IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

SAFETY NEWSLETTER No.96

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96/1 The liquid in a tank was inhibited to prevent polymerisation. The vapour that condensed on the roof was not inhibited; it polymerised and nearly blocked the vent.

96/2 A bigger pump was connected to a tank. The vent size was not checked and the tank was sucked in.

96/3 Two filling hoses came adrift while road tankers were being filled — but the right equipment and prompt action prevented a fire.

96/4 More incidents caused by reverse flow.

96/5 Are you clear on the difference between an operability study (or Hazop) and a hazard analysis?

96/6 Poor instructions confused an operator.

96/7 Poor labelling confused an instrument man.

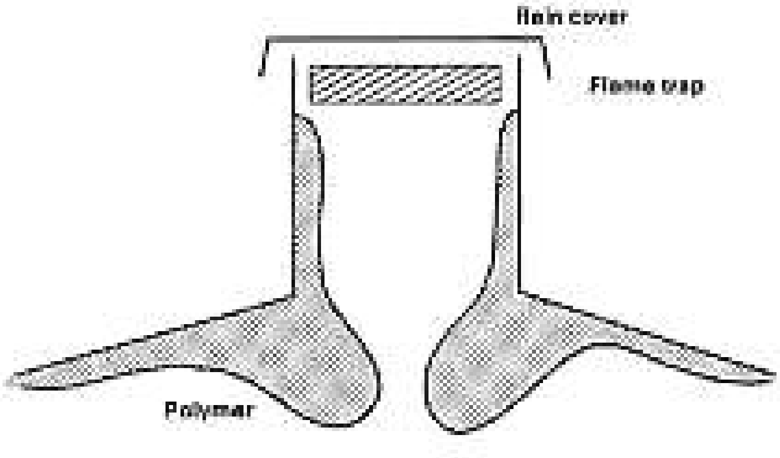
96/8 Poor design caused loss of sleep.

96/9 There are new papers on water sprays for gas dispersion, olefine plant safety and vapour cloud explosions.

Two of us checked the proof of the last Newsletter without noticing that item 95/3, summarised on the cover, did not appear inside. So we are just as prone to human error as everyone else. The missing item now appears as 96/4.

96/1 A NEW WAY TO SUCK IN A TANK

Previous Newsletters (78/8, 77/2, 47/5b, 42/1 and the supplement to 56) have described how tanks were sucked in or overpressured because the vents were choked. Another incident nearly occurred in the Division in a tank containing a hydrocarbon which is liable to polymerise and which is therefore always doped with an inhibitor. The hydrocarbon has a boiling point of 145° C and is stored at atmospheric temperature. When there is a fall in atmospheric temperature some vapour condenses on the roof of the tank; since the liquid formed in this way is not inhibited, it polymerises and a plug of polymer almost bridged across the bottom of the vent pipe as shown below.



The vent pipe is inspected regularly by removing the cover and flame trap and looking through the vent pipe to see that it is clear. The man doing this could not see the build-up of transparent polymer.

Now, as well as looking through the vent pipe, they push a wooden rod through it to make sure it is clear.

WARNING: If you do the same, make sure there is something on the end of the rod to prevent it falling into the tank.

The build-up of polymer was discovered when the plant manager, carrying out a personal inspection of the vents, noticed a thin coating of polymer on the inside of the vent pipe. He had the pipe removed for cleaning and the build-up was then discovered.

96/2 AN OLD WAY TO SUCK IN A TANK

A tank was fitted with a vent just big enough to cope with a pump-out rate of 30 m^3/hr. The tank was connected to another pump which had a capacity of 65 m^3/hr. Nobody checked that the vent size was still adequate and the tank was sucked in.

The operators were amazed that a 3 inch vent, fitted with a flame arrestor, was not big enough to prevent the tank being sucked in.

96/3 HOSE FAILURES DURING TANKER LOADING

Two incidents have occurred recently in the Division.

The first occurred while a road tanker was being filled with a light oil through a bottom connection. Three washers had been inserted in the screwed coupling to stop a slight leak with the result that only about 3/8 inch of screwed thread was available for use. In addition, the driver did not have the proper tool for tightening the hose connection. The hose was not held firmly on the tanker and a leak occurred.

The second incident occurred while a road tanker was being loaded with liquefied flammable gas. The female thread on the end of the hose was so badly worn that only about a third of the original depth remained. This was not enough to hold the hose firmly and when it got up to pressure it came off the tanker.

