IMPERIAL CHEMICAL INDUSTRIES LIMITED
PETROCHEMICALS DIVISION

SAFETY NEWSLETTER No. 71

71/1 A CLEARANCE WAS LOCKED UP AND A PLANT PUT BACK ON LINE BEFORE THE CLEARANCE WAS HANDED BACK

A manhole cover was removed from a reactor so that some extra catalyst could be put in. After the cover had been removed, it was found that the riggers would not be available until the next day so it was decided to replace the manhole cover and regenerate the catalyst overnight.

By this time it was evening and the maintenance supervisor had gone home and left the clearance certificate (permit-to-work) in his office, which was locked. The reactor was therefore boxed up and catalyst regeneration carried out with the clearance still in force.

The next day a fitter, armed with the clearance certificate, proceeded to remove the manhole cover again, and while doing so was drenched with process liquid. Fortunately, the liquid was mostly water and he was not injured.

The reactor should not have been boxed up and put on line until the original clearance had been handed back. If it was locked up, then either the maintenance supervisor should have been called in or his office should have been broken open. Except in an emergency, plant operations should never be carried out while a clearance is in force on the equipment concerned.

71/2 "THERE IS NOTHING WRONG WITH THE DESIGN—THE EQUIPMENT WASN'T ASSEMBLED CORRECTLY"

How often have we heard this said, by a designer, after a piece of equipment has failed?

The designer is usually correct, but some designs are easier to assemble than others, or are less likely to fail if they are assembled incorrectly they have more tolerance. Whenever we can, we should use equipment which does not demand the highest standards of workmanship during installation. Here are some examples:-

Screwed joints such as Ermeto couplings are satisfactory if they are assembled correctly, but it is very easy to use the wrong sort of ring or make some other error on installation; many accidents have occurred as a result. We therefore prefer flanged or welded joints except for small-bore lines carrying non-hazardous materials.

Loose-backing flanges require much more care during joint making than fixed flanges. Fixed flanges are therefore preferred.

Bellows require great care during installation as they cannot withstand any sideways thrust. With hazardous materials we therefore prefer fixed pipes, using U-bends if necessary to provide flexibility for expansion.

On many reciprocating compressors it is possible to interchange the suction and delivery valves. This has caused valves to be forcibly ejected from a compressor. Petrochemicals Division requires suction and delivery valves to be designed so that they are not interchangeable.

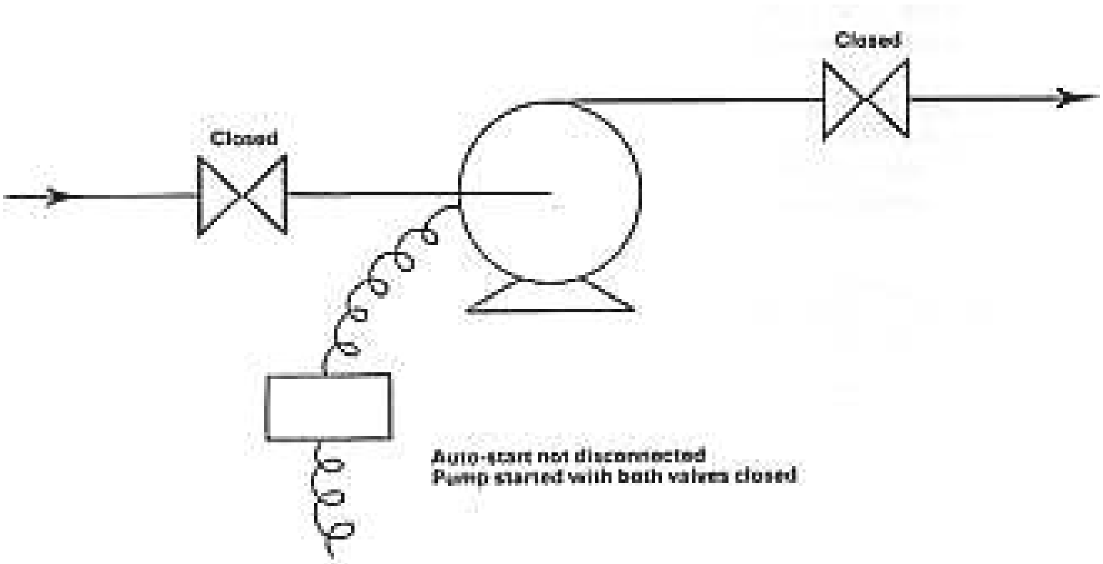
71/3 A PUMP STARTS AUTOMATICALLY WITH SUCTION AND DELIVERY VALVES CLOSED

Some pumps are wired up so that they start automatically if another pump fails. One of these pumps had to be taken out of use. The suction and delivery valves were closed but the auto-start was not disconnected.

