# Safety NEWSLETTER



An Engineer's Casebook No. 71:-
**Materials for Springs in Relief Valves and Safety Valves**

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**Shut downs and Upsets**


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## Shut-downs and Upsets

**The preparations for a shut-down (or a turn around), the work to be done during a shut-down and the subsequent start-up all need careful planning.**

Methods for doing unfamiliar and unusual tasks need to be carefully thought through. Those who are to do the work need to be clear about the objectives and about the methods to be used. Co-ordination of the work of many different groups is most important. They need to perform like one great orchestra and not like rival groups of ‘buskers’!

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## Low Pressure into High Pressure Won’t Go

**During a shut-down It is usually necessary to wash out process materials or to drain sections of a plant and purge them with steam or an inert gas such as nitrogen**

On a plant handling liquefied petroleum gases it was intended to remove a flowmeter from a pipeline. The man concerned decided not to use the usual method for preparing the job, which was to attach a flexible connection to a branch on the pipework and release the contents to a vent stack. Instead he closed isolation valves on either side to the section and blew the contents off to atmosphere. He then closed the blow-down valve and connected a flexible hosepipe from a nitrogen service point to a suitable connection on the pipework. He opened the nitrogen supply valve and brought the pressure in the system up to the nitrogen supply pressure of 90 psig. He intended to close the nitrogen valve and then to blow-off the pressure through the blow-down valve. However he went away to do some other work, meaning to return and complete the job later. In a nearby laboratory the same nitrogen supply was used on some of the chromatographs and they began to function incorrectly. Other chromatographs, using nitrogen from cylinders, were behaving normally.

The nitrogen supply to the hosepipe on the plant was isolated and the hosepipe disconnected. Several nitrogen service valves were opened to allow nitrogen to blow off to the atmosphere for a time and shortly afterwards the chromatographs in the laboratory all began to function properly.

As pressure in the pipework being purged was found to be 120 psig, above the nitrogen supply pressure, the nitrogen being blown off from the service points on the main was found to contain hydrocarbons.

One of the meter isolation valves was found to be passing and had allowed hydrocarbons at 120 psig through into the pipework being purged. The non-return valve on the nitrogen supply was found to have a stone in it. The valve had been held open and hydrocarbons had leaked into the nitrogen system.

I am sure you can work out the proper procedures for avoiding incidents like this.

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## Another Attempt Doesn't Work Either

**Attempts to push nitrogen into plant at a higher pressure are not all that unusual. However, here is another attempt with some unusual features.**

A distillation column had been emptied and was to be washed and boiled out with water to remove deposits from the trays. The drain valve had been left open. The steam to the re-boiler had been isolated by closing the control valve only, and not by the isolation valves.

An operator connected a water hosepipe to a riser which was connected at its upper end to the vapour main near the top of the column. It was intended that water should be fed into the vapour main and thence down the column taking the residues with it.

After some time the operator noticed that temperatures at various points in the column were not falling as they normally did when cold water was added. The water valve and the inlet valve to the column were then closed and the hosepipe disconnected so that the water supply could be checked. Liquor sprayed out of the line onto both the man's arms.

In the subsequent investigation three faults were discovered. The water pressure was lower than usual and would not have been sufficient to push water up the riser and into the column. Secondly, several tubes in the reboiler were leaking. Finally, the steam control valve was passing.

This combination of faults had allowed steam to enter the body of the column and vaporise residues in the base. The vapour then condensed at the top of the column in the cold vapour main and ran down into the water supply line.

If you were responsible for this operation what modifications would you make to the equipment and the procedure?

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## Disconnection is Sometimes Not Enough

**Sometimes, instead of valves and a slip plate being used for isolation of a vessel, a pipeline is disconnected and the**

A horizontal cylindrical dryer was used to remove the last traces of a flammable solvent from a powder. The dryer was fed from a filter through a down-comer pipe. One day, in readiness for maintenance work this pipe was disconnected and the open end pulled aside.

Three days later most of the work had been completed and the dryer was being re-assembled. The end cover was placed in position and bolted down. It only remained to cut off the guide pins on the cover.

**open end pulled aside. This may not be sufficient to stop material entering the vessel from the pipe.**

In the meantime the interior of the dryer was being flushed with water and the feed pipe was being re-assembled. A permit was then issued for cutting the guide pins. The area round the work was tested to make sure that no flammable gas was present. Because the dryer had been open to the atmosphere for three days the atmosphere inside it was not tested.

As a cutting disc was being used to cut off the guide pin on the cover at the side nearest to the inlet rotary valve there was a flash followed by a loud bang. Even an hour and a half later an explosimeter gave a reading of 40% LEL inside the drier.

There had probably been a leak into the feeder pipe. Because the open end had not been blanked off (blinded) some solvent had entered the drier in spite of the pipe having been disconnected and moved aside a little.

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## Surplus Equipment Needs Emptying

**Before services are disconnected from redundant equipment, a thorough check should be made to see that they are no longer needed.**

A laboratory building was to be closed and the equipment disposed of. Benches and cupboards were emptied and surplus equipment neatly arranged for inspection by people interested in transferring it to other buildings. All the services were shut off and disconnected at the mains outside the building.