Fortunately the leak was soon stopped. The operator closed an emergency isolation valve on the inlet line to the hose and the non-return valve on the tanker prevented back flow. If these two safety devices had not been fitted the incident would have been a dangerous one.

The Works test hoses every six months. Now they inspect couplings as well.

If you load or offload liquefied gases on your Works, is there an emergency isolation valve at one end of the hose and a non-return valve at the other? Do you have a system for regular inspection of hoses and couplings?

While investigating the last incident another fault was found. The hose and the tanker have different threads and so an adaptor is used to join them together. The adaptor is normally kept permanently fixed on to the hose. It was found that the hose had a female British Standard Pipe thread, but the adaptor had a male US National Pipe Thread. Although these two threads are similar and can be screwed together, they are not exactly the same and will not give a sound joint.

Reminders:

A note dated 11 January 1973 described a number of incidents which have occurred because of confusion between imperial and metric threads.

Newsletter 28/3 described other leaks of liquefied gases which occurred because hoses were not fixed correctly.

Safety Note 70/15 compared excess flow valves and remotely operated isolation valves. The latter are preferred as excess flow valves operate only when the flow is much greater than normal.

96/4 MORE INCIDENTS CAUSED BY REVERSE FLOW

Newsletter 79/2 (and an article in Hydrocarbon Processing, March 1976, page 187) described a number of accidents caused by reverse flow. Here are two more, both from other companies.

1 **Reverse flow of catalyst**

Some gases reacted in the inlet line to a convertor. The pipeline got so hot that it swelled and burst. At the previous shutdown the reactor had been swept out with nitrogen in the opposite direction to the normal flow and some catalyst dust had been deposited in the inlet pipe.

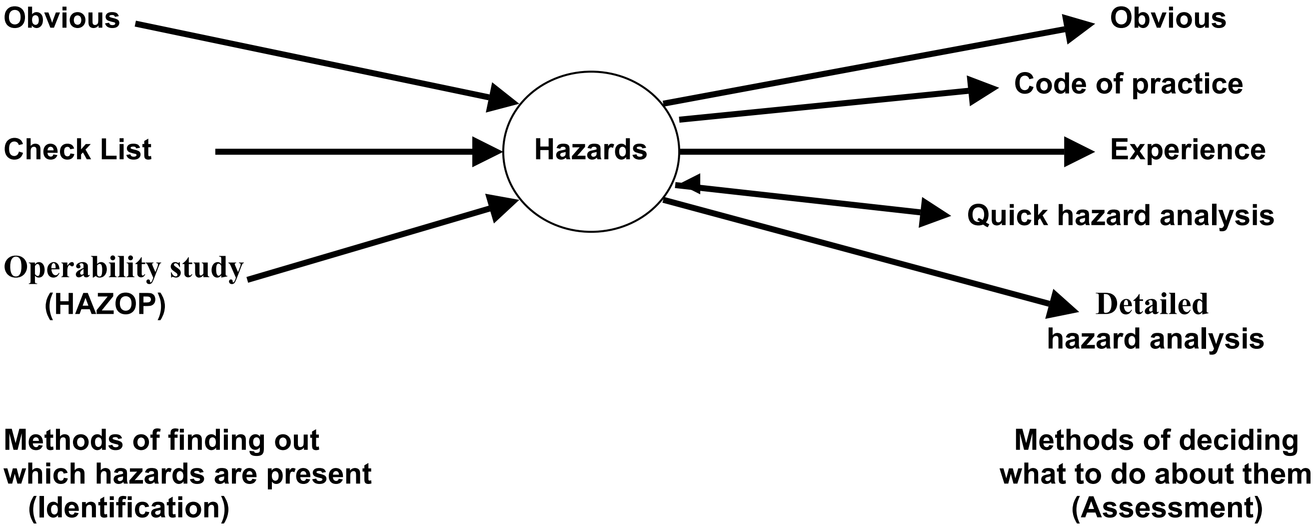
2 **Reverse flow through a pump**

The second incident was similar to the one described in Safety Newsletter 79/2c. Failure of a non-return valve caused gas at 25 bar to flow back up a liquid line when a pump stopped. This caused the pump and motor to rotate in the reverse direction at high speed. The motor was damaged beyond repair.

As stated in Newsletter 79/2, when failure of a non-return valve can have serious consequences, it should be registered for regular inspection. The use of two in series should be considered, preferably different types to avoid common mode failures.

