Recognising Small Plant Changes

Author: Colin Feltoe C Eng, FIChemE, MIPENZ

Plant changes have long been recognised as a hazard if not properly managed and many companies have in place procedures to address these. There is no relationship between the size of the change, either in physical or monetary terms, and the hazard which may be created. There is a risk that small changes may slip through the net. How comfortable are you that these risks are minimised on your plant?

Scenario: An I&E technician receives a work order to replace a faulty solenoid operating a block valve. The permit is issued and the technician goes to the store to uplift a new part. The correct size is not available but next size up fits and is available. This is issued and installed. Unfortunately the valve in question is part of an emergency de-pressuring system (EDP) and is situated on the outlet of a pressure vessel. The larger solenoid speeds up the valve causing it to close faster than the inlet valve thus creating the situation it is trying to prevent and compromising the depressuring system.

This is a small change in physical and dollar terms. It has happened at the level of a work order and work permit. Avoidance would have required the technician or the store-man to recognise that it was a change. Such decisions about small changes can have large consequential hazards and these are made at the "coal face" on a day to day basis. In human error terms the above example is a knowledge based mistake, the result of unconscious incompetence. We don't know what we don't know.

Are your safety critical systems clearly identified, would your technicians recognise this as a change requiring evaluation and would your testing regime catch it?

A similar scenario involved the wrong solenoid being issued and installed. A different porting arrangement rendered the protection system inoperative. It was picked up at the next full function test of the system. This differs from the first example in that it was a simple human mistake or slip, like pushing the wrong button. Asking employees to "take care" will not solve the problem. The best trained and motivated people will make mistakes with predicable regularity and in this case the safeguard was the protection system testing regime. There may be other precautions possible to minimise the likelihood of error in the area of labeling and inventory control.

What is a change? One possible definition is: *A non "like for like" change to the process, equipment, procedures or the organisation.* This definition is open to misinterpretation as a piece of equipment purchased to the same process design specification may not be "like for like".

Changes arising from projects, whether they are minor plant modification or major capital items, are obvious and most companies have in place review and authorisation procedures to deal with these. Typically once a new process has been subject to HAZOP all changes should go through change control. This will involve an initial assessment by a competent person followed by an appropriate review for the change (HAZOP, FMEA, HAZID etc), to identify additional hazards, apply necessary controls, update documentation and authorise the change. The type of change which led to the Flixborough disaster would likely be caught by the systems in place today. The correct method to be

used for the review is not always obvious. HAZOP is not always appropriate. For example, structural or mechanical changes, and small (in size and cost) changes, such as the one referred to above, can slip though the net.

Examples of changes leading to an incident.

1. Modifications were made to an elevated platform during a shut down to improve maintenance access. These were properly engineered and met all relevant codes and standards. On start up a nearby large high pressure steam line, which had been cold during the maintenance shut down, expanded on heating and impinged on the platform. This stressed the pipework causing it to crack resulting in extended downtime, repair and testing. What type of review would have identified this hazard? There are no guarantees but a HAZID type review having the "Impact" question or the High Temperature guideword in a HAZOP, or a general review involving a site visit and the presence of a person familiar with the expansion loops of this steam line may have.
   This was not a human error issue but a systemic error caused by not having a control of change procedure robust enough to identify the need for a review of this modification.

2. Following a debottlenecking exercise a control valve was struggling with the higher throughput and running 95% open. It was decided to reduce the trim thus increasing the CV of the valve. Unfortunately the fail open condition of this valve was the basis for sizing a downstream relief valve so the change compromised the plant's overpressure protection. If it had been identified as a change and sent through a change process, then HAZOP should at least have raised the question resulting in an action to confirm the sizing basis and impact on downstream relief.
   This falls into the same category as 1) above but also highlights the need for critical safety elements to be identified both in documentation, such as a Process Safeguarding manual, and physically in the field. This should include safety related Restriction Orifice Plates (RoP's) which are often omitted from documentation.

3. An old fixed ladder was to be replaced and the replacement met all relevant standards. Unnoticed, was a slight difference in the rung spacing and a projection from behind now coincided with one of the rungs. The first person to use the ladder hit their foot on the projection and fell. This would probably be classed as an occupational safety rather than a process safety hazard, but one which can occur on any process plant. Where could this have been caught? Surprisingly there is one permit to work system the author is familiar with which has a "ladder checklist" and one of the questions on this list is "projections in front, rear and sides". It should still have been classed as a change and reviewed possibly resulting in the change being implemented though the permit system.
   The failure here was not recognising this as a change requiring review.

