SAFETY NEWSLETTER

No. 111

IN THIS ISSUE

THE UNFORESEEN EFFECTS OF SMALL CHANGES

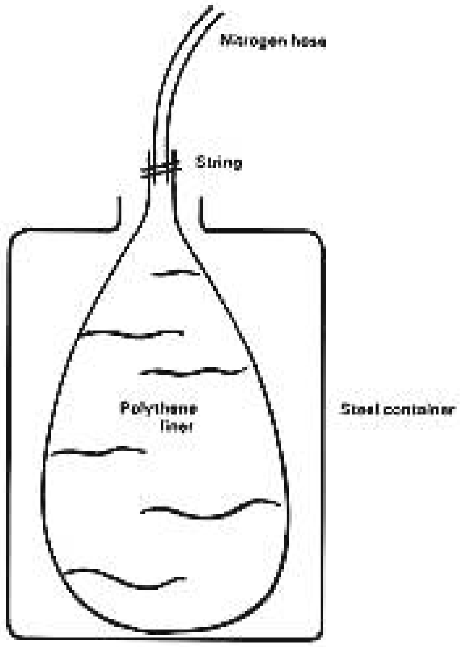
Earlier Newsletters (109/1, 100/2, 99/1, 97/6, 83, 71/7, 67/7d and 63/7) have described modifications that had unforeseen — and unpleasant — results Newsletter 83 described a method for checking modifications. This Newsletter describes the results of some changes so slight that they might not be recognised as modifications.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

PETROCHEMICALS DIVISION

111/1 POLYTHENE IS STRONGER THAN YOU THINK; VESSELS ARE WEAKER THAN YOU THINK

A large (57 m^3) container was being prepared for filling with powder. A polythene bag was put inside and the operator then inflated it with nitrogen. Usually the nitrogen hose is just placed inside the neck of the liner but on this occasion **the operator tied the neck to the hose with string,** hoping that by doing so he would be able to inflate the liner more quickly.



About 15 minutes later there was a loud crack and the roof of the container was found to have bowed out by about 3 inches. Fortunately it was still fit for use.

The liner was made of 700 gauge polythene, the container roof of 16 gauge mild steel. Everyone was surprised that the polythene did not burst before the container yielded.

Reminder: Newsletters 96/1 & 2, 81/1, 78/8, 77/2, 56/Supplement, 47/5b, 42/1, 29/7 and 27/4 have described ways in which tanks have been sucked in.

111/2 NITROGEN USED INSTEAD OF AIR

An operator in one of our overseas companies donned a fresh air hood to avoid breathing harmful fumes. Almost at once he felt ill and fell down. Instinctively he pulled off the hood and quickly recovered. It was then found that the hood had been connected by mistake to a supply of nitrogen instead of compressed air.

On the Works different connections are used for nitrogen and compressed air so it was difficult at first to see how a mistake had been made.

The place where the man was working was a long way from the nearest compressed air connection so several lengths of hose had to be joined together. This was done by cutting off the special **couplings and using simple nipples and jubilee clips.** Finally, the hoses were joined to one projecting through an opening in the wall of a warehouse. The operator then went into the warehouse, selected what he thought was the other end of the projecting hose and connected it to the airline. Unfortunately there were several hoses on the floor of the warehouse and the one to which he had joined the airline outside was already connected to a nitrogen line.

This incident does show us:-

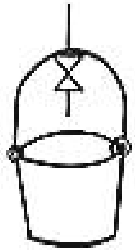
1 The ease with which safety precautions, such as using different connectors for air and nitrogen, can be by-passed.

2 It is better to use cylinders of air for breathing apparatus rather than piped air whenever possible.

Other incidents in which air and nitrogen were confused were described in Newsletters 59/3, 45/3, 41/5, 28/5, 27/5 and 18/6.

111/3 A FIRE WHILE DRAINING LIQUID INTO A BUCKET

Acetone has to be drained into a bucket (in another company). One day the operator **hung the bucket on the drain valve** instead of placing it on the ground.



The handle of the bucket was covered with plastic.

When the acetone was drained, a charge of static electricity accumulated on it and on the bucket. The plastic prevented the charge flowing to earth via the drain pipe. Finally, a spark passed between the bucket and the drain pipe and the acetone caught fire.

