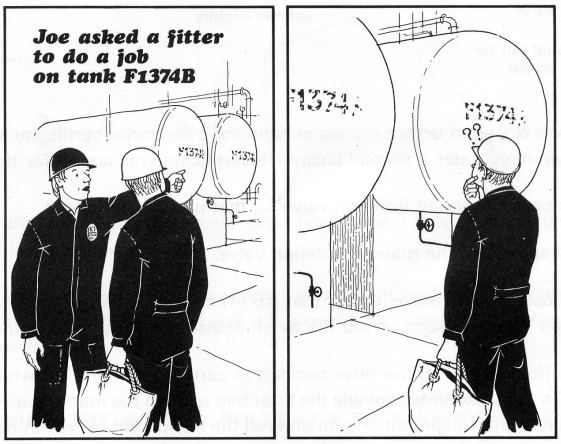
SAFETY NEWSLETTER

No. 146
MAINTENANCE MISUNDERSTANDINGS



146/1 Two jobs done without adequate isolation

146/2 Removal of an isolation caused a spillage

146/3 Removal of the wrong bolts caused an explosion

146/4 Poor labelling caused another incident

146/5 Carry-over damaged a compressor — many times in 8 years

146/6 Spare pumps which start automatically — How reliable?
A drastic cure for accidents

146/7 Can we use robots for hazardous jobs?

146/8 They used to blame the engineer

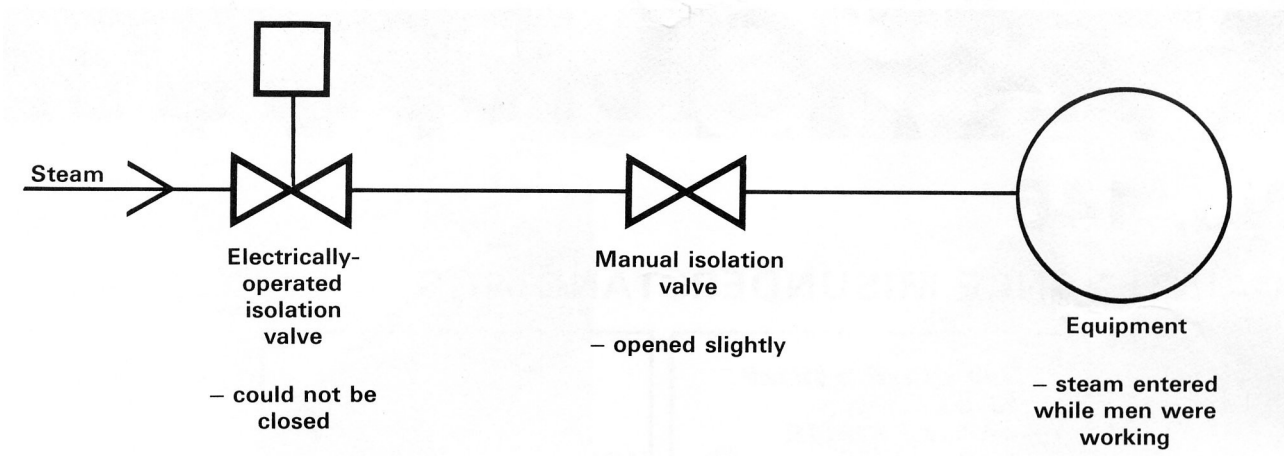
An Engineer's Casebook — Labyrinth seals

Photographs from our Archives — A poor weld

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

146/1 TWO JOBS DONE WITHOUT ADEQUATE ISOLATION



The manual valve was closed to isolate the equipment and a clearance certificate issued for work to be done on the equipment. Later a second clearance certificate was issued for two jobs:

(1) Repair the electrically operated isolation valve so that it could be closed.

(2) Fit an extended spindle to the manual isolation valve.

The clearance certificate did not make it clear that job (1) should be completed and the electrically-operated valve closed before starting on job (2), as otherwise the equipment would not be isolated.

Job (1) required scaffolding and so the fitter decided to carry on with job (2) while the scaffolding was being erected. To fit the extended spindle the fitter had to open the manual valve slightly and this defeated the isolation of the equipment. Steam entered the equipment on which men were working.

