SAFETY NEWSLETTER

No. 137
PREPARATION FOR MAINTENANCE AND ENTRY

137/1 An isolator was replaced but the old one was locked off.

137/2 An air line melted — an air supply stopped.

137/3 A welding gun leaked — a man was asphyxiated.

137/4 Isolation and labelling were poor — a man was killed.

137/5 Heat from welding tripped out a plant.

137/6 Moving a slip-plate position stopped leaks.

137/7 Rescuers rushed in and were killed.

137/8 A factory inspector discovered that alarms and trips were not tested.

137/9 More about Three Mile Island.

An Engineer's Casebook — More on roller contact bearings

ICI
IMPERIAL CHEMICAL INDUSTRIES LIMITED
PETROCHEMICALS DIVISION

137/1 BOLTING THE DOOR OF THE WRONG STABLE

Before inspecting an electric crane, a crane inspector locked the isolator in the open position.

To make sure that the power was isolated he tried to start the crane. It was then found that the power was not isolated.

On investigation it was found that, unknown to the inspector and some of the local supervisors, the starter had been replaced by one of a new design fixed to the other side of the same girder but the old starter had been left in position. The clearance for the replacement of the starter had been issued by the Services Day Foreman.

Redundant electrical equipment should be removed as soon as possible and until this is done it should be marked in some way.

After isolating electrical equipment we should always try to energise it. Fortunately that was done in this case.

On each section of plant, only one process supervisor (or group of shift supervisors) should be responsible for issuing clearances.

137/2 THE AIR SUPPLY FAILS WHILE A MAN IS WORKING INSIDE A VESSEL

A recent incident in the Division shows how easily an entry job can go wrong even though we think we have taken all necessary precautions.

While a man, wearing breathing apparatus, was working inside a tank, the air supply failed. He pressed the demand valve but no air came through. As he was near the man-hole he dived out of the tank and removed his mask.

It was then found that there was a hole in the air pipe about 6 inches along the hose from the mask. It is believed that before use the mask and air line had been hung over a pipe nearby and the air line had touched an unlagged steam tracing line. This melted the plastic but it did not rupture completely until it had been used for a time.

Reminder: Another occasion in which the air supply ran out while a man was working in a vessel was described in Newsletter 34/1

137/3 A MAN IS OVERCOME INSIDE A VESSEL

The **RoSPA Bulletin** for April 1980, p 3, reports that a welder collapsed while working inside the barrel of a road tanker.

When he went for lunch he switched off the ventilation fan and left his argon arc welding gun inside the barrel. The valve leaked, filling the barrel with argon gas.

When he returned he resumed work but soon collapsed. Fortunately an observer was present and he was rescued in time.

Argon is like nitrogen; it is not poisonous but causes death by lack of oxygen. A recent paper (copy on request) describes a number of incidents in which men have been killed or overcome by nitrogen —our most dangerous gas.

Reminder: Other incidents in which men were overcome inside vessels were described in Newsletters 125/1, 88/4 and 77/1.

137/4 A LOOK BACK AT NEWSLETTER 37 (Feb 1972)

A man is killed because equipment under repair has not been properly isolated and identified.

Many times these Newsletters have stressed the importance of isolating and identifying equipment which is given to maintenance. Now a fatal accident in another Division has demonstrated once again that:-

Equipment given to maintenance must be properly isolated, electrically and mechanically.

Equipment given to maintenance must be identified by a numbered label. If there is no permanent label a numbered tag must be used.

Two pumps (No 1 & No 2) were being repaired by two different fitters. When No 1 pump was finished the fitter decided to try it out. By mistake he pressed the start button for No 2 pump. It started up and the two men who were working on it were injured, one of them fatally.

Two things were wrong:-

1 The pumps should have been defused or the starters should have been locked off.

2 The label on the starter of No 1 pump was covered with tar and there was no label on the starter of No 2 pump.

As so often happens in these cases, the job was behind schedule and people were being pressed to complete it as soon as possible.

