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**

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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

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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

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$P_{damage\ state}$ 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

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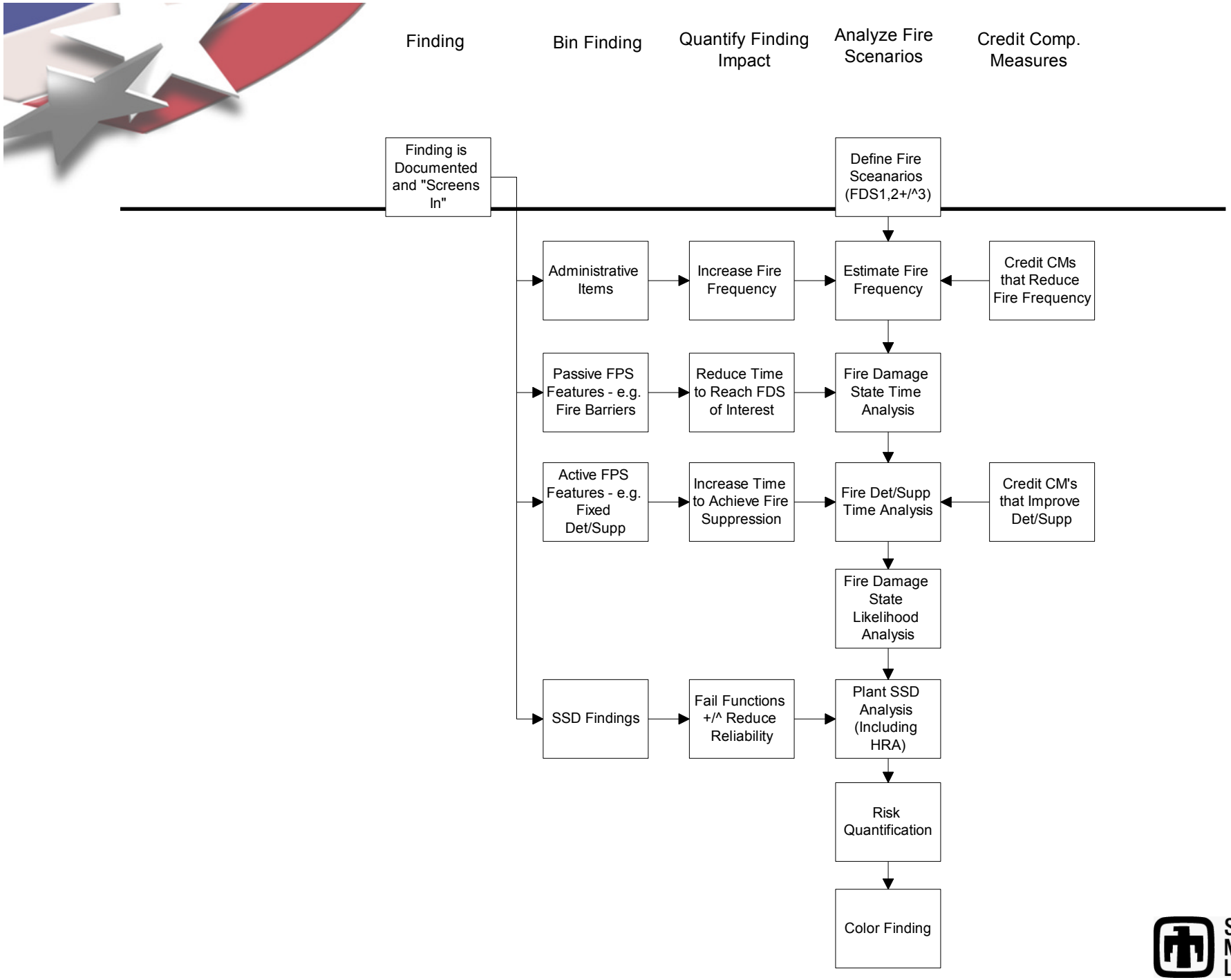

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