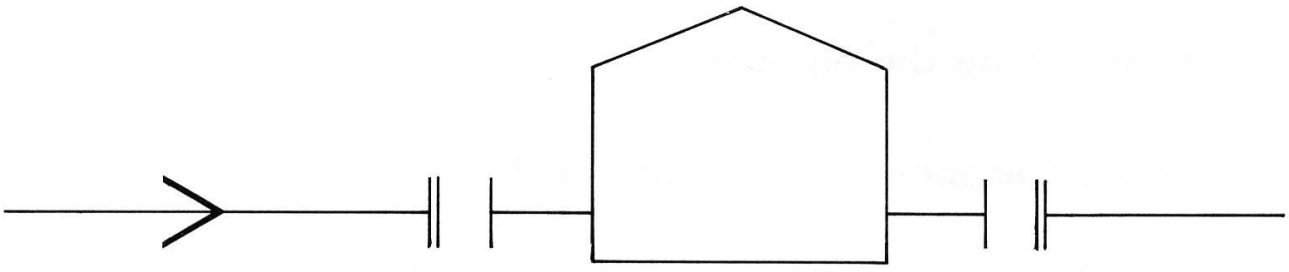
Three clearances should have been issued — the first for the repair of the electrically-operated valve.

When this job was complete and handed back, a second clearance should have been issued for the modification of the manual valve.

When this was complete and handed back, a third clearance should have been issued for the work on the equipment, a job that would normally be done under double isolation.

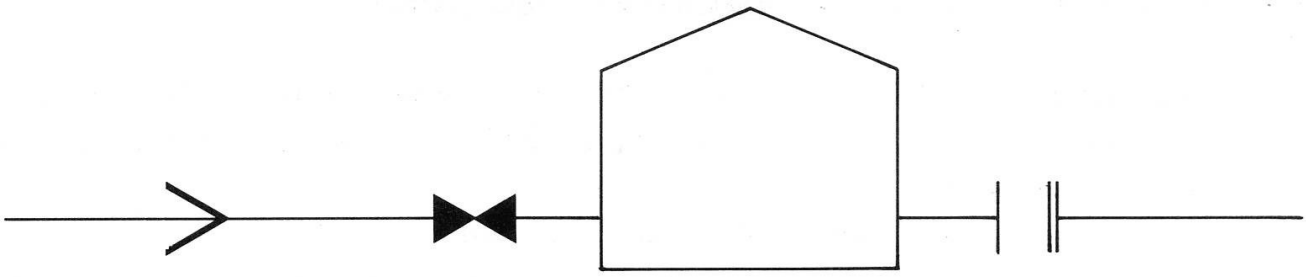
146/2 REMOVAL OF AN ISOLATION CAUSED A SPILLAGE

A tank was taken out of service for extensive repairs and was disconnected by removal of the inlet and exit valves.

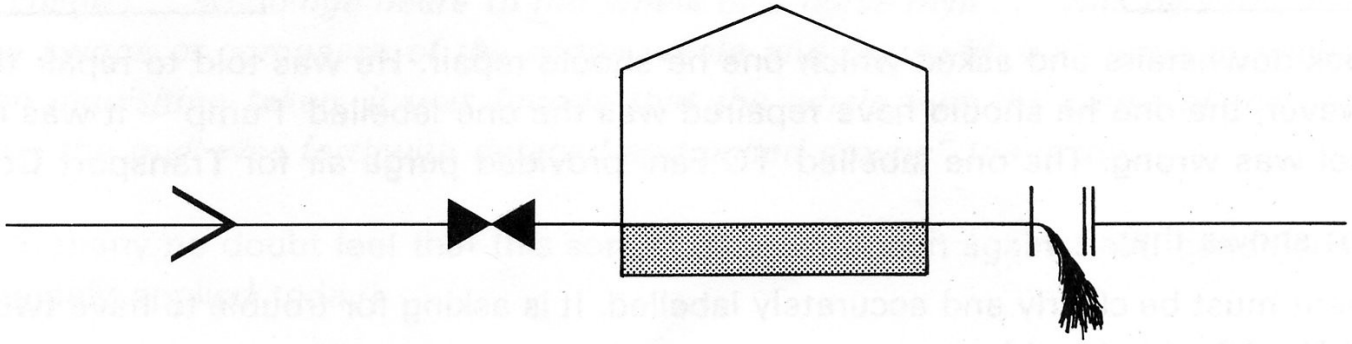


When repairs were complete, a separate clearance certificate, to replace the valves, was issued. The

inlet valve was replaced but the exit valve could not be replaced immediately as the type required was not in stock.



