

TREVOR'S CORNER No 2: FILLING STACKS WITH LIQUID

The reports on the explosion on the BP plant in Houston in March reminded me of another incident in which liquid entered a stack, described in a paper presented at the Mary Kay O'Connor Process Safety Center Symposium in 2001. I am not suggesting that the causes of the two incidents were in any way related but a reminder of the earlier one may be of interest.

An ethylene plant was starting up after a turnaround. At 2 am the shift team started the flow of cold liquid to the demethaniser column. A level should have appeared in the base of the column two hours later. It did not, but problems elsewhere distracted the shift team and they did not notice this until 7 am. By this time the temperature at the top of the column was -82°C (-116°F) instead of the usual -20°C (-4°F). At about this time the level in the reflux drum rose from zero to full scale in 10 minutes. This should have told the shift team that the column had flooded, had overflowed into the reflux drum and would now be filling the flare knock-out drum (see Figure). However, neither of the two level indicator/alarms on this drum, set at 8% and 22% of capacity, showed any response.

It was 12 noon before anyone had a thorough look at the column. They then found that the wires leading from the column level indicator were disconnected and that the valves between the knock-out drum and its level indicators were closed. Both vessels were shrouded with scaffolding and the state of the wires and connections was not easily seen. Liquid was now entering the flare stack. It failed as the result of low temperature embrittlement but fortunately the escaping liquid did not ignite.

The immediate causes of the incident were the failures to restore the isolations of the level instruments before start-up and the slowness of the shift teams to realize what was happening. The underlying causes were far deeper and were due to both short-term and long-term changes in organization.

Short-Term Changes

It was the practice on the plant to work 12-hour shifts instead of the usual 8-hour shifts during start-ups so that there were more people present than during normal operation. On this occasion the operators refused to do so (though they were willing to work overtime if necessary; this would give them more pay than working 12 hour shifts). However, the foremen and shift managers worked 12-hour shifts. They changed shift at 7 am and 7 pm while the operators changed at 6 am, 2 pm and 10 pm. This pattern of work destroyed the cohesion that had been built up over the years within each shift and lowered the competence of the team as a whole.

A report in the local newspaper said that, "A major influence over the behavior of the operating teams was their tiredness and frustration". A trade union leader was quoted as saying that the management team members were more tired than the operators as they were working 12-hour shifts.

In addition to the usual shift personnel, two professional engineers were also present on each shift but their duties were unclear. Were they there to advise the shift manager or, being more senior in rank, could they give him instructions? Should they try to stand back and take an overview or should they "muck in"? On the day of the incident they did the latter and got involved in the detail of the problems that distracted everyone from the demethaniser.

Long-Term Changes

So far I have followed the published report on the incident¹ but there had also been more fundamental changes. The incident shook the company. It had a high reputation for safety

and efficiency and the ethylene plant was considered one of its flagships – one of the least likely places where such a display of incompetence could occur, so what went wrong?

About seven years earlier there had been a major recession in the industry. As in many other chemical companies drastic reductions were made in the number of employees, at all levels, and many experienced people left the company or retired early. This had several interconnected results:

- Operating divisions were merged and senior people from other parts of the company, with little experience of the technology, became responsible for the ultimate control of some production units.
- There was pressure to complete the turnaround and get back on line within three weeks. This pressure came partly from above but also from within the team, as the members were keen to show what they could do. They should have aborted the shutdown to deal with the problems that had distracted everyone during the night but were reluctant to do so.
- There were fewer “old hands” on the plant who knew the importance, when there were problems, of having a look round and not just relying on the information available in the control room. A look round would have shown ice on the demethaniser column. Similar flooding of the demethaniser column had occurred several years before on the sister plant on the same site and was handled correctly but this experience had been forgotten².
- Delaying had produced a large gap in seniority between the manager responsible for the ethylene plant and the person above him. This made it more difficult for the ethylene manager to resist the pressure to get back on line as soon as possible. Previously an intermediate manager had acted as a buffer and prevented commercial people and more senior managers speaking directly to the start-up team. Also, he would probably have aborted the start-up. Senior officers, not foot soldiers, order a retreat.
- Some of the professional staff had a “passing through” attitude and took little interest in the detail.

The company had an outstanding reputation for openness but was reticent about this incident and no report appeared in the open literature, apart from the local newspaper, until about twelve years later, after the company had sold the plant.

This incident shows that before changes to organization are made they should be studied as thoroughly as changes to plants and processes. In the UK this is now required by law in hazardous industries and the regulator, the Health and Safety Executive, have issued Improvement Notices to a number of companies that lacked adequate systems for managing organizational change. I have the impression that the need to formally consider such changes is less widely recognized in the US.

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1. Anon, 2000, A major incident during start-up, *Loss Prevention Bulletin*, No. 156: 3-6.
 2. Crawley, F., Learning from past accidents – or do we? *Industrial Safety Management*, 7(1):24-29.