When the running pump stopped, the spare pump started automatically. It got very hot and a hole appeared in the pump casing.

Could this happen on your plant?

Are you sure you know which pumps are fitted with auto-start facilities?



71/4 AIR COOLER FANS SHOULD BE PREVENTED FROM MOVING WHILE MAINTENANCE WORK IS IN PROGRESS

Newsletter 68/4 reported that a number of fires on air coolers have been made worse by the draught produced by the fans. The stop buttons for the fans should therefore be located some distance away so that they can be operated during a fire. There must also be local stop buttons as required by the Factories Act (Section 1 3).

The same Company have now reported another hazard with air coolers. Even when the fan motor is isolated, natural air currents can cause the fan blades to rotate. The fan blades should therefore be prevented from moving before any maintenance work is carried out on the equipment.

71/5 FIRE HAZARDS FROM ELECTRIC AND INSTRUMENT CABLES

Newsletter 61/ga drew attention to a recent Company report, No HO/ENS/730,O1O/A, which describes methods for protecting cables so that they are not damaged by a small fire, thus causing a long and expensive shut-down.

A report from another Division draws attention to another hazard with cables. A fire spread through walls and ceilings via cabling slots. These slots should be sealed. The cost will be small and will hinder the spread of fire.

71/6 MAKE SURE YOU USE THE RIGHT MATERIALS OF CONSTRUCTION

The following appeared in Newsletter 34/4 in November 1971.

Several recent incidents have shown what can happen if the wrong material of construction is used.

The most spectacular incident occurred in another Company. The exit pipe from the synthesis converter on an ammonia plant was supposed to be made of ½ % Mo steel. Ordinary carbon steel was used instead. As would be expected it suffered hydrogen attack; the pipe broke and the reaction forces caused the converter to fall over.

As a result of this incident much of the equipment on critical duties in the Division is being checked to see it is made of the right materials.

The second incident occurred in the Division. A mild steel bolt was used instead of a stainless steel one to secure a flanged joint on a stainless steel line. The bolt corroded and the joint leaked.

In the third incident a titanium flange was fitted by mistake on a line carrying dry chlorine. The titanium caught fire.

The fourth incident occurred in another Company. A line was made of the wrong material and it corroded so much that when an ultra-sonic probe was being used to test its thickness, the probe was pushed right through the metal.

What methods do you use to make sure the right materials of construction are used?

The checking referred to in the second paragraph above disclosed that on many plants the wrong grade of steel had been used. On one plant a complete section of 12 inch line had to be replaced because it had been made from carbon steel instead of ½ % Mo and 50 large welds had to be remade because the incorrect weld material had been used for the root run. This caused a four week shutdown.

On another plant a supervisor noticed that '321' was marked on a pipe which should have been made from 316L steel. His alertness prevented a serious failure.

As a result of these incidents Petrochemicals Division Engineering Department issued the following instruction in December 1973.

All isometrics, pipe sketches, or individual lines on general arrangement drawings covering high hazard pipelines should be endorsed in bold characters:

METASCOP CHECK AFTER ERECTION

It is an Engineering Department responsibility to identify high hazard pipe-lines on new projects and a Works responsibility on maintenance, and modifications which they engineer themselves.

The lines which are classified high hazard are as follows:

1 All ferritic alloy lines (because carbon steel, which is the most likely material to be wrongly included, will fall).

2 Most austenitic stainless steel lines where the duty is not simply anti-contamination or low temperature suitability. (It will be essential to know that the material is austenitic and that, for example it contains molybdenum when specified, though, as noted above, this may not be sufficient).

3 Carbon steel pipelines on specific duties involving flammable or toxic fluids or potential serious production loss, for example,

Liquefied ammonia

Liquefied petroleum gas

Very high pressure steam etc.

The purpose of checking is mainly to ensure that, for example, low alloy components do not become incorporated into carbon steel lines as these might crack if welded by procedures appropriate to carbon steel.

The METASCOP is a portable spectrographic analyser. A small electric arc is used to excite the metal so that it emits light. Each metal emits light of a different wavelength and in this way the metals present can be identified. The amount present can be estimated from the brightness.

Do not assume that the tubing in store is always correctly labelled. It may not be though the stocks at Wilton are being checked and the labelling is better than in the past.

Metascop testing is carried out at Wilton and Billingham by the Non-Destructive Testing (NDT) Sections.