The inlet valve was left slightly open or was leaking. When the inlet line was in use, *a month later*, for a movement to another tank, product entered the tank and ran out of the open end. Five tonnes were spilt and although it was recovered from the tank compound, it was fit for use only as fuel oil.



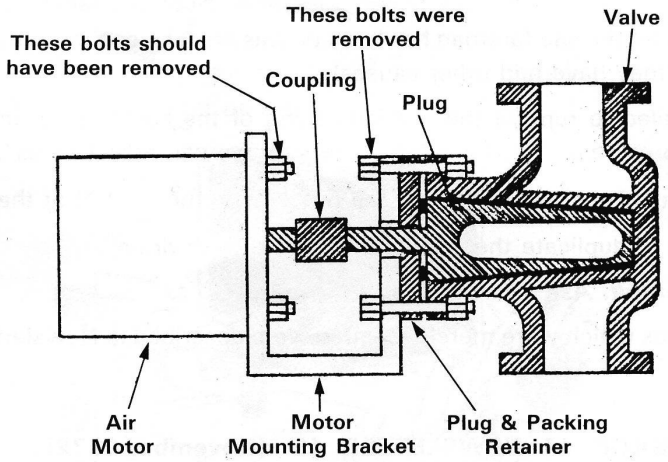
The inlet line to the tank should have been slip-plated once it was realised that the exit valve could not be replaced immediately.

The clearance certificate expired, as usual, after a week but was simply allowed to lapse. It should have been handed back and signed off and this would have drawn attention to the fact that the job was only half complete.

146/3 REMOVING THE WRONG BOLTS LED TO A VAPOUR CLOUD EXPLOSION

A remotely operated valve, in another Company, was used to isolate equipment which was under maintenance. To make sure the valve was not opened at the wrong time, it was decided to remove the compressed air motor that operated the valve — the usual procedure.

Unfortunately the men removing the motor removed the bolts holding the valve plug in place instead of the bolts holding the motor. The plug blew out and propylene at 150 psig escaped. The cloud of vapour exploded, killing 6 men and causing extensive damage.



If the valve closes on an air failure then it would have been sufficient to have disconnected the air line. If, however, it opens on air failure, removal of the motor is necessary.

A similar incident was described in Newsletter 139/4 while Newsletter 122 described some other accidents which occurred because the people concerned did not understand how things worked.

146/4 POOR LABELLING CAUSED ANOTHER INCIDENT

A filter was given a clearance certificate to repair a fan which blows air into a storage vessel. The fan was isolated and the fuses withdrawn. On the clearance certificate, the section headed “Equipment” was filled in as follows:

No 16 Silo purge air fan

The fitter went up two floors to the place where the fan was located and found two similar fans side by side. They were labelled:

No 16 Purge Pump	and	No 16 TC Fan

He went back downstairs and asked which one he should repair. He was told to repair the Fan. He did so. However, the one he should have repaired was the one labelled ‘Pump’ — it was really a fan and the label was wrong. The one labelled ‘TC Fan’ provided purge air for **T**ransport **C**ontainers.

This incident shows that:

1 Equipment must be clearly and accurately labelled. It is asking for trouble to have two fans both labelled No 16, side-by-side.

2 The process and maintenance supervisors should have visited the job and one of the process team should have gone to the job with the fitter.

3 When the fitter came down to say he was unsure which fan he should work on, one of the process team should have gone back with him.

A similar incident was described in Newsletter 134/1.

146/5 LIQUID CARRY-OVER DAMAGED A COMPRESSOR - MANY TIMES IN 8 YEARS

A report on the incident includes the following:

“Besides taking gas from the first stage, the second stage draws gas from a flash drum. The level in this flash drum is not adequately controlled and, if the level alarm fails to operate or the operator fails to react to it sufficiently quickly, liquid carry-over occurs, followed by a catastrophic failure of the compressor”.