Although acetone is conducting, a static charge can still build up if it is in contact with equipment which is not earthed.

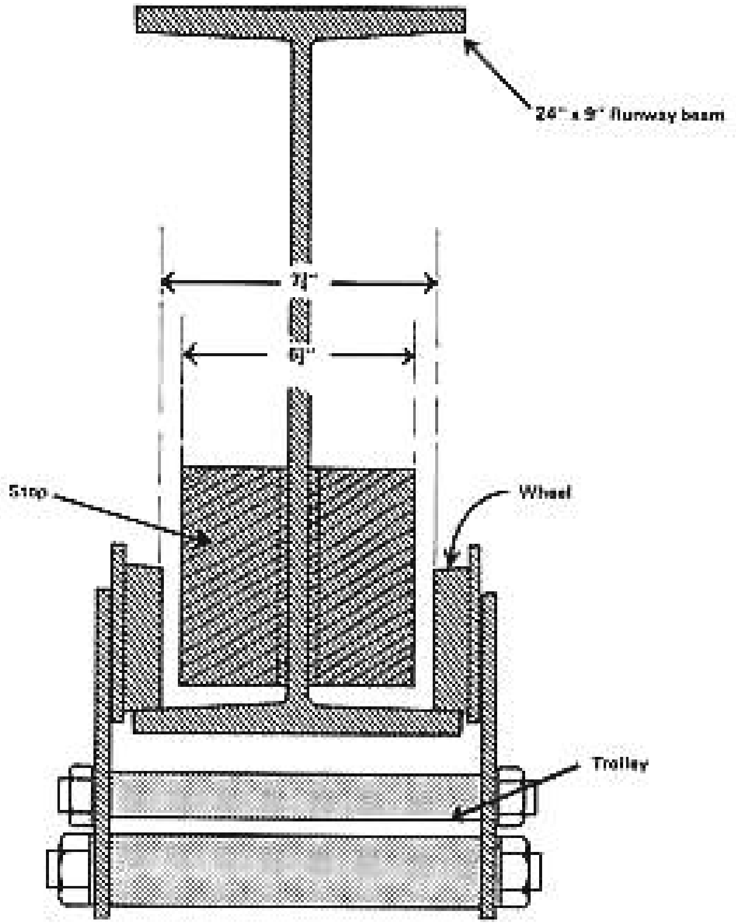
Similar incidents were described in Newsletters 18/2 and 57/10b (Safety Note 73/18).

For other items about static electricity see Newsletters 18/3, 19/8, 20/6, 59/7, 63/8, 66/2, 69/8d, 72/3, 75/3 and 81/7.

Flammable and corrosive liquids should be drained into cans, not buckets. See Newsletter 90, page 8.

111/4 A SMALL CHANGE TO A HOIST

A runway beam (in another Division) was made from a 24 inch by 9 inch girder. Stops were fitted at the ends; they did not cover the full 9 inches of the beam, only 6.5 inches of it, but this was sufficient to prevent the wheels of a 7½ tons runner getting past.



However, the biggest load that had to be lifted was 1 ton, so the runner was changed for a smaller one. It had thinner wheels which ran past the end stop and the runner fell off the end of the beam.

All stops should cover the full width of runway beams.

111/5 CHANGES IN OTHER INDUSTRIES

Brunel's *Great Britain*, completed in 1846, was the first iron screw-propelled ocean-going steamship and, at the time, the largest ship ever built.

> *"Leaving Liverpool on the evening tide, in the middle of the night, when she was believed to be off the Isle of Man, the Great Britain struck and when morning dawned she was found to be high and dry on the sands of Dundrum Bay beneath the Mourne Mountains in Northern Ireland. Her master, Captain Hosken, was a most experienced navigator and such an error seemed almost incredible until it was found that, not only was there a serious mistake in the chart he was using, but the unprecedented amount of iron in the hull had affected the ship's compass. In future iron ships this was countered by mounting the compass at the head of the mast and viewing it by a periscope. This is a good example of the unforeseen perils that must beset all great engineering innovators."*

From "Victorian Engineering" by L. T. C Rolt, Penguin Books, 1974, page 90.