71/7 MODIFICATIONS TO PLANT EQUIPMENT CAN INTRODUCE HAZARDS

Several recent Newsletters have shown how plant modifications can introduce hazards which were not foreseen at the time:

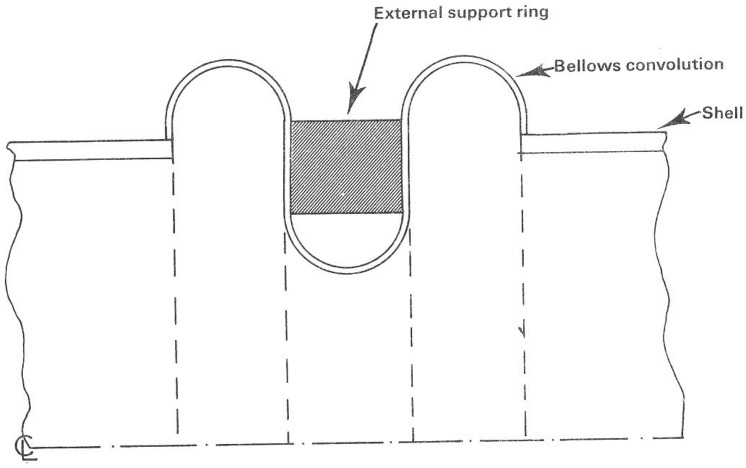
Newsletter 65/2 described two modifications made to new plants, both of which resulted in serious fires.

Newsletter 63/2 described how a minor modification, probably authorised by a foreman's chit, introduced a hazard that led to a small fire a sub-standard valve was installed as a drain point on a butene line.

Newsletter 49/1 described a simple modification to a plant that had been operating safely for thirty years. As a result a man wearing breathing apparatus got a face full of water.

Two more incidents are described in *ICI Engineering News* for August 1974 (Report No. A.128,120/74/8). In the first incident a plant engineer decided that Belleville washers were needed to give additional flexibility to a bolted joint. (Belleville washers are dished washers. They become flatter when compressed). He selected the washers from a manufacturer's catalogue. This could have been more disastrous than having no spring washers at all since experience has shown that proprietary Belleville washers, even from a reputable supplier, are rarely suitable and are very prone to failure. Each application requires washers designed to suit the conditions.

The second incident occurred on a heat exchanger bellows which was supplied with an external support ring to give support to the convolutions against internal pressure while allowing the bellows to expand with rise in temperature. The support ring was removed and as a result the bellows became deformed. Fortunately, this was observed before serious fatigue failure occurred. Manufactured equipment should never be modified without first taking expert advice. In cases like those described advice can be obtained, on Teesside, from Stress Analysis Section or Petrochemicals Division Engineering Department.



71/8 OPERABILITY STUDIES AND HAZARD ANALYSES

These two very different techniques are sometimes confused.

An *operability study* (sometimes called a hazard and operability study — but we prefer the shorter name) is a technique for identifying hazards by systematically examining a line diagram, line by line, using a series of guide words, such as 'none', 'more of', 'less of', 'part of' and so on. For example, 'none' applied to a pipeline suggests no flow. The possible causes and consequences are worked out and any action required is decided. There is a good description of an operability study in an article by Bert Lawley in *Chemical Engineering Progress*, April 1974, page 45. We can let you have a copy. Report No HO/SD/740,009/2A, available from Division Reports Centres, gives the papers presented at a Company seminar on operability studies held in June 1974, together with a report of the discussion.

When a problem has been identified by means of an operability study or in some other way, we have to decide whether it is big enough to justify a change in the plant or if it is so small that it can be ignored. Often the answer is obvious, but sometimes it is necessary to work out the size of the problem. How often will the event occur and how serious will the consequences be? This is called *hazard analysis* and there is also an example of this in the paper by Bert Lawley. A Company seminar on hazard analysis will be held in April 1975.

71/9 SOME QUESTIONS I AM OFTEN ASKED

6—WHO SHOULD TAKE DECISIONS ON SAFETY MATTERS - THE MANAGER OR THESAFETY OFFICER?

The manager must always have the final say. He is responsible for running the plant and for the safety of the men on the plant.

But the safety officer can help the manager to come to the right decision and safety officers, like other advisers, differ in the amount of responsibility they carry.

At one extreme is the safety officer who merely gives the manager the information on which to make a decision. His influence on the final decision is *remote.*

Then there is the safety officer who displays the alternatives clearly to the manager and sets out the advantages and disadvantages of each. He *contributes* to the final decision.

Finally there is the safety officer who says clearly what he thinks should be done, urges the manager to do it and is prepared to take the responsibility if things go wrong. He *shares* the decision making with the manager and his salary should be comparable with the manager's (though sometimes it is not).

