Safety Corner

Addressing Uncertainty in a Risk Assessment

In a risk assessment, uncertainty exists in the parameters and the models used to address the physical phenomena and the system under study. In general, there are two types of uncertainties: aleatory uncertainty and epistemic uncertainty.

Aleatory uncertainty, or statistical uncertainties, is the type of uncertainty that arises because of natural, unpredictable variation in the performance of the physical world or the system under study. An increase in knowledge may be useful in quantifying the uncertainty but is not expected to reduce aleatory uncertainty. Epistemic uncertainty is due to limited knowledge about the physical phenomena or the system under study and can be reduced with increased knowledge through a better understanding of the system.

Distinctions between the two types of uncertainty in risk assessments are mainly for our convenience in understanding and investigating complex phenomena. Probability is used as a measure of degree of belief for both types of uncertainty. Risk values should be expressed as probability distributions, not point estimates, to address underlying uncertainties. It must also be noted that a risk assessment using generic values for input parameters rather than system-specific values cannot be trusted to represent the particular system under study.

Probably distributions can be continuous or discrete. Continuous distributions have a smooth profile, in which any value within the limits can occur, with a different probability. If a variable can only be represented by discrete items, a discrete distribution should be used. There are also other ways to describe the form of probably distributions used to represent uncertainties in a risk assessment:

- Bounded or unbounded: Unbounded distributions extend to infinity or vanishingly small number at the tail ends; e.g., a normal distribution; and
- Parametric or non-parametric: Parametric distributions are theoretically derived, after making assumptions about the nature of the process being modelled, e.g., in an exponential distribution. Nonparametric distributions are those that are artificially created; e.g., triangular distributions, to capture our level of belief of the characteristics of the uncertainty.

==========

The Safety Corner is contributed by Ir Dr. Vincent Ho, who can be contacted at vsho.hkarms@gmail.com