“In the eight years that the site foreman has been on this area, he can remember about 16 failures of this type”. (Some may have had other causes).

“We have so far failed to rupture the outside casing of the compressor and cause a major leak. However, if we go on trying hard enough, I am sure we can achieve this”.

“Urgent action should be made to correct the problem of the control of the liquid level”.

It has been decided to duplicate the level alarm on the flash drum.

Don’t just repair a fault. Ask what caused it.

Other repeated failures which were merely repaired were described in Newsletters 51/8 and 37/8.

146/6 A LOOK BACK AT NEWSLETTER 46 (November 1972)

Spare pumps which start automatically — How reliable?

A report from one of the oil companies describes two dangerous incidents which occurred because spare pumps, which are supposed to start up automatically when the operating pump stops, failed to do so.

If you have any similar pumps on your plants, do you test them regularly to make sure the spare pump really starts when it is needed?

If you are designing a plant with a pump on it that is supposed to start automatically, have you worked out the reliability with which it will do so? Is this satisfactory? If not, should the reliability be increased by duplicating some of the components?

Extract from the ‘Annual Report of HM Chief Inspector of Factories” for 1971

The Chief Inspector quotes the following description of a fatal accident which occurred in 1540:—

“A young childe … standinge neere to the whele of a horse myll.. . was by some myshap come within the swepe or compasse of the cogge whele and therewith was tome in peces and killed. And, upon inquisition taken, it was founde that the whele was the cause of the childes dethe, whereupon the myll was forthwith defaced and pulled downe” (page xv).

He adds that many no doubt feel that this sort of decisive action against bad conditions in industry should be widely applied today!

146/7 COULD WE USE ROBOTS FOR HAZARDOUS JOBS?

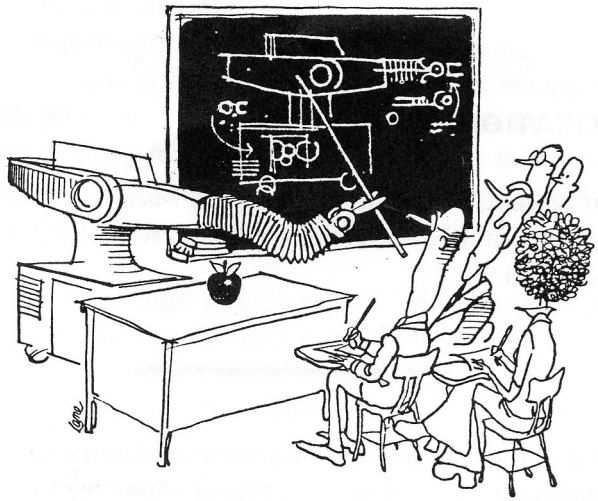
Another Division is using a robot to lift sacks off a pallet, cut them open and tip them into a hopper. It is being done to save cost and to gain experience of robots but robots could be used for handling hazardous chemicals.

The following are some suggestions. Some need programmable robots which do the same job again and again. Others need remotely controlled robots.

* Fire-fighting
* Filling tankers, drums or sacks
* Breaking joints, tightening leaking joints

* Erecting or dismantling scaffolding
* Doing jobs at inaccessible places, thus avoiding the need for scaffolding
* Closing valves near leaks or fires
* Cleaning or inspecting vessels or ducts
* Handling radioactive sources
* Drilling catalyst out of tubes

Any other suggestions? If so, please let us know.



An Unimate demonstrating how it works

146/8 OTHER MEN'S VIEWS No 24

Engineers who worry that they may be blamed if there is an accident on the plant they have designed or maintained (unnecessary worries on the whole — see Newsletter 102/9 and Safety Note 80/7) should be thankful that they did not live 50 or 100 years ago. Courts of Enquiry were much readier then to blame the engineer. For example, the report of the enquiry into the collapse of the Tay Bridge in 1879 stated

"We find that the bridge was badly designed, badly constructed and badly maintained and that its downfall was due to inherent defects in the structure. . . For these defects in design, construction and maintenance Sir Thomas Bouch is in our opinion mainly to blame".

