Calculation of Importance Measures For Use In SSC Categorization

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Overview

- Intended Use of the Categorization
- Risk Achievement Worth
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- Fussell-Vesely
  - Definition
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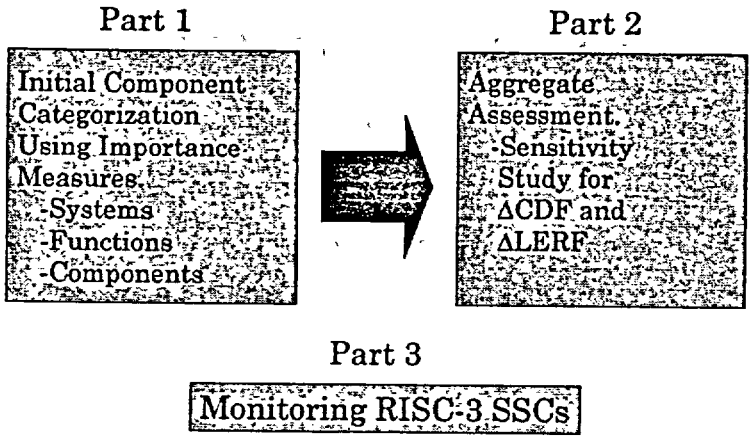
Option 2



RAW Definition

The Risk Achievement Worth of a basic event or group of basic events that represent a feature ***i*** of a system (component, sub-system, train or the entire system) is represented by:

$RAW_i = R^+_i/R_0$

where:

R_0= base (reference) case overall model risk,

R^+_i = the increased risk level without feature ***i***

Component RAW Calculation

- A correct calculation of RAW for a component is performed by removing the component from the model, re-solving the model and calculating the ratio of the risk metrics indicated by the definition.
- Consider the following example: a three component system (A, B & C) requiring the failure of all three components to fail the top event.

Component RAW Calculation

Calculate RAW_A:

$$R = A \cap B \cap C + AB \cap C + AC \cap B + BC \cap A + ABC$$

$$R_A + = B \cap C + BC^*$$

$$RAW_A = \frac{B \cap C + BC^*}{R}$$

Component RAW Calculation

To demonstrate the problem with the approach of calculating R^{+}_{A} by taking the complete solution for the system and setting all events related to component A to TRUE (A, AB, AC, and ABC) as suggested by the DG. The result would be:

$$R_A+ = B \cap C + C + B + BC + TRUE = TRUE$$

Which is obviously not a result equivalent to:

$$R_A+ = B \cap C + BC^*$$

Component RAW Calculation

- Complete RAW calculations are too time consuming for all the components in a typical PRA.
- An acceptable method for RAW estimation is to use the largest basic event RAW value for those events related to the component, excluding common cause.
- This produces an approximate result equivalent to setting a basic event that fails only the subject component to TRUE.

System RAW Calculation

- A correct calculation of RAW for a system is performed by removing the system from the model, re-solving the model and calculating the ratio of the risk metrics indicated by the definition.
- An acceptable method for RAW estimation is to use the largest basic event RAW value of those events whose failure results in system failure, often this is a common cause event.

FV Definition

The Fussell-Vesely Importance of a basic event, or group of basic events that represent a feature ***i*** of a system (component, sub-system, train or the entire system) is represented by:

$$FV = 1 - \frac{R_I}{R_0}$$

where:

R_0= base (reference) case overall model risk,

R_i = the decreased risk level with feature ***i*** completely reliable.

FV Calculation

The methodology for the calculation of FV for a component consists of the following steps:

Set the value of the basic events associated with the feature to FALSE,

Solve the model to determine the value of R_1

Calculate the value of FV for the feature using the result from step 2 and the reference risk value R_0

It can easily be shown that estimation of FV values for any feature can be accomplished by summing the FV importance for all basic events related to the feature. This estimate will be greater than or equal to the actual value.

Conclusion

- The method for importance measure estimation in NEI 00-04 are acceptable for assessing preliminary risk significance of SSCs.
- Estimation of the risk impact of the proposed change is addressed through the final sensitivity study.

ASSESSMENT OF CANDIDATE SAFETY SIGNIFICANCE