Reminder: Other incidents which have occurred because equipment under maintenance was not properly isolated or identified were described in the following Newsletters:-

Isolation 125/7, 125/3, 121/4, 93/1, 91/2, 77/3, 69/1, 68/6, 58/5, 57/5, 51/7, 48/6, 43/9, 42/2, 37/1 & 2, 27/2, 25/1, 20/3, 19/2, 17/1, 14/7 & 8, 12/1, 11/2, 6/1, 4/1, 3/2 and 1/2.

Identification: 125/5, 102/5, 91/1, 80/2, 59/5, 54/5, 47/1, 44/9, 41/4, 37/1, 32/3, 29/3, 20/1, 13/2, 11/1, 10/1, 9/1 and 1/2.

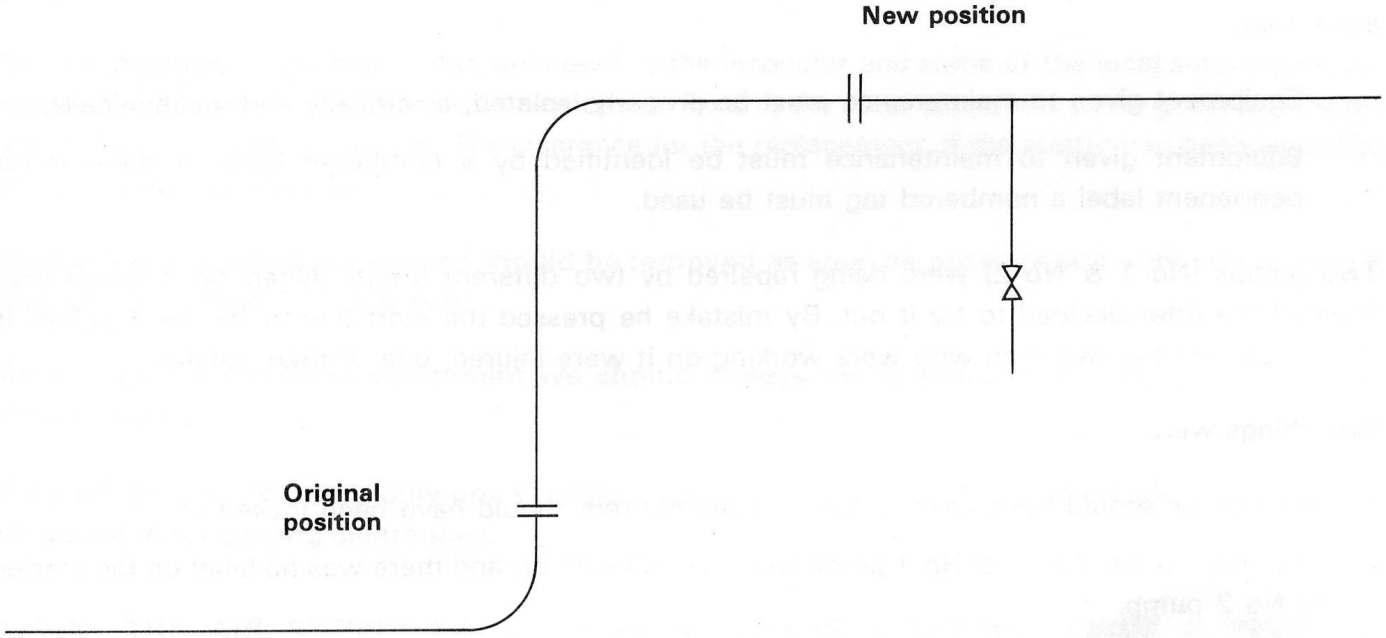
137/5 ANOTHER MAINTENANCE JOB WITH UNFORESEEN RESULTS

A clearance was issued to remove some redundant brackets. A burner started work and accidentally heated an adjacent impulse line leading to a pressure switch. As the impulse line was choked the heat caused a rise in pressure which operated a trip and shut down the plant.