In recent years, there have been many "social shocks" when new materials were found to have undesirable and unforeseen side-effects, for example, thalidomide, the Pill, DDT, sugar-substitutes, Chinese restaurants. A recent book, 'Technology and Social Shock" by E W Lawless (Rutgers University Press, New Brunswick, New Jersey, 1977, $6.95), describes and analyses 45 of these alarms and controversies.

111/6 A LOOK BACK AT NEWSLETTER 11 (July 1969)

(a) A fire in an ethylene compressor

A serious explosion involving the isolation of equipment for maintenance has been reported by another Company. An ethylene compressor had been shut down for maintenance and had been correctly isolated by slip-plates. When repairs were complete the slip-plates were removed before the machine was tried out. During the try-out some ethylene leaked through the closed isolation valves into the machine and the ethylene/air mixture was ignited, either by a hot spot in the machine or by copper acetylide on the copper valve gaskets. The compressor was severely damaged.

(b) Clearing choked lines with compressed gases

Gas pressure has sometimes been used for clearing choked lines. This should never be allowed. A recent report from another Division describes how a slip-plate was made concave by the impact of a plug of solid pushed along by gas pressure. The report includes some calculations to show how much energy can be accumulated in the plug of solid which in some cases might come out of an open end. For example, if the pipe diameter is 2 inches, the gas pressure 50 psi and the plug is moved 50 ft. before it emerges, its kinetic energy could be 300 ft lb, more than that of a bullet leaving a service rifle. If the plug weighed 1 lb its exit velocity could be 300 mph.

(c) Find the cause, don't just cure the symptoms

A pin-hole leak developed in a pipeline carrying condensate at 105° C into a condensate collecting drum. The leak got bigger until finally the plant was shut down. It was then found that the scouring action of the hot water and steam as they reached the end of the pipe had eroded the pipe and the flange and that if the leak had been clamped and the plant had been left on line for one or two weeks more, as originally suggested, then the pipe would have blown off.

111/7 OTHER MEN'S VIEWS No 8

— **How reliable are our memories?**

A second major source of information is provided by the evidence of the pilot, and of other parties involved in the accident; and here there are many possible sources of distortion. Occasionally one or more people may lie, either in an attempt to save themselves, to avoid embarrassment, to protect their jobs, or out of misplaced loyalty to a colleague. The word 'misplaced' is used with some reluctance, but it is clear that the vital necessity for total honesty and objectivity in accident investigation may well conflict with some very deep emotions.

A far more important source of distortion lies in the poorness of the human memory. Man absorbs a truly vast amount of information during every moment of his life. Much of this remains in the memory for a very short time; a very little dwells for longer periods. But every moment, memories are decaying and are being contaminated with the arrival of fresh information. A pilot may, therefore, remember the pressure setting he used on the trip from which he had just landed, but probably does not remember what value he set last Tuesday week; and the thousands of such settings which he has made over the years form a general blur.

Closely controlled laboratory experiments confirm the everyday experience that memories are distorted in the direction of simplicity and coherence. If a story is repeated many times from one witness to another, it is progressively simplified until only the bare bones remain. Similarly, the human desire for order out of chaos means that non-sequiturs in a story are gradually eliminated until a clear and logical account of events emerges. However, this final account usually bears very little resemblance to the original message.

The pilot who repeats his story a number of times, and who discusses the accident with many people, may, with total integrity, give a false account of what actually happened. He 'remembers' *that the reading on a dial was such and such because that reading would make sense in the context of his story.*

Distortion can be minimised, a/though not eliminated, when statements are taken from the parties concerned as soon as possible after the accident. However, pilots have yet to be trained to crash alongside the investigator's office, and prevention of any discussion of the accident pending the arrival of the investigator is not without its difficulties.

M Allnutt in "Pilot Error", edited by R Hurst, Crosby Lockwood Staples, London, 1976.

Newsletter 101/1 described an incident in which men forgot which valve they had closed.

111/8 UNUSUAL INCIDENTS NO. 77

Some years ago we ordered a compressor from Germany. The German manufacturer asked their sub-contractors to use degrees Fahrenheit on all instrument scales. They explained how to convert degrees Centigrade to degrees Fahrenheit.