27 - WHAT IS THE DIFFERENCE BETWEEN OPERABILITY STUDIES AND HAZARD ANALYSIS?

The diagram below may help to make the difference clear.



If we are designing a new plant or having a new look at an old one, we want to find out what hazards are present. Sometimes they are obvious. If we are mixing hydrocarbons and air it is obvious that if we mix them in the wrong proportions we may get an explosion. Sometimes we use a check-list; the disadvantage of a check-list, however, is that hazards which are not on the list do not get spotted. In an attempt to avoid this the list tends to get longer and longer and finally gets so long that people are reluctant to use it. We therefore prefer to use an “Operability study” or “Hazop”. This is a technique in which all the lines on a line diagram are gone through one at a time asking a series of questions such as:-

Could there be more flow than normal?

What could be the cause?

What would be the consequences?

How could they be prevented?

A simpler form for use on small plant modifications was described at the end of Newsletter 83.

After we have identified our problems we have to decide what to do about them. Is the hazard so great that it must be removed straight away, or is it so small and unlikely that we can ignore it?

Sometimes the answer is obvious; the hazard is cheap and easy to remove and so we simply get on with it. Sometimes we follow the advice given in a Code of Practice or do what experience has shown to be satisfactory. Sometimes we try to work out how often the hazard will occur, what its consequences will be and compare them with some sort of target in order to decide whether or not action is justified or whether it would be better to spend our time and money on bigger risks. This is called a “Hazard analysis”. It may be quite quick or long and detailed.

It is called “hazard analysis” rather than “hazard assessment” because an essential stage is splitting the events leading up to the hazards into their component stages and looking at each one separately.

If you want to find out more about operability studies and hazard analysis the following papers are recommended.

Operability Studies

1. "Operability Studies and Hazard Analysis", H G Lawley, Chemical Engineering Progress, Vol 70, No 4, April 1974, p 45.

2. "Size up Plant Hazards This Way", H G Lawley, Hydrocarbon Processing, Vol 55, No 4, April 1976, p 247.

3. "Introduction to Hazard and Operability Studies", A E Knowlton and D K Shipley, Report No HO/SD/760003/A, February 1976. This report deals particularly with small scale and batch plants.

4. "Seminar on Hazard and Operability Studies, June 1974", Process Safety Report No 2, Report No HO/SD/740009/2A, November 1976. The papers and discussion at the seminar are reproduced.

Hazard Analysis

5. "Hazard Analysis — A Quantitative Approach to Safety", TA Kletz, I Chem E Symposium Series No 34, 1971, p 75.

6. "The Application of Hazard Analysis to Risks to the Public at Large", T A Kletz, Proceedings of the Symposium on Chemical Engineering in a Changing World, Session A5 — Environment and Human Activities, July 1976.

7. "Risk Evaluation in Plant Design", TA Kletz, Proceedings of the Institute of Petroleum 1976 Annual Conference.

8. "Seminar on Evaluation of Risk, April 1975", Process Safety Report No 4, Report No HO/SD/740009/4A. The papers and discussion at the seminar are reproduced.

9. "Guide to Hazard Analysis", M R Gibson and C M Elton, Process Safety Guide No 4, Report No HO/SD/74001 0/4, August 1976.

Items 5 - 8 deal with the principles and philosophy of hazard analysis; item 9 is a guide for those who wish to carry out their own calculations.

Copies of reports can be obtained from Division Reports Centres. Copies of papers are available from us.

96/6 ANOTHER INCIDENT CAUSED BY POOR INSTRUCTIONS

A batch went wrong. Investigation showed that the operator had charged 104 kg of one constituent instead of 104 g (0.104 kg).

The instructions to the operator were set out as follows (the names of the ingredients being changed).

Blending Ingredients	**Quantity Tonnes**
Marmalade	3.75
Oxtail soup	0.250
Pepper	0.104 kg
Baked beans	0.020
Raspberry jam	0.006
TOTAL	4.026

With instructions like these it is very easy for the operator to get confused.

Fortunately, in this case the mistake had no serious consequences. Next time it might

What do the instructions on your plant look like?

Reminders: Newsletter 91/6 described incidents caused by poor design of a form.

Newsletter 94/4 compared good and bad lay-out of instructions.

96/7 HUMAN ERROR DURING ALARM TESTING

Alarm testing is usually considered less risky than trip testing but errors can occur.

