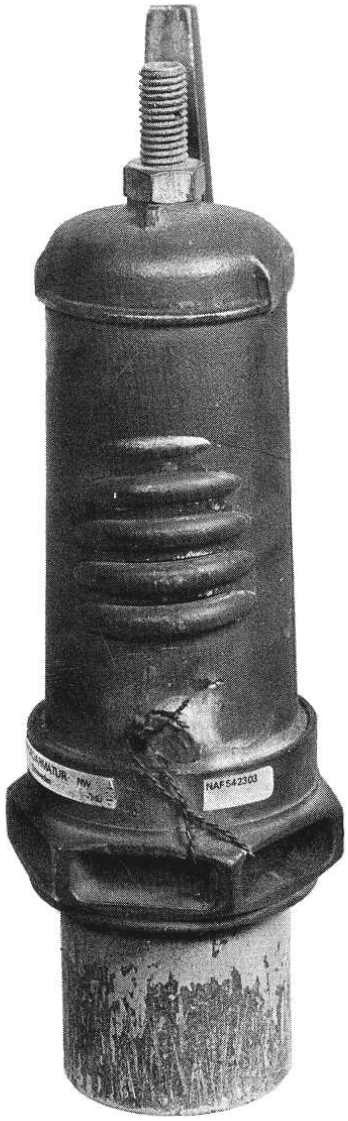
IMPERIAL CHEMICAL INDUSTRIES LIMITED
PETROCHEMICALS DIVISION

SAFETY NEWSLETTER No.75

75/1 DID YOU KNOW THIS COULD HAPPEN TO A RELIEF VALVE?

The photograph shows a relief valve in which the spring has vibrated its way through the body. This occurred (in another Division) because a relief valve, supplied with a compressor, was of an unsuitable type, vibrated excessively and was mounted horizontally.



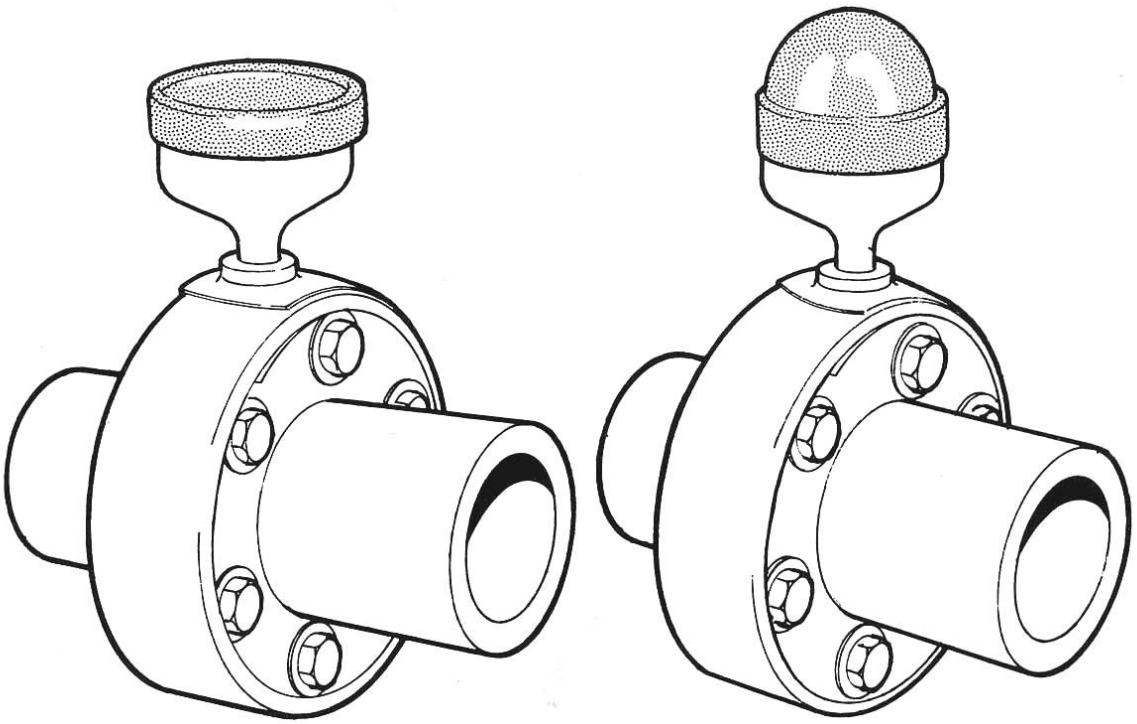
All relief valves should be mounted vertically and should be checked to make sure they are not subject to excessive vibration.