The report of an inquiry into the explosion of a boiler at Cammell Laird's shipyard in 1929 stated

"We hold the Manchester Steam Users Association (the engineering insurance company) primarily to blame for the explosion".

With regard to Mr Petrie, DSc, Chief Engineer to the Association, it is difficult to know what to say. We cannot relieve him of responsibility because he has undertaken to carry out duties which he is wholly incompetent to fulfil'1 (He was appointed only a year before the accident happened.)

The explosion. . . caused the death of two men whose lives would have been saved but for the gross neglect of the Association and of the two officers to whom we have referred".

Quoted by R Booth in "Safety: too important to be left to the Engineers?". Inaugural Lecture, University of Aston in Birmingham, 1979.

146/9 UNUSUAL ACCIDENTS No 106

There was a dense fog near the German town of Gütersloh. Two motorists travelling in opposite directions along the same road, both kept close to the crown of the road and craned their necks out of their side windows to keep the centre marking in better sight. They ended up in hospital after a “collision” in which their heads met but their cars didn’t. We have heard of “head on”, but ...

Mond Division Safety Report, November 1980

146/10 RECENT PUBLICATION

A value analysis on a recent project, involving a particularly hazardous raw material, showed that the cost of added-on safety features, above those taken for granted, such as relief valves, was 14% of capital. Details in Safety Note 81/2.

Newsletter 144/2 stated that pumps should normally be shut down and started up with their delivery valves closed. Several readers have pointed out that this applies only to centrifugal pumps and not to positive displacement pumps.

For a copy of Safety Note 81/2 or for more information on any item in this Newsletter please ‘phone P.2845 or write to us at Wilton. If you do not see this Newsletter regularly and would like your own copy, please ask us to add your name to the circulation list.

April 1981

An Engineer's Casebook No 46
LABYRINTH SEALS—A CASE HISTORY

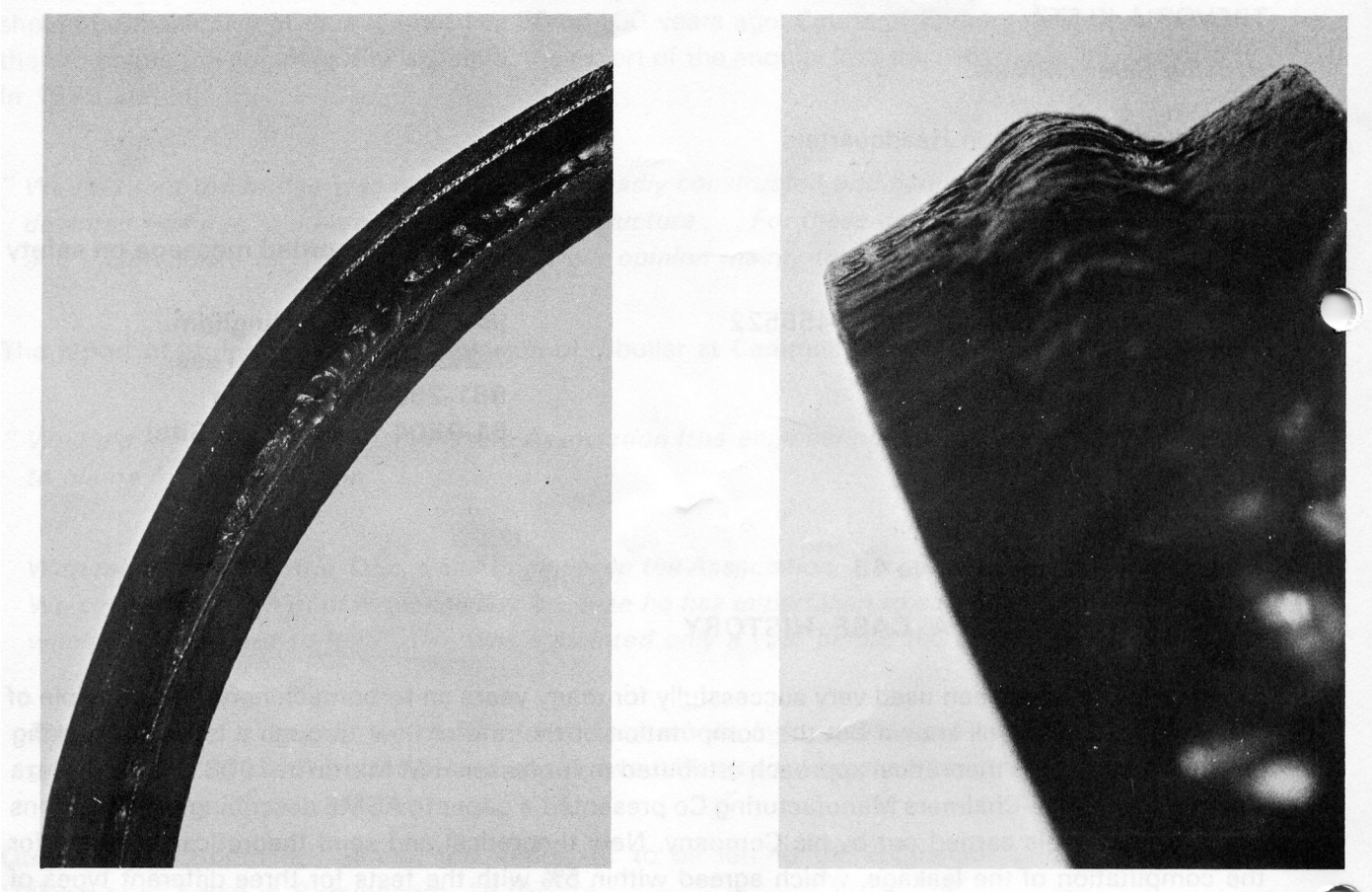
Labyrinth seals have been used very successfully for many years on turbomachinery. The principle of labyrinth sealing is well known but the computation of the rate of flow through a labyrinth packing has been based on a theoretical approach attributed to Professor H M Martin in 1908. In 1960, Geza Vermes of the Allis-Chalmers Manufacturing Co presented a paper to ASME describing investigations into labyrinth seals carried out by his Company. New theoretical and semi-theoretical formulae for the computation of the leakage, which agreed within 5% with the tests for three different types of seals, were introduced. Vermes cited two reasons why activity in trying to determine leakage rates more accurately was now necessary. First was the rapidly growing size of turbomachinery making the investigation of relatively small losses worth-while and second the recent possibility of leakage of contaminating products required a more accurate calculation procedure.

