Safety Corner

What is the probability of fire-induced damage or personnel injuries?

In a typical fire safety calculation, a subject is considered damaged when the characteristics of the environment, such as the temperature or impinging heat flux, exceed the corresponding thresholds of the subject. For example, if a fire causes the temperature of power or control cables to exceed their rated damage temperature, the cables are considered damaged and unable to perform their intended functions. Often, the time to damage, t_D, would be compared to the time to control the fire by suppression efforts, t_C; i.e., damage occurs if t_C exceeds t_D. While t_D can be calculated by tools such as CFD simulation, t_C are estimated by the sum of detection time, decision time and time to suppress the fire. If human life is in concern, t_C would also include the estimation of evacuation time. This approach yields a discrete answer of “yes” or “no” in addressing whether a subject can be damaged by a given fire size.

However, uncertainties exist because the exact value of the parameters supporting the calculation of t_C and t_D may never be known in real life situations; e.g., the thermal properties and damage thresholds of a cable installed years ago may be changed due to ageing, the evacuation time of a large crowd will never be exact. Therefore, it is unreasonable for a QRA to base on only one set of input parameters to assess the fire risk of a situation. Thus, t_C and t_D should be represented by probability distributions as discussed in the Jan-09 issue of this Corner, and the answer to the question whether a subject can be damaged in a given scenario should then be a probability that measures our level of belief that the subject will be damaged with a value between 0 and 1 instead of just 1 or 0 for yes or no. (This also demonstrates the differences between a Bayesian risk analysis and a classical statistical analysis in dealing with hypothesis testing.)

Mathematically, the probability of fire-induced damage, or called the fire non-suppression factor f_{NS}, is then the fraction of $F(t_D) < F(t_C)$, where $F(t_D)$ and $F(t_C)$ are probability distributions. We will address how to assess f_{NS} = Fraction $[F(t_D) < F(t_C)]$ in the next issue.

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