Particular care is needed with relief valves which are bought as part of a package, such as a compressor. These must be included in the relief valve register and checked to make sure that they conform with our engineering and process design standards.

Relief valves should also be mounted vertically for another reason — so that any condensation or dirt which collects in the branch has the maximum chance of falling out and not causing corrosion or choking of the branch.

75/2 DETECTION OF HYDROCARBON LEAKAGE FROM JOINTS

A method of detecting small leaks from joints was described in Safety Newsletter No 53/3. A silicone rubber band is strapped around the edge of the joint, and a small plastic funnel is inserted into a hole in the band. The top of the funnel is covered with a thin rubber diaphragm. Any escape of gas within the band causes the diaphragm to blow-out. The device is marketed by Martindale Protection Limited, Neasden Lane, London NW1 0 1 RN.



This method is effective only when dealing with non-condensable gases. Gases which condense create a vacuum inside the band and the rubber diaphragm is sucked in. As the rubber diaphragm is normally in this position, a leak is not obvious.

A highly effective procedure has, however, been developed for the detection of condensable hydrocarbons. A gas sample from the space contained by the silicone rubber band is sucked through a Draeger tube. The chemical in the tube discolours, giving a measure of the hydrocarbon concentration.

On one plant in the Division it has been shown that scores of small leaks are present during normal operation. When these leaks occur below the liquid level on a vessel, there is a significant risk that the leak will get worse. Tightening up the bolts usually stops the leaks.

In another variation of the method an instrument for measuring low concentrations of a toxic material is connected to the hole in the silicone rubber band.

75/3 ELECTRICALLY CONDUCTING POLYETHYLENE BINS

In a plant in another Division some crystals are drained in a vacuum filter and then transferred to polyethylene bins. The bins become charged with static electricity, and over a period of five years this caused three small fires. The hazard was overcome by using a new conducting grade of polyethylene containing 0.5% carbon.

For further details see the ICI Materials Handling Review for January/February 1975. More information about the conducting plastic can be obtained from Dr G Forsyth, Polyethylene Technical Service, Plastics Division, Welwyn Garden City.

75/4 QUICK RELEASE FITTINGS ON PRESSURE VESSELS—THE NEED FOR INTERLOCKS OR SELF-RELIEVING DEVICES

Newsletter 68/2 described two fatal accidents which occurred as a result of operators opening up vessels which were still under pressure.

Every day, in every works, equipment which has been under pressure is opened up but this is normally done under clearance — one man prepares the job and another opens up the vessel — and it is normally done by slackening bolts so that any pressure present will be detected — provided the joint/s broken in the correct way.

The two fatal accidents happened under unusual circumstances — when one man does the whole job —preparation and opening up — and uses a quick-release fitting instead of nuts and bolts.

Whenever this happens it is inevitable that sooner or later, through oversight or neglect, an attempt will be made to open the equipment while it is under pressure.

Therefore, whenever an operator has to open up equipment which has been under pressure either

(a) an interlock should be provided so that the vessel cannot be opened up until the vent valve is open.

or

(b) The design of the cover or lid should allow it to be raised about half an inch whilst still capable of carrying the full pressure and a separate operation should be required to release the cover fully. If the cover is released while the vessel is still under pressure, then this is immediately apparent and the pressure can blow off through the half-inch gap or the cover can be resealed.

Method (b) should always be used in stead of method (a) if the vent fine is liable to choke.

There are several mechanical devices which can be used to achieve (a) or (b), for example, the 'Bolt-lock' device patented by the Leeds and Bradford Boiler Company.

Mond Division have now patented an improvement on this device. It is called the Safebolt, and details can be obtained from Mr D A Beattie, Engineering Department, Mond Division, The Heath, Runcorn, Cheshire.

75/5 SOME CODES AND SIMILAR DOCUMENTS

Newsletter 73/1 explained that, under the new Health and Safety at Work Act, Codes of Practice will become more important. Some will be formally adopted by the Factory Inspectorate and will have the power of law. Industry will then have to follow these or another code which is as safe or safer. Factories may be licensed in a few years time, and the Inspectorate will probably want to see that they have been designed, and are operated, in accordance with recognised codes.

Some readers have therefore asked me to provide a list of codes with which they should be familiar.

A full list of all the codes which we use would fill a thick volume, but the following are some of the most important ICI and Division codes, using "code" in the sense used in the Health and Safety at Works Act to include "a standard, a specification and any other documentary form of practical guidance". In many cases, of course, we do not have our own codes but use the recognised British or American standards.

ICI Engineering Codes and Regulations

These are Company documents and most of them are available to the public from RoSPA. The most important are:-

Group B, volume 1 .4, "Registration and Periodic Inspection of Pressure Vessels".

