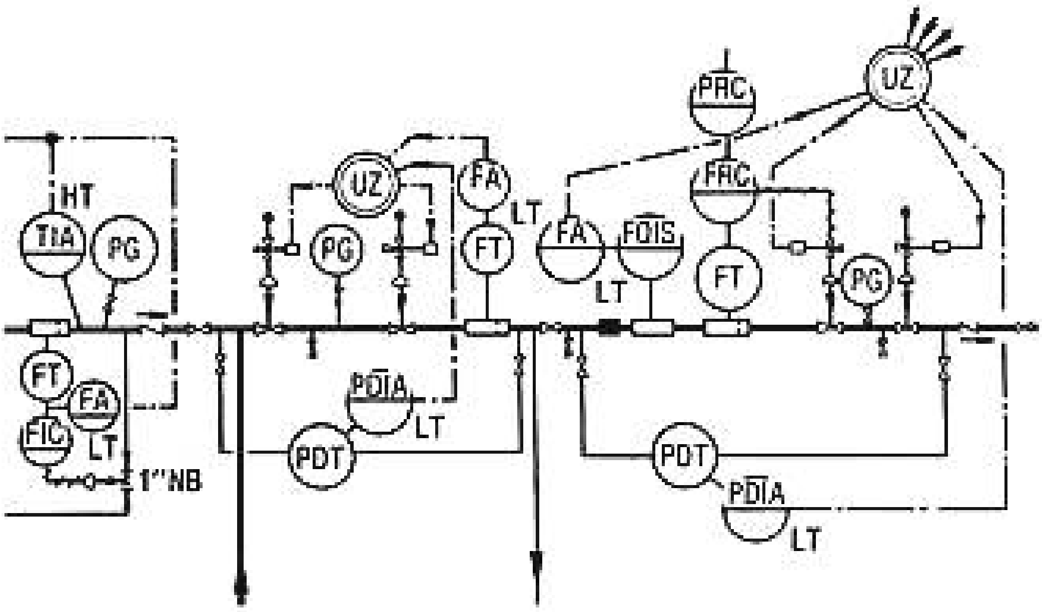
SAFETY NEWSLETTER

No. 117

IS THERE A SIMPLER SOLUTION?



117/1 **We usually identify the hazards on a plant then *add on* protective equipment. Could we remove the hazards by altering the process?**

117/2 Does ICI add on more protective equipment than other companies?

117/3 Test liquid nitrogen before off-loading.

117/4 The correct material of construction was forgotten.

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An Engineer's Casebook— Registration and Examination of Pipework.

ICI

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

117/1 IS THERE A SIMPLER SOLUTION?

Plant designers sometimes complain that operability studies result in a big increase in the cost and complexity of a plant, many additional protective devices being added on.

Of course, it is not the operability study that adds to the cost and complexity, but the weaknesses in the original design. The operability study merely brings them to light at the design stage before we find them out the hard way. If the original design had been better, there would be no need for so many changes.

Operability studies are a technique for identifying things that can go wrong. As part of the study we should try to estimate the size of the problem — how often will it occur and how serious will the consequences be? — and this will help us decide how far to go in removing the problem or protecting people from the consequences. Not all hazards require the “full treatment”.

However, it is true that our usual approach is to:

Design a plant

Identify the hazards

Add on protective equipment of various sorts to control the hazard.

We do not as a rule see if we can *remove the hazard by modifying the process.* In fact, by the time the operability study is carried out it is often too late to do this and all we can do is to add on protective equipment.

This note suggests a few ways of making plants safer by simplifying them, or by changing the process.

1 Newsletter 95/1 and my paper, “What you don’t have can’t leak” (copy on request) point out that we would not need so much protective equipment if our plants did not contain such large quantities of hazardous materials, or handled them at lower temperatures and pressures. Some ways in which this has been and might be done are discussed.