Sometime later a group of people searching for useful equipment decided to look in a refrigerator in the laboratory. It was still switched on at the local switch though of course it had warmed up to the temperature of the laboratory! When it was opened, the refrigerator was found to contain samples of organic peroxides which should be kept at low temperatures to avoid risk of explosions.

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## Tournament Day

**Ancillary workers on a plant during a shut down are usually given strict instructions about the need to leave the plant and where to go when an emergency alarm sounds. However they do need to leave their equipment secure.**

During a recent shut-down there was an emergency alarm requiring a plant to be evacuated. Scaffolders at work on the plant evacuated by the shortest route and went to the assembly point nearby for a roll call.

About 15 minutes later when a supervisor was making a search of the plant he heard a loud bang on from the roof of a building. It was later found that a 16 ft long scaffolding pole was embedded in the roof. During the inquiry a scaffolder explained that he had clipped a pole to a handrail on a platform on a nearby high structure. This pole was then used as a ‘stop’ for a number of others which he intended to use and which were not secured in any way. During the emergency, when the poles were left unattended, vibration in the pipes of an adjacent pneumatic transfer system had dislodged one of the poles. That pole had then flown through the air like a spear in a medieval tournament and had struck the edge of the roof of the building below it. After all that it was discovered that the original ‘emergency’ was a false alarm.

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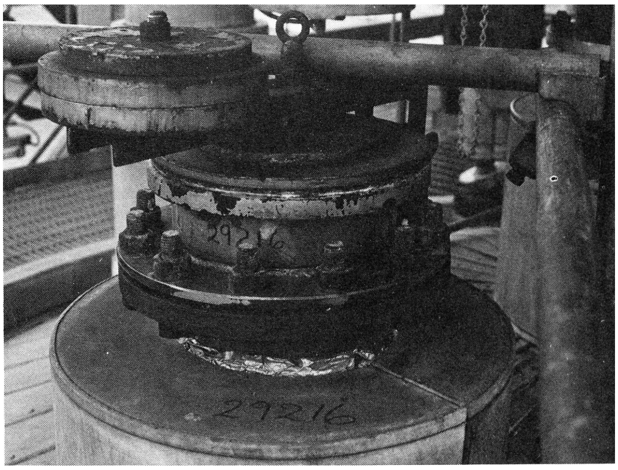
## Puzzle Corner

**Occasional ancillary workers cannot be expected to know the functions of all the items of equipment on a plant. They must therefore be carefully instructed and supervised to ensure that their special equipment does not Interfere with the ability of the plant equipment to function correctly**

Do you know, or can you guess, what the photograph illustrates?




It shows part of a scaffold erected on a plant. One of the horizontal poles has been secured immediately above a dead weight relief valve. Had the relief valve been required to lift the pole would have prevented it. This would not matter in the middle of a shut-down but ancillary work often starts when the plant is still online and continues after the start up. Those are periods when perhaps the relief valve is more likely to be needed than when steady operation has been established

**An Engineer’s Case Book No 71 MATERIALS FOR SPRINGS IN RELIEF VALVES AND SAFETY VALVES**

Relief and safety valves are commonplace and yet vital pieces of equipment in any chemical plant operating at high pressure. The heart of a relief valve is the spring, normally of the helical compression type. The choice of spring material has been the cause of much work and concern over the recent years.

For many years the stress analysis team in Materials Group of Engineering Department has uprated, downrated and also designed some of its own relief valves. The methods used for the spring design are standard. However, considerable expertise has been developed in their application and material choice. The trend towards buying proprietary equipment, however, has increased the reliance on the relief valve manufacturer for ensuring spring integrity.

Economic relief valve design requires that each valve body can operate on a range of duties and that body sizes are small to keep costs down. The body size is closely related to the size of the spring it needs to accommodate. There is therefore a tendency to use high performance spring materials close to their limits of torsional stress. High strength carbon and tungsten steels are often used but it has been found by bitter experience that these suffer failure by hydrogen embrittlement in corrosive chemical plant environments.

Many years ago a search for a strong material resistant to corrosion and hydrogen embrittlement, led to the use of precipitation hardening stainless steels of which FV520B is our standard selection. This steel meets all the requirements provided it is not harder than Hv 420 (equivalent to a strength of 1360 N/mm$^2$). Otherwise it can be susceptible to hydrogen embrittlement. This material has been used successfully in many applications. The rare failures have always been due to the spring being too hard. As the material does not strain harden significantly in service the failed springs must have been too hard on installation.

The solution to the immediate problem is to check the hardness of FV520B springs on critical relief valve duties prior to service, preferably on receipt from the manufacturer. The solution to the long term problem is to use less highly stressed springs. Limits on hardness, and hence stress, are at present being considered for inclusion in British Standards specifications.

Although nearly always under static compression, the service conditions of some relief valve springs can be arduous. FV520B in this duty has developed a notoriety, yet if the material is kept below Hv 420 this is totally unjustified. Other materials were previously tried for critical spring duties, but their performance was most definitely inferior to that of FV520B. Another steel of this type, which is commonly used by some oil companies is 17-4 PH

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