Group C, volume 1 .5, "Electrical Installations in Flammable Atmospheres".

Group D, volume 1 .6, "Liquefied Flammable Gases — Storage and Handling".

ICI Process Safety Guides

These are a new series, and only one has so far been issued, “Emergency Isolation of Chemical Plant” (available from Division Reports Centres by asking for Report No HO/SD/740010/1). A second Guide on “Protection Against Excessive Temperature” will be issued soon.

These are called Guides because it is difficult to lay down definite rules, but all plants, new and old, should be reviewed in the light of the suggestions made in these guides.

Petrochemicals Division Production Codes of Practice

Those issued so far deal with modifications to piping systems, movement of cranes, preparation of equipment for maintenance, and emergency isolations. They have not been given a wide circulation because in each Works they will be incorporated in the Works Instructions. The last one is a summary of the Process Safety Guide mentioned above.

Petrochemicals Division Engineering Specifications

These take up 2 ft of shelf space. They are divided into volumes dealing with piping, machines, vessels, instruments, electrical, civil and projects. The last volume is of most general interest, particularly the following parts:-

PR	0301	Pressure Relief
PR	0310	Isolation of Equipment for Maintenance
PR	0311	Flare Systems
PR	0322	Gas Blanketing, Purging and Flame Arrestors.

The specifications can be obtained from Standards Section, Petrochemicals Division as complete volumes (except PR) or as individual specifications.

Petrochemicals Division Loss Prevention Guides

These summarise our recommendations on a variety of topics, and are available from us. The following is a list of titles

1	Pressure Relief
2	Hazard Analysis
3	Furnace Fires and Explosions
4	Vessel Entry Certificate
5	Non-Pressure Storage Tanks
6	Static Electricity Lightning and Stray Currents
7	Clearance Certificates (Permits-to-Work) and Isolation of Plant for Maintenance
8	Liquefied Flammable Gases—Safety in Plant Design and Operation
9	Thermal Radiation
10	Ignition Sources and Explosive Mixtures
11	Aluminium and Light Metals— Incendive Sparks
12	Electrical Area Classification
13	Flame Arrestors
14	Some Everyday Toxic Hazards
15	Portable Gas Cylinders
16	Electric Cables on Process Plants
17	Flexes and Hoses

18 Gas Detectors

19 Leaks

20 Breathing Apparatus

21 Reliability and Reliability Data

22 Explosions and Explosion Venting

23 Fire Extinguishers/Firefighting Media

24 A Guide to the Legal Responsibilities of Plant Managers and Engineers

25 Safety Aspects of Plant Layout

26 Dispersal of Flammable Gases and Vapours

27 Road Tanker Transport (Including Filling)

28 Alarms and Trips

Miscellaneous

To decide on the size of a relief valve, reference should be made to John Fitt's 1969 Report on "The Process Engineering of Pressure Relief and Blowdown Systems". This has now been published in the Proceedings of the Symposium on Loss Prevention and Safety Promotion in the Process Industries, held in Holland in 1974 (Elsevier Publishing Company).

If you are looking for a guide or "other documentary form of practical guidance", on any other aspect of safety, please write or telephone; we may be able to help you. If there is no code available, then perhaps we ought to be thinking about one.

75/6 SOME QUESTIONS I AM OFTEN ASKED

10—HOW OFTEN WILL AN OPERATOR ACT CORRECTLY WHEN AN ALARM SOUNDS?

In Safety Newsletter 66/3 I described a method for calculating how often somebody will press the wrong button and I described an accident that had occurred as a result of the wrong button being pressed.

I have often been asked how often we can expect an operator to act correctly when an alarm sounds. Suppose that when an alarm sounds he has to go outside and operate a valve. How often will he operate the wrong valve or fail to operate any valve at all?

There are no definite data available, but my feeling is that on the sort of plants we operate we should not expect the operator to act correctly more than 99 times out of 100; that is, once in 100 times he will either operate the wrong valve or operate no valve at all.

In some cases the operator's failure rate may be much higher. If he works in a busy control room with lots of alarms sounding, telephones ringing, people demanding clearances and so on, and in addition the layout of the valves is poor and action is required in a hurry, then he may fail to act correctly as often as one occasion in ten.

If these estimates are correct then we have got to take them into account in our designs. It is no use expecting people to do the right thing every time. We must expect an occasional mistake, sometimes it is 1 in 10 times, sometimes 1 in 100 times and sometimes 1 in 1000 times. Do you think these estimates are too high or too low? If so, I shall be glad to hear from you. I shall be particularly glad to hear from operators and from people who have been operators.