Two furnaces are each fitted with a temperature recorder controller and high temperature alarm.

The two recorders are side by side on the instrument panel in the control room with the recorder for A furnace on the left.

An instrument artificer was asked to test the alarm on A furnace. He put the controller on manual and then went behind the panel.

The next step is to take the cover off a junction box, disconnect one of the leads, apply a gradually increasing potential from a potentiometer and note the reading at which the alarm sounds.

Behind the panel the junction boxes for A and B are in line with the recorders and therefore B is on the left.

The only label was very small and close to the floor so it was hardly readable.

The artificer, who had done the job many times before, took the cover off B junction box and disconnected one of the leads. The effect was the same as if the thermocouple had burnt out. The recorder registered a high temperature, the controller closed the fuel gas valve and the furnace tripped.

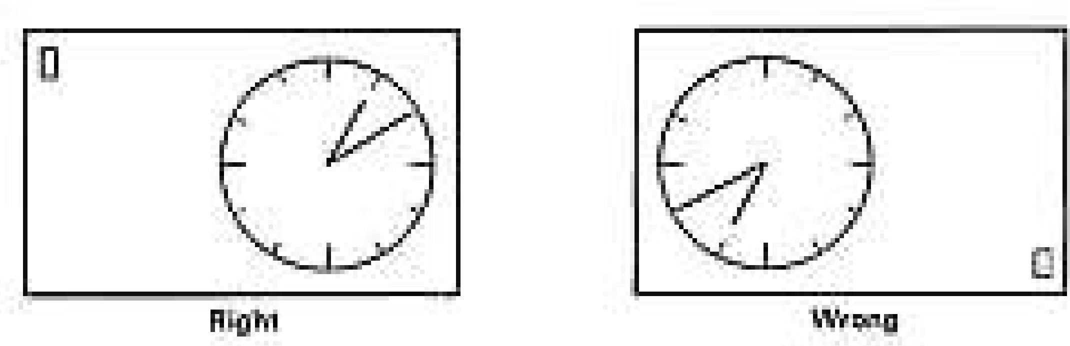
The two junction boxes should have been labelled A and B in large letters. [Note added later: Or. better, the connections used for testing could be on the fronts of the instruments.

96/8 UNUSUALACCIDENTS No 63— ANOTHER EXAMPLE OF HUMAN ERROR

Eileen Turner, (my secretary at the time. – TAK],

in an unusually houseproud mood, cleaned the bedroom before going early to bed one night. She woke the next morning at six o'clock and, finding she couldn't get back to sleep, decided to get up and wash her hair.

After showering, brushing her teeth and washing her hair, she went into the living room, where, after a few minutes, she noticed that the time by the rather old clock there was ten past one. The clock had obviously had its day and was going haywire but Eileen went to the bedroom to check. On first glance the time was twenty to seven but closer examination showed that the clock was upside down!



Eileen's chosen method of altering the 'work situation' is not to dust.

Reminder:

For other examples of human error see Newsletters 86 and 89/8.

96/9 RECENT PUBLICATIONS

(a) There is increasing interest in the use of water spray for dispersing leaks of flammable or toxic gas. Safety Note 77/2 describes some ICI installations, outlines a design method and suggests topics for further research,

(b) "Olefine Plant Safety Over the Last Fifteen Years" and "Unconfined Vapour Cloud Explosions - An Attempt to Quantify Some of the Factors Involved", two papers to be presented at the March Loss Prevention Symposium of the American Institute of Chemical Engineers.

(c) Safety Note 77/3 describes a new interim Division standard for the design of control buildings and other occupied buildings in plant areas.

For copies of these papers or for more information on any item in this Newsletter please 'phone E.T.(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.

February 1977

Who's Who in Safety?

No. 10 W G HIGH

Bill High was born in Barrow-in-Furness where he served an apprenticeship as a fitter in Vickers shipyard. He won the Vickers Group University Scholarship and graduated in mechanical engineering. He worked for several organisations, including a period at sea, before joining ICI in 1956. He has worked in a number of departments at both Billingham and Wilton and is now Carbonylation Section Engineer in Oil Works. While he was in Research Department a small reactor exploded and blew down the walls of a containing cubicle. Bill was asked to design a better one and this began an interest in explosions which he has kept up ever since. He is almost a part-time unpaid member of the Safety Group and spends a lot of his own time answering questions on explosion damage and giving advice.

His hobbies include mountaineering and sailing. He is married and has two young boys.