2 Often the need for large relief valves and a large flare system can be avoided by using stronger vessels. For example, if we have a series of vessels with a fall in pressure between them, then the need for relief valves can be avoided by making all the vessels strong enough to withstand the full upstream pressure. The need for a large relief valve on a distillation column can sometimes be avoided by making the vessel strong enough to withstand the boiling point of the contents at the temperature of the heating medium.

However, vessels are ordered in the early stages of a project. If the relief and blowdown review or the operability study shows a need for stronger vessels, it is too late to order them and relief valves and a flare system (or instrumented trips) have to be installed.

3 A plant was designed with a chlorine blower made from titanium and a scrubbing tower before the blower to remove dust and wet the chlorine. As titanium reacts rapidly with dry chlorine, an elaborate system of trips and controls was installed to make sure that the chance of a water failure was very small.

Following a study of the design it was decided to install a rubber-covered steel blower instead of a titanium one. This old-fashioned piece of equipment is less reliable than a titanium blower but it does not matter if it comes into contact with dry chlorine and the control and trip system on the scrubber could be made much simpler.

4 Multi-stream plants are sometimes provided with complicated cross-overs so that, in the extreme, any pump or reactor can be used on any stream. Though these cross-overs in theory give better on-line times, the advantages are sometimes outweighed by the greater chance of a leak (as there are more

valves and flanges) and the greater chance of an operating error, or an error in preparing equipment for maintenance.

5 Newsletter 61/4 shows how a simple length of unlagged pipe removed liquid from a sample line much more effectively than either of two elaborate scrubbing systems.

6 A control unit containing sparking electrical equipment was located in a Zone 2 area and was therefore swept with nitrogen to prevent flammable vapours diffusing into the unit. The nitrogen became contaminated with process materials, the nitrogen pressure was so low that air diffused into the unit and the low nitrogen pressure trip which should have isolated the power supply had been disarmed. As a result, an explosion occurred.

After the explosion the trip was improved and steps taken to reduce the chance that the nitrogen would be contaminated. However, if the control unit had been moved a few metres it would be in a safe area and the whole of the nitrogen sweeping and trip system could have been left off.

Safety Note 78/8 (copy on request) describes these and other examples in greater detail. Can you think of any other examples of plants which have been, or might be, made safer by simplifying them? If so, please let me know.

Next time someone suggests that the protective equipment is getting too complex, see if it is possible to remove the hazard by altering the process rather than by adding something on.

The cover shows part of the trip system necessary to prevent back-flow of a reaction mixture into a feed tank. A non-return valve is nowhere near reliable enough.

Can anyone devise an alternative, simpler but equally reliable system?

117/2 SOME QUESTIONS I AM OFTEN ASKED No 34

DOES ICI ADD ON MORE PROTECTIVE EQUIPMENT THAN OTHER COMPANIES?

The answer is yes. We do spend more than many other companies on gas detectors, emergency isolation valves, fire insulation, trip systems and so on and this costs real money.

But, in the long run we get this money back on a greater freedom from serious fires and explosions (see Newsletter 66/8).

Next time someone suggests copying another company by installing less protective equipment, it is fair to ask how their loss record compares with ours and if we would be satisfied with their record.

117/3 TEST LIQUID NITROGEN BEFORE OFF-LOADING

Newsletters 27/5 and 41/5 described occasions on which liquid air or oxygen have been supplied instead of liquid nitrogen and recommended that all liquid nitrogen should be analysed before it is off-loaded.

Another incident has now occurred; a load of liquid oxygen was delivered to the Division instead of liquid nitrogen. The mistake was discovered when the gas was fed to a small plant and a high oxygen concentration alarm operated.

The plant concerned normally analyse their regular deliveries of liquid nitrogen before off-loading, but did not analyse this special extra delivery.

This recent incident emphasises again the need to analyse liquid nitrogen before it is off-loaded.

117/4 THE CORRECT MATERIAL OF CONSTRUCTION WAS FORGOTTEN

A trip valve failed to close, causing a small fire. The trip is tested regularly. It was found that the spindle of the valve had broken, so that while the valve looked as if it was operating correctly, it was actually always open.