For some estimates of human failure rates, both those used in ICI and those used elsewhere, see Safety Note 74/7A — copy on request.

75/7 SURVIVAL

A fifteen-year-old boy survived alone for 4 days and nights on the Yorkshire Moors in February because he had the right protective clothing and equipment and used it intelligently.

Police Supt. John Edwards, who led the search, said John was an intelligent boy with initiative and pluck.

"He got lost, realised it but heeded his instructors. The book says when you are lost to stay put. The boy did that. He has survived because he played it by the book."

John was found 1,700 feet above sea level about four miles North-East of Grassington, where he was last seen on Sunday. He had hoped to link up with a weekend camping hike for fellow members of Barnsley mountaineering club.

John, who set off alone, took a wrong compass reading on a peak called Meugher. He wandered off and realised on Sunday lunchtime that he was lost.

To eke out his rations, packet soups, eggs and fruit juice; the boy carefully ate the least nutritious food first.

He had a stove and boiled water from ice scraped off his polythene survival sleeping bag, listened to his radio and, in case rescuers were close by, he shouted and used a whistle every hour.

From the Daily Telegraph, 14 February 1975

75/8 UNUSUAL ACCIDENTS No 45

The supplement to Occupational Safety and Health, August 73, points out that eye inflammation and lung damage has been caused by the use of computer paper tape punch waste as confetti.

75/9 RECENT PUBLICATIONS

(a) The third issue of the Loss Prevention Bulletin, published by the Institution of Chemical Engineers, describes a number of explosions which have been caused by the presence of impurities which have either acted as catalysts or reacted violently themselves. It also includes an account of some accidents which have occurred during entry to vessels and accounts of some incidents involving hydrogen sulphide.

(b) Newsletter 70/7(b) pointed out that Fire Research Note No 1003, available from the Fire Research Station, Borehamwood, Herts., shows that steel solvent cupboards give less protection than wooden cupboards. This Fire Research Note has now been re-numbered as No 998.

(c) A review of dust explosion test methods has been issued as Process Safety Report No 1 (available from Division Reports Centres by asking for Report No HO/SD/740009/1 A).

(d) Safety Note 75/3 summarises some published papers on the application of quantitative methods to safety problems.

For a copy of (d) or for more information on any item in this Newsletter please phone Mrs 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.

April 1975

SUPPLEMENT TO SAFETY NEWSLETTER No.75

The following is an extract from "Some Questions raised by a paper presented at the March 1975 Symposium on Loss Prevention held by the American Institute of Chemical Engineers. We can let you have a copy of the complete paper. **[This was one of the first papers published on inherently safer design.]**

CAN WE REDUCE PLANT INVENTORIES?

Generally speaking, in designing processes, we have accepted whatever inventory is called for by the design. If the material in the plant is hazardous we have tried to contain the hazard by good design and by the provision of control features such as emergency isolation valves, steam curtains, and so on. Rarely, if ever, have we asked if it is possible to reduce the inventory by changes in design.

Prevention of leaks by good design and operation should continue to be our main approach, but where the inventory can be reduced by changes in design without too much increase in cost, we should do so. There may be some pay-back in a reduced need for other safety equipment such as emergency isolation valves and steam curtains.

The following are some suggestions for further consideration. The inventories we wish to reduce are those of boiling or flashing liquids, and these occur mainly in distillation columns, refrigeration systems, heat transfer systems and reactors.

DISTILLATION COLUMNS

There is a large inventory of boiling liquid in the base and a larger inventory—typically several times more — is held up in the column. Should we make more use of packed columns or film trays which have a lower inventory per theoretical plate than other types of tray. The cost per theoretical tray is lower for a packed column. Film trays are more expensive per tray but this will be wholly or partially offset by reduced column height (Fig. 1).

Should we design distillation columns with a tall, thin base so that the base inventory is smaller but the bottoms pump still has a good suction head? Such columns have been built when the bottoms product was liable to degrade.

Can we place some of the peripheral equipment, such as reboilers, bottoms pumps and condensers inside the column, thus reducing inventories, saving space and piping and putting equipment in a place where leaks will not be hazardous?

Can we make more use of liquid/liquid extraction instead of distillation? Though inventories are large, the liquid is usually cold.

