A Note on the Data Requirements for Predicting Risks in the LUP Advisory Context

Background

At the Buncefield Board Meeting on 22nd March 2007 I was asked by Dr Peter Baxter about the data requirements for making predictions of Individual Risk and Local Societal Risk. I realise, with the benefit of further thought, that the response I gave was incomplete and, therefore, potentially misleading. In order to avoid misunderstanding I thought it necessary to produce this note.

Definitions and Assessment Processes

Individual Risk is '*the frequency with which an individual may be expected to sustain a given level of harm from the realisation of specified hazards*' (1). In most cases the calculation is performed in respect of a representative or hypothetical individual. In HSE LUP practice, calculations are performed in respect of a '*hypothetical house resident*' and judgements in other cases related to this base assessment.

Local Societal Risk is '*the relationship between frequency and the number of people suffering from a specified level of harm in a given population from the realisation of specified hazards*' (2).

Predictions of Individual Risk and Local Societal Risk start from the same representative set of major accidents. It is necessary to be able to predict:

- the likelihood (frequency) of each accident (e.g. major release of LPG from a failed vessel); and,
- all the conditional probabilities that determine how the initial accident will proceed to its various possible outcomes (e.g. does the LPG cloud ignite immediately, does it drift away and ignite later or not at all and, if it ignites, does it burn as a flash/cloud fire or as a VCE); and,
- predict the hazardous effects associated with each of these possible outcomes (for example the magnitude of the thermal radiation or explosion overpressure, and how it various with distance); and,
- the consequences of each of these hazardous effects on a person at any particular location, taking account of any situation or ability of the person to mitigate the effects of the hazards (for example being in a building or being able to move away from a source of thermal radiation).

In many cases no attempt is made to model the full complexity of each situation, especially where this can change over time in an uncontrolled or unmonitored way. The protection concept is an example of a system where much complexity is not modelled although it starts from the same representative set of major accidents.

Data Requirements

Local Societal Risk

Predictions of Local Societal Risk require the most complete dataset in order to perform the calculations. In particular details of the local population, in terms of numbers, locations and patterns of occupation are required. This can be difficult to obtain and keep up to date. The Office for National Statistics does this once in every 10 years for occupied premises, but would needed to be supplemented by establishing data about significant transient populations such as those on major traffic routes and major sports stadiums.

Once completed, predictions of Local Societal Risk do not lead directly to zones on a map that can be used to make decisions in individual cases. The contributions to the overall risk from existing development might

[1] Nomenclature for Hazard and Risk Assessment in the Process Industries (second edition) – Institution of Chemical Engineers, 1992, ISBN 0 85295 297 X
[2] ibid

be used to set zones but this is zoning the 'here and now' rather than zoning for 'what might be'. The latter seems to me to be the correct approach and distinguishes a regulatory QRA from an LUP advisory QRA.

Individual Risk

Predictions of Individual Risk do not require any knowledge of local population. The prediction, and hence the zones, are the same for a green field area as they are for a built up area. The only changes that trigger a change of zones are on-site changes to plant and processes. These may be controlled as part of the PHS Consent (such as bulk tank capacities, and locations) or not (such as numbers of transfers to/from road tankers, and process throughput generally).

Some of these process changes are quite subtle and unlikely to be detected. For example if chlorine supply by road tanker changes from company A to company B (often part of the normal process of periodic contract re-tendering), it may be that the modelling of transfer releases changes significantly due to different tanker designs. The risk from transfer operations of chlorine often determines the size of the inner zone. These considerations apply equivalently when making predictions of Local Societal Risk.

Protection Concept

Zones based on the Protection Concept (contrary to popular belief) start from the same representative set of major accidents. It requires the same knowledge of events, their outcomes and consequences to hypothetical exposed persons. Knowledge of major accident frequencies is also required but in less detail. For example if there is one dominant event which is predicted to occur at a high enough frequency then it can be used as the basis for all three zones.

An example might be the BLEVE fireball from a pressure liquefied LPG tank, an event which creates the same hazardous thermal effects in all directions equivalently. If this is predicted to occur at a frequency of not less than 1 in 100,000 per year than it may be used to set all three zones (at different effect levels). If the predicted frequency were lower, then a less hazardous but more likely accident would set the inner zone. Continuing with the example of a pressure liquefied LPG tank, such an accident might be a jet fire from fractured pipework. Similarly if there were a more hazardous accident predicted to occur at a lower frequency then its predicted hazardous effects might only be used as the basis for an outer zone or perhaps considered too unlikely to set any zone.

Summary

I have set out these assessment methods in order to illustrate a hierarchy from the most to least demanding. They all have their strengths and weakness and many authors have written entire books on the subject. The protection concept and individual risk based methods have found a niche dealing with developments near existing hazardous installations and pipelines. Local societal risk methods have found a niche dealing with the establishment of new hazardous installations and pipelines and the periodic reassessment of local, regional or national situations.

The right method to use in each case is that which strikes the right balance between complexity of application and quality of decision outcome. In this case quality of decision outcome is the LUP advice given and not the elegance of risk numbers, or lines on a map.

Final Thoughts

The best is the enemy of the good. — Voltaire (1694–1778)

He who is determined not to be satisfied with anything short of perfection will never do anything to please himself or others. — William Hazlitt (1778–1830)

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