The fracture of the spindle was due to stress corrosion cracking, the result of making it from stainless steel instead of Incoloy 825. In 1967 a change from stainless steel to Incoloy 825 had been recommended for the valve and associated pipework. With the passage of time this recommendation had been forgotten.

Newsletters 60/1, 72/6, 101/1 and 111 (An Engineer's Casebook No. 11) described other incidents which occurred because knowledge or skills had become lost.

The valve which failed was of a rather uncommon type. The nose sits on a depression and the valve is closed by an upward movement of the spindle. If the spindle breaks, the valve remains open.

On new plants, most motor valves close by a *downward* movement of the spindle and remain closed if the spindle breaks.

Valves which close by an upward movement should not be used as trip valves. Organisations have no memory. Only people have memories and they move.

117/5 A FIRE IN A COOLING TOWER

Surprising though it may seem, cooling towers often catch fire, usually when they are out of use for maintenance.

For example, another company have reported a fire that occurred last year.

The forced draft fan support had to be repaired by welding. An iron sheet was put underneath to catch the sparks, but it was not big enough and some of the sparks fell into the tower and set alight the dried wood which caught fire very easily.

117/6 A LOOK BACK AT NEWSLETTER 17 (February l970)

Purging electrical equipment — air or nitrogen?

Electrical equipment for use in hazardous areas is sometimes purged with air or nitrogen. Which is best?

The purpose of the purge gas is to keep a slight pressure in the equipment and a slight flow of gas outwards so that any flammable gas or vapour outside cannot diffuse inside where it might meet sparking electrical equipment.

The advantage of nitrogen is that if the flow of purge gas fails, then air has to diffuse into the equipment as well as flammable gas, before an explosion can occur.

On the other hand, the pressure of the compressed air supply is usually much more reliable than that of the nitrogen supply and compressed air is much less likely to get contaminated with flammable materials. For these reasons I prefer air. (The only common flammable contaminant in air is oil mist, and this can be filtered out). Of course, if an instrument contains flammable materials *and* electrics in the same compartment nitrogen must be used.

Whether we use air or nitrogen there should always be an alarm to tell us if the supply fails and, if possible, a trip to shut-off the electricity.

If the volume to be purged is large and there is substantial leakage, then a low flow alarm is best. If the volume is small and substantially air-tight, then a low pressure alarm is best.

As mentioned in Item 117/1, the need for purging can sometimes be avoided by moving equipment to a safe area.

Don’t heat plastic pipes electrically

A small fire occurred on an electrically traced PVC line, as the result of an electrical short. The pipe melted and the solution inside it put out the fire.

Electric tracing of PVC pipes is not recommended.

Burnt toast — and oily rags

“A man once said he knew it was time to get up when he heard his wife scraping the burnt toast; and quite bitter he sounded when he said it, too. / know how he feels: it’s not the mistakes people make — it’s not even one’s own mistakes — that really get one down; it’s the fact that we go on making the same mistakes over and over again”~

Katherine Whitehorn wrote this in the *Observer* recently. I know just how the man feels. Most of the accidents described in these Newsletters have happened before.

I have in front of me a report on a fire which occurred because oily rags were left round a steam valve.

Perhaps some people do not know that oily rags or oil-soaked lagging left near a steam pipe will burst into flames. Although the oil may be high-boiling, it slowly decomposes under the action of the heat and forms products that catch fire easily.

Some years ago at Billingham some oily overalls were left in a locker. A steam pipe ran under the row of lockers, to keep the clothing dry. The heat was enough to set the oily overalls on fire and the whole roomful of lockers was destroyed.

117/7 ANOTHER ROAD TANKER TIPS UP

Newsletter 84/1 showed a road tanker which tipped up because the front compartments were filled first.

Another company have reported a similar incident, illustrated on page 5.

A load of sulphuric acid monohydrate was delivered and left standing in the tanker for a few days. The weather was very cold and some of the contents, freezing point 10^0C, crystallized, particularly at the front of the tanker which was exposed to a cold wind.