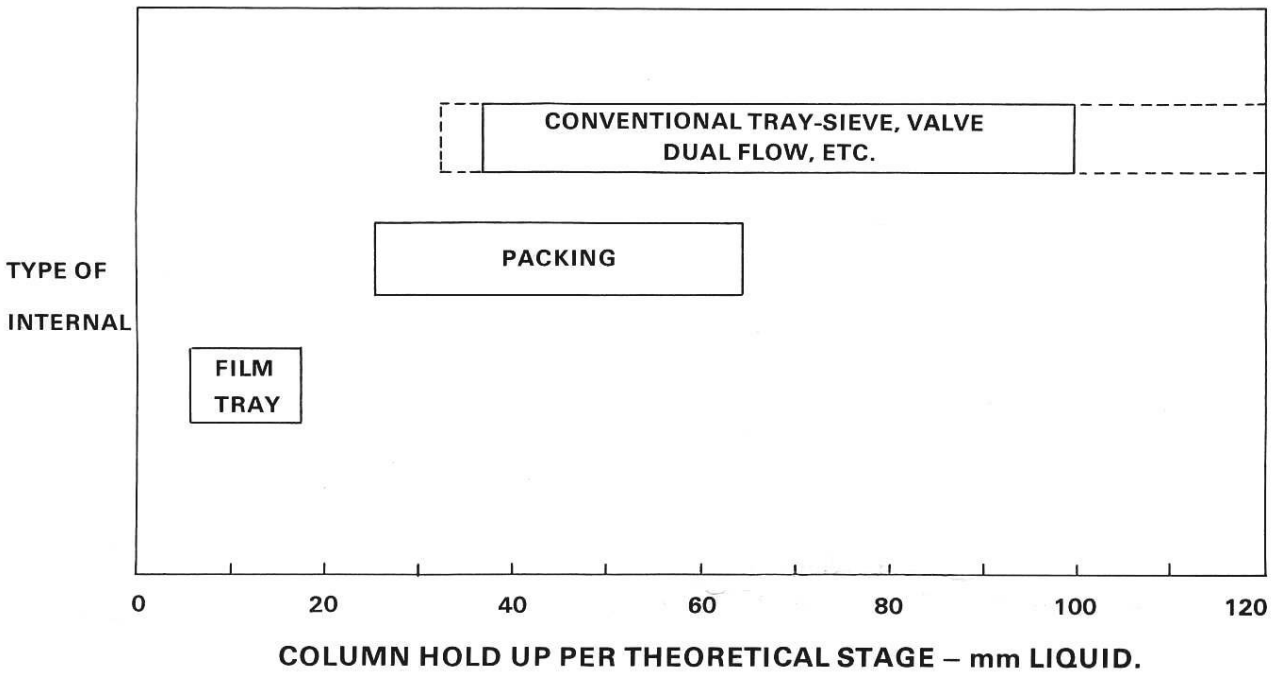
Can we make more use of low-inventory distillation processes such as the Luwa evaporator? Unfortunately it seems that the high energy costs may make them impracticable except for a few special cases.

REFRIGERATION SYSTEMS

Some plants, for example, olefine separation plants, contain large inventories of flammable refrigerants such as ethylene and propylene. The advantages of these materials as regards both availability and physical properties are so overwhelming that other, nonflammable materials seem to be ruled out Ammonia has occasionally been used instead of propylene, but, while difficult to ignite, it is highly toxic and on balance no safer. Carbon dioxide has been used on occasion as a direct refrigerant, but little information seems to be available. Perhaps someone has some new ideas to offer.

Continued on page 9

FIG. 1: COLUMN HOLD UP.



HEAT TRANSFER SYSTEMS

In many plants the biggest inventory of flashing liquids is in the heat transfer system. Many ethylene oxide plants, for example, contain a large quantity of boiling kerosene under pressure. The hazard of mixing ethylene and oxygen can be kept under rigid control and the kerosene is probably more hazardous now than the ethylene/oxygen mixture.

Have process engineers given sufficient consideration to non-flammable heat transfer fluids, including water, or to higher boiling fluids?

REACTORS

If a reaction is slow, the plant usually contains a large inventory of material. If conversion is low, a large quantity has to be recycled. Research workers in the past have tended to accept whatever inventory the process required and have not made a low inventory one of their objectives.

In contrast, the modern nitroglycerine and black powder processes contain very small inventories.

Is it possible to develop more gaseous phase processes, where leaks will be in the form of gas or vapour, or more processes using tubular reactors, where the maximum leak is limited by the size of the tube?

The question is not simply how much extra cost would we pay for a gas phase or tubular reactor, but rather in what direction should research be directed in its early stages, and when should it stop? There should be no absolute bar on high inventory processes, but we would like research workers to put low inventories among their aims.

So often we keep a lion, and build a strong cage to keep it in. Our cages are usually very strong, and only rarely, as at Flixborough, does the lion break loose. I am sure that by good design and operation we can make the chance of it breaking loose acceptably low. But before we keep a lion, we should perhaps ask if a lamb will do instead.

April 1975