This incident is a good example of the pitfalls in what may look like a simple, straightforward maintenance job. When issuing any clearance certificate we should look not only at the piece of equipment which is being worked on, but also at equipment nearby which might be affected by heat or accidental mechanical damage. This can only be done if we carry out a detailed inspection of the working area.

137/6 PUT SLIP-PLATES WHERE LIQUID WON'T COLLECT

The diagram shows the original position of a slip-plate that had to be withdrawn whenever there was a change of product on a plant that operates in campaigns. Liquid collected above the slip-plate and sprayed out when the joint was broken. The slip-plating point has now been moved to the position shown and a drain line added. The report on one of the spraying incidents recommends that during operability studies we should try to identify equipment that needs to be maintained with the plant online and how this can be done.



Reminder: Newsletter 82/4 recommended that slip-plate positions should be at high points rather than low points.

137/7 ONCE AGAIN — RESCUERS ARE KILLED

Newsletters 88/4 and 59/4 described how men were overcome in a confined space and then other men rushed in to rescue them and they in turn were overcome. A particularly unpleasant case of this sort was described in the Daily Telegraph for 30 July 1979. A man fell into a cow dung pit in India, six people jumped in to rescue him and all seven were killed by lack of oxygen.

Entering a vessel to rescue someone who has been overcome is a natural human reaction — but doing so without the proper protective equipment may mean that others have two people to rescue instead of one.

137/8 INSTRUMENTS NOT TESTED

A Factory Inspector visited a company which stores liquefied gas at low temperature in six large storage tanks, each fitted with high level alarms and independent high level trips which close valves in the inlet lines. The Inspector found that:

(a) Five of the high level alarms were not working and no-one knew how long they had been in this condition.

(b) The high level trips were never tested, could not be tested and were of an unreliable design.

(c) One of the tanks was six months overdue for internal inspection.

(d) There had been no qualified electrical engineer on site for 5 months.

As the company did not agree to the Factory Inspector’s proposals, Deferred Prohibition Notices were issued requiring them to install satisfactory level measuring devices — two independent systems on each tank— and satisfactory alarms and trips by stated dates. In the meantime the tanks must not be filled to their normal levels.

I do not suggest that this installation is typical of the organisation concerned — I hope it is not. Even in the best run organisations some installations may fall below standard. This story shows what can happen when they do. For this reason some system of internal auditing is necessary, particularly in companies that carry out inspections and testing in-house. The report, in **Hansard**, 8 May 1980, columns 683-694, adds that "changes in management have been instituted".

137/9 THREE-MILE ISLAND

*In Newsletter 135/7, I recommended an article in **Scientific American** for March 1980. An Article by WJ Lanouette in **The Bulletin of the Atomic Scientists**, January 1980, p 20 concentrates on the deficiencies in the software and quotes extensively from the official US report, including the following:*

"First of all, it is our conclusion that the training of TMI operators was greatly deficient. While training may have been adequate for the operation of a plant under normal circumstances, insufficient attention was paid to possible serious accidents. And the depth of understanding, even of senior reactor operators, left them unprepared to deal with something as confusing as the circumstances in which they found themselves.

Second, we found that the specific operating procedures, which were applicable to this accident, are at least very confusing and could be read in such a way as to lead the operators to take the incorrect actions they did.

Third, the lessons from previous accidents did not result in new, clear instructions being passed on to the operators.

In conclusion, while the major factor that turned this incident into a serious accident was inappropriate operator action, many factors contributed to the action of the operators, such as deficiencies in their training, lack of clarity in their operating procedures, failure of organizations to learn the proper lessons from previous incidents, and deficiencies in the design of the control room. These shortcomings are attributable to the utility, to suppliers of equipment, and to the federal commission that regulates nuclear power. Therefore — whether or not operator error 'explains' this particular case — given all the above deficiencies, we are convinced that an accident like Three Mile Island was inevitable."