When the tanker was emptied it tipped up.

As stated in Newsletter 84/1 compartmented tankers should not be loaded or unloaded without a tractor unit in position or a portable frame underneath the front of the tanker.

117/8 UNUSUAL ACCIDENTS No 82

After having a bath a man covered himself with a body lotion. He got dressed and lit a cigarette and the vapour from the body lotion ignited and engulfed him in flames.

The bulk of the liquid in body lotions (and after-shave lotions) is alcohol or other flammable solvent. Normally only a small quantity is used. In this case the user covered his whole body, he was warm after his bath and this encouraged evaporation and he was in a confined space — a bathroom — where ventilation is poor.

Remember that cosmetics of this type give off flammable vapour.

From *Consumer Safety*, May 1978

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.

November 1978

The supplement to Newsletter 115, “How Strong is a Storage Tank” has been made into a set of slides and is included in a package of slides and notes “Hazard Workshop No 1”, available from the Institution of Chemical Engineers, 165-171 Railway Terrace, Rugby CV21 3HQ, price £50.

An Engineer's Casebook — No 17

REGISTRATION AND EXAMINATION OF PIPEWORK

This week has once again seen an enforced shut down of one of our major single stream plants when a leak developed on a blanked branch. A corrosive by-product of the main reaction had condensed in the cooler branch and over many years of operation had, at one place, gone right through the pipe wall thickness. Examination of branches in other places where conditions were similar revealed similar corrosion and a shutdown of several days is necessary for repairs.

There was a history of corrosion in the feed/product heat exchanger and attempts had been made to check the adjacent piping. Nothing had been found probably because the main pipe wall was above the critical temperature for deposition of the corrodent.

Whilst the inspection of pressure vessels is well ordered and regulated through the rules in the ICI Code Group B1.4, pipework often fails to get the attention it deserves. When the Code was revised in 1972 a new category, B8, was introduced to apply to selected pipework in known erosive/corrosive or high hazard service. There has been a reluctance to identify many systems in this category and few piping systems are registered on our plants. This may have been due to lack of guidance on registration and inspection methods.

Code B 1.4 is currently reprinting and includes additional guidance on the problem of piping. Section 3 has been expanded to include a separate section on the registration and classification of piping systems. This identifies the criteria for registration which is required when:-

(i) a system or part thereof is known or suspected to deteriorate from corrosion, erosion, fatigue or other factor

AND

(ii) is in such service, and location, that failure would give rise to an unacceptable situation.

The responsibility for registration lies with each Works; when taking action the inspection organisation and materials engineers will be able to offer advice and assistance.

Registration creates an inspection task and since the means and techniques available for this are in some cases different from those traditionally used for pressure vessels guidance is required. A new Section 14 has been written for this purpose and is in the revised edition now at the printers.

By the time this Safety Newsletter reaches you copies of the revised Code will have been issued. If you have not reviewed pipework on your plant by now and registered those systems as appropriate you should be doing so.

E H Frank

Reminder: Newsletters 99/5 and 84/2 described other incidents which occurred because water or corrosion products collected in dead-end pipes.

Photographs from Our Archives No.2

The picture shows the result of an explosion in the base of a flare stack in September 1966.

Air leaked into the stack through a large bolted joint. The flow of nitrogen into the stack was not measured and had been cut back virtually to zero to save nitrogen.

Stacks should be welded; we should not make bolted joints between large unmachined surfaces.

The atmosphere inside a stack should be analysed regularly for oxygen content. Large stacks should be fitted with oxygen analysers; small stacks should be analysed with a portable analyser.

There should be a continuous flow of gas, nitrogen if possible, up each stack to prevent air diffusing down and to sweep away any small leaks that occur. The flow should be measured.

These recommendations apply to vent stacks as well as flare stacks.

For further details see Loss Prevention Guide No 1, Engineering Specification PR 0311, Newsletters 72/3, 69/1, 47/5d, 45/6, 40/8, 14/5, 5/3 and 3/3 and Chemical Engineering Progress, June 1968, p49.