4. A plant was close to commissioning and belatedly one of the design process engineers was informed that the specified catalyst mesh size on a reactor was not available but one slightly larger was. After checking the pellet size against the mesh the process engineer agreed to the change without further review. Unfortunately the catalyst physically shrank on reduction making it small enough to pass through the mesh where it disintegrated. This resulted in the

total loss of catalyst and unplanned shutdowns costing millions of dollars and not a few grey hairs. Had this change been subject to review following HAZOP, there were a number of people, including the catalyst manufacturer, who could have identified the problem.
The solution in this case would have been to have a control of change process in place which was rigorously applied post HAZOP.

5. A plant, who's metallurgy was largely stainless steel extensively used CAF (Compressed Asbestos Fiber) jointing, changed their supplier (this is a historical case and predates current thinking on this type of gasket). This supplier had their logo imprinted on the face of the gasket and the ink used contained chloride ions. Stress corrosion occurred and almost every flange on the plant had to be replaced. A costly exercise. Hindsight is a wonderful thing and this hazard would have been a difficult one to spot up front. Almost all of the classical HAZOP guidewords would have been irrelevant but "Composition Change" just might have triggered a question.

6. A large plant used various materials of construction from titanium through stainless steel to carbon steel depending on the levels of corrosion expected. In one particularly corrosive section of the plant a slip plate was installed to provide an isolation for maintenance. Unfortunately a carbon steel rather than stainless plate was used which fully corroded away within two days. The mistake was picked up when the isolations were removed. No injuries resulted but the potential for harm was significant. This, like some of the above examples was an unintended change caused by human error. It could have been spotted by the maintenance fitter who installed the slip plate had he been aware of the requirement. In this case the action was to remove all carbon steel slip plates from the store and have stainless as the minimum standard for the plant. Improving the process understanding of the maintenance staff was also identified as important.

The above examples illustrate:

1. The size of a change in physical or dollar terms bears no relation to the magnitude of the hazard which may be created.
2. Small changes must be recognised and caught at the coalface - the permit office, the workshop or the store. All plant staff should be trained to recognise and control a change not only by understanding the management of change procedure but by having a fundamental understanding of the process.
3. The correct type of review must be selected, appropriate for the change. HAZOP is not always the answer. FMEA , HAZID , What If, JSA, site tour or some combination may be appropriate. Guidelines on when to choose what, can help but experience is hard to replace.
4. Experience and engineering competence is essential at the operational level for those charged with identifying the hazards associated with a change. A basic understanding of the process by maintenance personnel is highly desirable regardless of their discipline.
5. **All** changes should go through a Management of Change (MOC) process to ensure that there is a record of the change, that new hazards are identified by competent persons,

that documentation is updated and that the change is authorized at an appropriate level.

6. The term “Like for Like” should mean exactly that-same make, model and version not simply the same specification. Any other definition means that discretion may be applied and the boundary as to what is and is not a change can move.
7. All elements of a safety critical system should be clearly identified both in documentation and, in the authors opinion, in the field. Documentation should include the basis for design and be readily available to plant personnel. For instrumented protection functions, unintended changes provide an additional justification for testing.

Having said all of the above it is important that the MOC procedure is not too cumbersome so good ideas become bogged down in unnecessary or inappropriate reviews. The procedure itself can become a hazard if safety related changes stagnate. The solution is to have an efficient filter with a competent person in control.

Organisational changes have not been discussed but it is recognised that budget cuts, personnel changes, manning level changes, changes to shift patterns, structural changes and maintenance strategies must all be reviewed for their impact on process safety and that companies should have senior personnel capable of understanding the implications of their decisions on process safety. This topic was specifically addressed in the Baker Panel Report following the Texas City disaster. They recommended the Centre for Chemical Process Safety (CCPS) produce guidelines on the subject. These are now available: *Guidelines for Managing Process Safety Risks During Organizational Change, Published by Wiley ISBN 978-1-118-37909-7*

Colin Feltoe C Eng, FIChemE, MIPENZ