Every safety officer (and every other adviser) has to decide for himself where he stands but I hope that many will try to *share* the responsibility.

71/10 UNUSUAL ACCIDENTS NO 41 — A TANK RISES OUT OF THE GROUND

Workers in a factory in Worley had a surprise last February when a 60 m^3 underground propane tank rose ten feet out of the ground.

The tank had been installed five years before in a concrete pit. The pit was then filled with sand and a six inch layer of concrete put over the top.

Water accumulated in the pit and the buoyancy of the tank was sufficient to break the holding down bolts and push it through the concrete covering.

The tank and pipework did not leak.

A sump had been provided in the pit for removal of water but either the pump out-line had become blocked or pumping had not been carried out regularly.

From "IP Safety News No. 6' Petroleum Review, October 1974, page 683

In ICI we do not like underground tanks as the outside cannot be inspected. Before you install one, consult your Division inspection service.

71/11 RECENT PUBLICATION

Safety Note 74/8A presents revised methods of calculating the extent of the flammable gas clouds which result from leaks on equipment.

For copies of this note or for more information on any item in this Newsletter, please write to E.T at Wilton or phone ext P2845. 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.

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Are safety valves old-hat?

T. A. KLETZ*

The installation of relief valves on steam boilers and pressure vessels is the accepted practice and, in some cases is compulsory but as plants get bigger the cost of relief valves and of the associated flare or absorption systems gets higher. There is therefore increasing interest in ways of avoiding their use. One method is to use stronger vessels, another is to use a high pressure trip to isolate the source of pressure. It is quite simple to design a trip with a reliability as good as or better than a relief valve

THERE WERE MANY EXPLOSIONS on steam boilers and air receivers during the 19th century, many of them due to the lack of a relief valve, to the setting on a relief being raised too high, or to lack of maintenance of a relief valve. The installation of adequate relief valves (or other relief devices such as bursting discs) on steam boilers, steam receivers and air receivers was therefore made compulsory in the UK and many other countries, and the laws also insisted on regular maintenance and testing.
In some countries, though not in the UK, these laws were extended to all pressure vessels. In the UK the Chemical Works Regulations (1922) require all vessels "in which the pressure is liable to rise to a dangerous degree" to be fitted with relief devices, but these Regulations apply to only a small part of the chemical industry.

For many years it has been the universal practice to fit relief devices on all pressure vessels and this is required by the various national pressure vessel codes. However, as plant and equipment get bigger the cost of providing relief devices rises. Relief valves are not so expensive in themselves but, if flammable materials are being handled, they may give rise to the need for flare systems which are expensive, sterilize a lot of ground and give rise to complaints about the noise and light. If toxic materials are being handled the relief valve discharge may have to pass through a scrubbing system. There is therefore increasing interest in ways of avoiding the need to use relief valves.

There is a feeling that relief valves, together with their downstream equipment, are becoming the dinosaurs of the chemical industry. This is no reflection on the quality of the relief valves they are some of the most reliable and well-engineered equipment we have. The problem is dealing with the material that comes out of the relief valve's tail-pipe.

One method of avoiding the use of relief devices is by the use of stronger vessels. For example, if a distillation column is heated by steam, the size of the relief valve is usually determined by assuming that there is a loss of cooling water to the condenser or a loss of reflux but the heat input continues. This usually calls for a large relief valve. If the column can be made strong enough to withstand the vapour pressure of the contents at the temperature of the steam there is no need for a relief valve to cover these requirements, only a smaller fire relief valve will be needed.
In other cases the need for a large relief valve can be avoided by making a vessel strong enough to withstand the maximum upstream pressure that can be applied when all outlets from the vessel are shut off. Technically, strengthening a vessel presents no problem and calculations often show that it is cheaper to build stronger vessels than install a large flare or scrubbing system. The difficulties are logistic. Vessels are usually ordered during the early stages of a project, while the relief valve review comes later. By the time it is realized that a stronger vessel would avoid the need for a relief valve, it may be too late to increase the strength of the vessel.
Of course, while increasing the strength of a vessel may avoid the need for a process relief valve, if flammable materials are handled on the plant a fire relief valve will still be necessary. However, fire relief valves can usually discharge to atmosphere if there is a fire raging under the vessel it does not matter if another flame appears on the end of the relief valve tail pipe provided it does not impinge on other equipment and the cost and inconvenience of a flare system is then avoided.
In practice, the most economic solution may not be to make all vessels stronger, but to strengthen one or two vessels with large relief requirements and thus reduce the flare system size.

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This is the first page of a recent article
We can let you have a copy of the complete article.