



Код: 10469

Use of the FORM/SORM (most likely failure point) method for uncertainty analysis

Издательство WS Atkins Science & Technology

115 стр; формат: 30 x 21 см; библиографический список: 20 единиц.

The FORM/SORM method (alternatively referred to here as the most likely failure point method) has been used to perform uncertainty analysis for a range of hazard consequence calculations, namely: chlorine release (toxic dose); BLEVE fireball (thermal dose); BLEVE blast (overpressure) and VCE blast (overpressure).

Realistic semi-empirical models, such as those which would be employed in a practical hazard/risk analysis, were used in all cases.

The method was used to calculate the probability P_f that the estimate of hazard consequence, calculated on the basis of best-estimate data to be below an appropriate safety limit, would actually exceed that limit when data uncertainties are taken into account.

In each case, the method produced its estimate of P_f within roughly 10N-20N evaluations of the consequence model, where N is the number of input data items represented as uncertain. Values of P_f were within 10%-20% of values obtained using a benchmark Monte-Carlo calculation, which was much less efficient.

Numerical experiments were carried out to investigate the accuracy of the sensitivity estimates produced by the method, ie the sensitivity of P_f to a change in median value of each variable, the sensitivity of P_f to a change in standard deviation of each variable and the effect on P_f of replacing uncertain variables by fixed values.

The estimates were shown to be accurate within a factor of about 2. This was concluded to be more than adequate for the purposes of screening out unimportant variables and of identifying areas where calculated values of P_f (which in many cases can be identified with risk) could be reduced by improved data accuracy.

A preliminary investigation was carried out into the representation of quantities used to characterise weather conditions (wind speed, wind direction and Pasquill stability category) by continuous distributions rather than the discrete distributions of conventional quantified risk analysis. For the chlorine release calculations, the method correctly identified that calm conditions, though relatively rare, can strongly influence risk because of the high doses they give rise to.

This report and the work it describes were funded by the Health and Safety Executive. Its contents, including any opinions and/or conclusions expressed, are those of the authors alone and do not necessarily reflect HSE policy.

Ключевые слова:

Содержание.

1. Introduction /
2. The FORM/SORM method /
 - 2.1. Description of the general problem /
 - 2.2. Transformation of the basic variables /
 - 2.3. Location of the most-likely failure point /
 - 2.4. Approximation of the failure probability integral /
 - 2.4.1. The FORM approximation /
 - 2.4.2. The SORM approximation /
 - 2.5. First-order importance and sensitivity measures /
 - 2.5.1. Sensitivity of the quantity of interest to variations in the basic variables /
 - 2.5.2. Contributions of each variable to the failure probability (importance) /
 - 2.5.3. Sensitivity of the failure probability to changes in assumed mean values /
 - 2.5.4. Effect of replacing an uncertain variable by a constant /
 - 2.5.5. Discussion /
3. Selection of test cases and consequences /
 - 3.1. Scenarios /
 - 3.1.1. Chlorine release /
 - 3.1.2. BLEVE /
 - 3.1.3. VCE /

- 3.2. Consequence models and quantities of interest /
 - 3.2.1. Chlorine release /
 - 3.2.2. BLEVE /
 - 3.2.3. VCE /
- 4. Chlorine release calculations /
 - 4.1. Consequence model /
 - 4.1.1. Source term /
 - 4.1.2. Gravity-driven phase - gas transport /
 - 4.1.3. Gravity-driven phase - slumping and air entrainment /
 - 4.1.4. Transition to passive dispersion /
 - 4.2. Instantaneous release case /
 - 4.2.1. Selection of the uncertain variables /
 - 4.2.2. Description of the median case /
 - 4.2.3. Search for the most-likely failure point /
 - 4.2.4. Investigation of sensitivities /
 - 4.2.5. Further elimination of variables /
 - 4.3. Continuous release case /
 - 4.3.1. Selection of the uncertain variables /
 - 4.3.2. Description of the median case /
 - 4.3.3. Search for the most-likely failure point /
 - 4.3.4. Investigation of sensitivities /
- 5. BLEVE and VCE calculations /
 - 5.1. BLEVE fireball model /
 - 5.1.1. Combustion /
 - 5.1.2. Combustion products /
 - 5.1.3. Fireball temperature /
 - 5.1.4. Solution of equations /
 - 5.1.5. Calculation of thermal dose /
 - 5.2. BLEVE blast model /
 - 5.3. VCE blast model /
 - 5.4. BLEVE fireball model - results /
 - 5.5. BLEVE blast model - results /
 - 5.6. VCE blast model - results /
- 6. Discussion and conclusions /
 - 6.1. FORM/SORM (most-likely failure point) method: theory and FARSIDE development /
 - 6.2. Use of method for consequence calculations /
 - 6.2.1. Calculation cost /
 - 6.2.2. Accuracy of failure probability prediction /
 - 6.2.3. Use of by-product information /
 - 6.2.4. Other observations /
 - 6.3. Discussion of future applications /
 - 6.3.1. Other consequence models /
 - 6.3.2. Calculation of risk /
 - 6.3.3. Inclusion of wind direction as an uncertain variable /
 - 6.3.4. Probability distributions for weather variables /
- 7. References /
- Tables /
- Figures /
- Appendix A. Inclusion of second-order (SORM) approximation in farside /
- Appendix B. Derivation of first-order importance and sensitivity formulas /
- Appendix C. Probability distributions available in farside /