On the No 2 KA Plant on Nylon Chemical Works there are 4 Sharples (now Pennwalt) P5000 centrifuges on the Crystallisation Section. These centrifuges, which were commissioned in 1967, had a Crane double mechanical seal mounted back to back at each end of the rotor. For the first 3 years of intermittent production these seals gave continuous problems with maintenance expenditure, in 1970, amounting to £6000. In 1971 a split labyrinth seal was designed using the formulae from the above paper. It was manufactured and tested under simulated working pressure on Nylon Chemical Works. The calculated and test results for the labyrinth leakage were within 2%. By designing a split seal it could be removed for inspection or replacement without having to remove the rotor from the machine and strip off the gearbox, pulley and main bearings as was required with the existing mechanical seals. Nitrogen at 5 psi is applied to the seal; two-thirds of this exhausts from the seal into the slurry tank below the centrifuges and one-third exhausts direct to atmosphere. The nitrogen consumption through the labyrinth seal amounts to about half the normal slurry tank usage.

Since 1971, when the first centrifuge was modified, the labyrinth seals have proved extremely reliable and durable. The labyrinth seals, which are manufactured from a Copper Alloy to BS1400 LB4, have been replaced only once in ten years. The successful application of labyrinth seals on these centrifuges may remind engineers that this method of shaft sealing should still be considered for turbomachinery.

A W Kell

Photographs from Our Archives No.6



These pictures show a piece of 8 inches bore stainless steel pipe which was installed in a plant constructed about 1965. A short length of the pipe has been cut out to show one of the welds. It is seen that the two pipe ends did not fit exactly and they have been welded together with a step between them! The weld was then covered with lagging.

This example illustrates the point made in my paper, “Safety Aspects of Pressurised Systems”, (copy on request) that many pipe failures are the result of errors in construction (or of a failure to specify precisely what is required) and that detailed inspection after construction is more important than ongoing inspection during the life of the plant.