"The existence of a vast body of regulations by the (Nuclear Regulatory) Commission tends to focus industry attention narrowly on the meeting of regulations rather than on a systematic concern for safety."

'While many of the proposed 'fixes' seem totally appropriate, they do not come to grips with what we consider to be the basic problem. We have stated that fundamental changes must occur in organisations, procedures, and, above all, in the attitudes of people. No amount of technical fixes will cure this underlying problem."

137/10 COMMENTS FROM READERS

Newsletter 135/1 (and earlier Newsletters) pointed out that if water is mixed with oil above 100°C, the water vaporises with explosive violence.

A reader points out that the oil does not have to be above 100°C as mixtures of two immiscible liquids have a boiling point below that of either component. For example, a mixture of water, boiling point 100°C and n-heptane, boiling point 98.4°C, boils at 80°C. If water at 95°C and n-heptane at 95°C were mixed, part of the mixture would vaporise immediately and might overpressure the containing vessels. If the liquids were initially close to their boiling points at an elevated pressure, the potential

overpressurisation would be greater.

137/11 UNUSUAL ACCIDENTS No 98

Malcolm Andrew McCaffer, shortly to be three years old, backed his mother's Mini into his father's Marina in the drive at their home in Quorn. His father's feelings are curiously mixed.

From Loughborough University of Technology News, No 100, April 1980, p 23.

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.

July 1980

An Engineer's Casebook No 37
MORE ON ROLLING CONTACT BEARINGS

In most applications of rolling contact bearings both inner and outer races must be restrained from rotation in some way so that rotational movement takes place solely between the rolling elements themselves and their tracks.

Inner races are frequently arranged so that they are an interference fit to the shaft on which they are mounted. To fit them they have to be pressed or driven onto the shaft. Heating the bearing in an oil bath to a maximum of 80°C can markedly assist the fitting operation.

Repeated withdrawal and subsequent replacement of bearings on the same shaft tends to relax the interference fit which is essential for proper operation. It is therefore important to check the shaft diameter on which the bearing is located before fitting any replacement bearing. The degree of interference fit required depends on the shaft diameter, loading, duty etc and can be found by reference to bearing manufacturer's catalogues. As a guide, for a 2 inches diameter shaft to which a normal single groove ball bearing has to be fitted, the interference should be 0.0005 inch ± 0.0002 inch (or on a 50 mm shaft +2 to +13 thousandths of a millimetre). These limits do not convert directly since the standardised limits for inch bearings are differently disposed about the nominal than those for metric bearings.

If the fit is too slack then there is a tendency for the inner race to creep round the shaft when it rotates. This further reduces the initial fit since all wear takes place on the shaft which is invariably much softer than the hardened inner race. The interference fit can be reduced to the point at which the inner race is no longer restrained and it will start to spin on the shaft. This creates frictional heat and rapid destruction of the bearing arrangement.

If the fit is too tight then the desired degree of internal bearing clearance for the rolling elements may be lost. This will result in overheating, rough running and rapid destruction of the bearing even if correctly lubricated.

On the question of internal clearance designation you should be aware of the changeover from the original dot identification to the current marking which is — no marking for 'normal' clearance, C3 (= 3 dot) for some increased internal clearance and C4 (= 4 dot) for even greater clearance. Increased clearance is required for hot shaft applications, differential materials, thermal gradients etc. Clearance designation, if other than normal, is etched on the side of the bearing close to the bearing number.

A useful set of cards, about 6 inches x 6 inches, in a plastic envelope giving bearing code designations, illustrating different types of rolling contact bearings, data for fitting, etc. was produced by Dr D Summers-Smith a few years ago. Sets are available from R A Morrow, Non-metallic Materials Section, ICI Agricultural Division, Billingham. The cost is £10 per 10 sets and a job number is required with each order.

E H Frank

Reminder: An earlier article on rolling contact bearings appeared in Newsletter 111.