Difficulty was experienced in starting up the compressor. This was finally traced to an incorrect setting on the governor...An angle which should have been set at 60° had been set at only 15°.

The sub-contractor who manufactured the governor had converted degrees of angle into degrees Fahrenheit so that an angle of 15° was labelled 60°; when the angle was set at 15° on the scale it was actually very much less.

111/9 RECENT PUBLICATION

The Institution of Chemical Engineers have published a 28 page booklet on the safe use of stainless steel in Chemical Process Plants. It is not intended as a do-it-yourself guide to avoid the need to refer to a materials specialist but provides the background information that all managers and engineers should know. Copies can be obtained from the IChemE., 165-171 Railway Terrace, Rugby, CV21 3HQ, price £1.50.

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.

May 1978

An Engineer's Casebook No. 10

ROLLING CONTACT BEARINGS

Rolling contact bearings, i.e. ball races, roller races, angular contact thrust bearings etc. will not last forever. Constant slight deformation at the point of contact between the rolling elements and the races between which they run, essential to give a contact area to carry the radial and/or axial load, gradually fatigues even the best material. Fatigue leads to the detachment of small pieces of metal from one or other surface. These pieces of metal are then trampled on by the rolling elements which further increases the loading on material which is already tired and fairly rapid failure results.

The life of a rolling bearing may be calculated, life representing the period of unimpaired performance of the bearing when properly mounted, adequately lubricated, protected from foreign matter and not subjected to extreme operating conditions. If a reliability is chosen as the probability that a bearing will attain a certain specified life, or exceed it, then a basic rating life can be defined as the life associated with 90% reliability. Calculation methods for dynamic load ratings and rating life are given in BS 5512 Part 1 1977 which is a copy of ISO 281/1-1977. L_{10} (formerly B_{10}) is the basic rating life in million revolutions. For a given speed of rotation this can be easily converted into hours. For example, an L_{10} life of 40000 hrs, which is the preferred selection for pump bearings in our Engineering Specifications, relates to 3600 million revolutions at 1500 rpm. 90% of identical bearings operating under the same conditions should reach this milestone before the first evidence of fatigue develops.

In practice premature failure usually takes place due to operation under non-ideal conditions, dirt in the oil, vibration, periods at rest giving local effects (Brinelling) etc. Rolling bearings which have run for 16-25000 hours (2-3 years) should be considered for replacement even though they may still appear, and feel, in excellent condition. Their expectation to survive a further 8-16000 hrs (1-2 years), which is a fairly common life between overhaul of much equipment, is pretty low.

An Engineer's Casebook No. 11

HAVE YOU THE RIGHT SPARES AND INSTRUCTIONS?

On restarting a turbo-compressor after a major overhaul it soon became apparent that some internal fault was allowing gas from one part of the compressor to leak into another part so contaminating the outlet. The machine was designed so that this should not happen. However, as we seem to find all too often, the original system did not work too well. It was modified 8 years ago and had been quite satisfactory from then up to the overhaul.

Plant staff at Engineer and Supervisory level had changed in the intervening years and those in charge at the recent overhaul were unaware of the previous history and modifications which had been made to the compressor. In advance of the overhaul, which was carried out by a team of men from the manufacturer's service department, those spare parts which it was thought might be needed were drawn out of stores from the plant spare gear references. Amongst those fitted was one part, a shaft labyrinth with a special modification for this machine. This part had undergone a design change as part of the 1970 modifications and though a spare to the new design had been ordered, unfortunately (you have guessed it) the old spare had not been thrown away and was inadvertently fitted. As a result the plant had to be shut down to allow the compressor to be opened up again and the fault rectified; an expensive error.

Somewhere along the line an obsolete capital spare had not been written off nor had a maintenance instruction been prepared to detail the special requirements of this otherwise apparently 'standard' machine, It is easy at the time of change to think 'I know all about this, why should I write an instruction' and 'We had better keep that old design as a standby, we could always modify it in an emergency'. Time passes, memories fade, staff change …..!

How are your spares and instructions, all ship-shape for tomorrow's generation?

E H Frank