



Fire SDP: Proposed Quantification Approach

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Working proposal is to quantify up to three discrete fire damage states:

- **FDS0: fire damages only initiating component(s)
– not a risk contributor, not quantified**
- **FDS1: localized fire damage to unprotected
equipment near the fire source**
- **FDS2: widespread fire damage within fire area
including all unprotected equipment and
protected equipment if barrier is degraded**
- **FDS3: fire spreads to an adjacent compartment
given degradation of inter-compartment barrier
element – may involve sub-scenarios**



Which FDS is of interest depends on nature of the finding

Examples:

- **A degraded fire area boundary element would impact only FDS3 – room to room fire spread**
- **A degraded raceway fire barrier would impact only FDS2 – damage to protected equipment within fire area**
- **A degraded fire suppression system might impact all three FDS's**
 - **We may want a method to screen one or more FDS's for such examples**



Approach uses 3-term equation derived from fire PRA:

$$\text{Risk} = f_{\text{fire}} \times P_{\text{damage state}} \times P_{\text{core damage}}$$

F_{fire} = fire frequency

$P_{\text{damage state}}$ = likelihood of reaching FDS
given the fire

$P_{\text{core damage}}$ = likelihood that SSD fails given
fire damage state



Findings quantified based on impact to one of the three terms

- **Fire frequency, e.g.:**
 - **Administrative control issues**
- **Likelihood of FDS being reached, e.g.,**
 - **Fire detection and suppression**
 - **Manual fire brigade**
 - **Fire barriers**
- **Likelihood that SSD fails, e.g.:**
 - **Remote shutdown findings**
 - **Manual actions**



P_{damage state} is critical factor

- **Question asked: Given a particular fire, what is the likelihood that FDS'n' is reached?**
- **Most FP features will be credited in this term**
 - **Fire detection**
 - **Fire suppression (fixed and manual)**
 - **Fire barriers (local and inter-area)**
 - **Most compensatory measures (except those impacting fire frequency)**
- **This would be the place for severity factors as well**
 - **Likelihood of a fire capable of reaching FDS'n' if unsuppressed**



P_{damage state} (cont.)

- **Proposal is to tie the scenario and all credited factors to time:**
 - Time to reach fire damage state
 - Time to suppress fire
- **Most fire protection findings would impact one of these two times:**
 - Damage occurs more quickly (e.g., fire spread through a degraded fire barrier), or
 - Fire takes longer to put out (e.g., a degraded fire detection or suppression system).
- **Degradations would need to be quantified accordingly – in a time context**



For inspectors:

- **Provide a “road map” - starting with a finding and running through the analysis path:**
 - **Which FDS to quantify (one or more – yet to be defined)**
 - **Which factors in the equation need to be adjusted**
 - see flow chart for a working draft of this part
- **Provide look-up tables for fire damage times and fire suppression times**
 - **Use “high likelihood” values rather than a distribution**
 - **Requires that we define some set of fire scenario conditions that correspond to anticipated scenarios**
 - e.g., heat release rates, locations, distance to targets, room size for hot layer, availability of detection and suppression, etc.
- **Lead them through quantification of each term**
- **Use of discrete damage states should make this possible**

