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Practical approaches to QRA in fire protection engineering.

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The goal of this presentation is to discuss QRA methods in the area of fire engineering from own engineering experience and from a wider fire community and literature. QRA usually involves issues such as input data and scenarios, models, uncertainty, sampling techniques and assessment criteria. All these elements are often difficult to address in practical QRA due to lack of data, knowledge or because of stochastic nature of fire events or lack of appropriate tools or models which facilitate such analysis. Typically the first difficulty is to address fire initiation i.e. its frequency and modes. Unfortunately such data is often hard to find for many specific applications. Further progress of analysis depends on the type of event modeling is selected. The least complex approaches involve fault trees, event trees, bow tie and other methods which are also popular in process safety and nuclear engineering. These methods involve some assumptions on probabilities both for protection systems and human response to characterize their performance and reliability. This stage must also include some characterization of the interactions between protection measures. All this event analysis typically requires significant amount of expert judgment. A more quantitative approach involves physical fire modeling of multiple scenarios which is based on models with complexity level that is carefully selected for the problem at hand. In such cases either the whole fire is modeled or only selected fire phenomena which are particularly relevant. Typically the central issue is design fire characteristics –fire spread rate, heat release rate, smoke generation and the resulting fire development and all related events strongly depend on fire input data and their associated uncertainty. Multiple scenario calculations accumulated using some sampling technique such as Monte Carlo can give us risk profiles which are usually more representative in terms of risk than a single scenario calculation. The last stage of QRA involves the assessment and ranking of consequences – typically in terms of human, monetary or environmental losses. A separate issue is the selection of acceptance criteria which must be established or adopted. Very often due to lack of absolute criteria some comparative criteria are used where risk levels are compared with existing standards or legally accepted solutions. Full QRA in fire engineering is a complex process and ideally it should be done using comprehensive engineering tools. Many attempts have been made in this area in fire engineering discipline but there is still a significant need for integrated analytical tools. Some existing tools will be discussed together with some own solutions.

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