THE WORK OF THE EUROPEAN PROCESS SAFETY CENTRE (EPSC) TECHNICAL STEERING COMMITTEE WORKING GROUP: 'ATYPICAL SCENARIOS'

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Atypical Scenarios – 'Known and Unknown Unknowns'

The Chemical Industrycontinues to have major accidents. Whilethese might be infrequent, they continue to have large effects on thecommunity, the environment and the economic viability of chemicals productionand use. Furthermore they are a stain on our industry's reputation andperceived value to society.

Our risk management processesaim to identify potential hazardous events, analyse them and eliminate wherepossible and provide sufficient control and protection for risks which remain.These processes have served us well when all the possible scenarios have beenidentified although 'worst cases' sometimes present special challenges. Whatremains to be accomplished is the identification of all possible scenarios.Examples such as Texas Cityand Buncefield show us that we either did not identify and anticipate theevents which actually occurred or we assumed that they were so unlikely as tobe of an acceptable likelihood or even, not worth comprehensive study.

How can we improve ourability to find and deal with 'atypical' scenarios? Our hazard identificationmethods such as Hazard and Operability and 'What if' studies are effective whensufficient creativity is allowed to identify what we can call 'atypical'scenarios. The other tools such as Fault Tree Analysis, Layer of ProtectionAnalysis and Quantitative Risk Assessment can then address a complete set ofscenarios to help us manage risk comprehensively.

TheEuropean Process Safety Centre (EPSC) has a working group which has sought tofind best practices which offer an improvement in scenario development whichaddresses these missing 'atypical' scenarios. The results of the work areencouraging and offer a way ahead. Thework builds on strengthening and enhancing the tools we already use by addingdimensions which appear to have been missed in the past. The paper describespractical steps which when properly applied will close some of the gaps in ourprocess risk management systems.

SUMMARY

The Chemical and Process Industries continue to have major accidents. While these might be infrequent, they produce large effects on the facility employees, the community, the environment and the economic viability of chemicals production and use. Furthermore they are a stain on our industry's reputation and perceived value to society.

The number of reported Process Safety Incidents has declined in most years since 1995 according to the statistics collected by the American Chemistry Council. This concern has led to the establishment of a EPSC Work Group studying the subject of Process Safety Incident Metrics and ultimately to the Work Group authoring this paper on Atypical Scenarios. The success of the Metrics group will lead to an improvement in our ability to learn and apply lessons.

Our risk management processes aim to identify potential hazardous events, analyse them and eliminate where possible and provide sufficient control and protection for risks which remain. These processes have served us well when the possible scenarios have been identified although 'worst cases' sometimes present special challenges. What remains to be accomplished is the identification of all possible scenarios. Major Accident examples such as Texas City and Buncefield show us that we either did not identify and anticipate the events which actually occurred or we assumed that they were so unlikely as to be of an acceptable likelihood or 'had never happened' or even, not worth comprehensive study. The same pattern emerges from studies of the Fukushima Nuclear Power plant tragedy in Japan where large amplitude tsunamis had been experienced several times in the last 500 years.

How can we improve our ability to find and deal with these 'atypical' (ref 1) scenarios? Our hazard identification methods such as Hazard and Operability and 'What if' studies are effective when sufficient creativity is able to identify what we can call 'atypical' scenarios. The other tools such as Fault Tree Analysis, Layer of Protection Analysis and Quantitative Risk Assessment can then address a complete set of scenarios to help us manage risk comprehensively. The studies carried out with Hazard Identification and Risk Assessment tools appear in some cases to come up short where worst cases are concerned.

The European Process Safety Centre (EPSC) has a working group which has sought to find best practices which offer an improvement in scenario development which addresses these missing 'atypical' scenarios. The results of the work are encouraging and offer a way ahead. The work builds on strengthening and enhancing the tools we already use by adding dimensions which appear to have been missed in the past. This report describes practical steps which when properly applied will close some of the gaps in our process risk management systems.

If we categorise events into:

- 'known knowns' – Events which we know about and can plan to prevent or control
- 'known unknowns' – Events which we can predict even if they have not occurred yet
- 'unknown knowns' – Events which have occurred but we have failed to remember and study (e.g. loss of corporate memory)
- 'unknown unknowns' – Events which we have so far failed to predict or have been dismissed as unrealistic.

We might see how our Hazard Identification and management processes can be used for each.

Process Hazard Analysis: Is often driven by a questionnaire which embodies much of the learning experience of the company. A more detailed formal examination of worst cases within the analysis has been shown to yield good results. This includes a strict requirement to cover relevant events from history from the industry and predefined worst cases. As an example, the U.S. Environmental Protection Agency Risk Management Plan (RMP) requires that Vapour Cloud Explosion is included in studies for any flammable material.

HAZOP Study: Is frequently carried out in the steady state and reliance is often dominated by 'credible' versus 'worst cases'. Furthermore, worst cases may be consigned to the mitigation offered by emergency plans. Here seem to be missed opportunities which might be helped by starting with the worst cases and working backwards through a HAZOP process to determine root causes.

Risk Assessments such as LOPA and to a lesser extent QRA will not be fully effective if they are not presented with the scenarios to study. The paper gives examples of company practices which effectively 'mandate' a core set of scenarios which must be studied. This allows a much more strict inclusion of potential events from the technology and history which might not be known by today's generation of operations.

We might conclude that:

- We sometimes fail to identify some significant scenarios through: limitations of our methods or
- We might be unaware of events which have happened in the past and could apply to us.
- So called 'unknown unknowns' are in many cases to be found in history or in a more creative approach to worst case scenarios and their management.

The activity of Process Hazard Analysis can be

The EPSC 'Scenarios' group all have a formal approach to Hazard Identification in their:

- Project Management
- Normal Operations
- Management of Change

The Hazard Identification method of choice is usually built into the Process Hazard Analysis and HAZOP methodologies although member practices are not identical. Where HAZOP is concerned, all members carry out studies in the steady state, but HAZOP is not always conducted for start up and shut down phases. These critical phases are not overlooked but are covered by detailed instructions which include potential hazards and their consequences. The predominant cases in these studies are 'credible' and 'from learning experiences' and rely very much on the discipline and creativity of a properly constituted and competent team.

Whilst efforts are made to study worst cases may occur in HAZOP, events seem to show that we are not always successful. Indeed, even when a worst case scenario is considered, HAZOP may not be the best method to study it. If this is true, the 'bow tie' has potential to become the method of choice.

What comes out of this and a review of company practices could be an approach which says:

We need to gain consistency from our Hazard Identification practices:

- Address steady state comprehensively (e.g. HAZOP or FMEA or 'What if')
- Ensure that complementary start up and shut down studies are included in Hazard Identification (and study)

And there is much to be gained from:

- critical task analysis and
- human error analysis

in predicting atypical events and managing them better and exploit them for the 'known knowns', 'known unknowns', 'unknown knowns' and use a creative approach to imagine the 'unknown unknowns' which can be studied with 'bow tie' analysis and perhaps controversially study them with a 'reverse' HAZOP approach where we start with the worst case consequence and work out what can initiate or fail for the full impact to be realised. We may imagine that the likelihood of all the holes in the Swiss Cheese aligning is very unlikely or unimaginable.... but can we be sure?

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