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IMPROVED TREATMENT OF MANUAL SUPPRESSION IN FPRA

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**Office of Nuclear
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Background

- NUREG/CR-6850 (EPRI 1011989) “EPRI/NRC-RES Fire PRA Methodology for Nuclear Power Facilities” treats manual suppression via prompt detection/suppression, and delayed detection followed by suppression
- Delayed detection leads to manual actuation of fixed suppression system, and to manual suppression by the fire brigade
- Credit for manual suppression provided in NUREG/CR-6850 only after full fire brigade arrives at the site of the fire.



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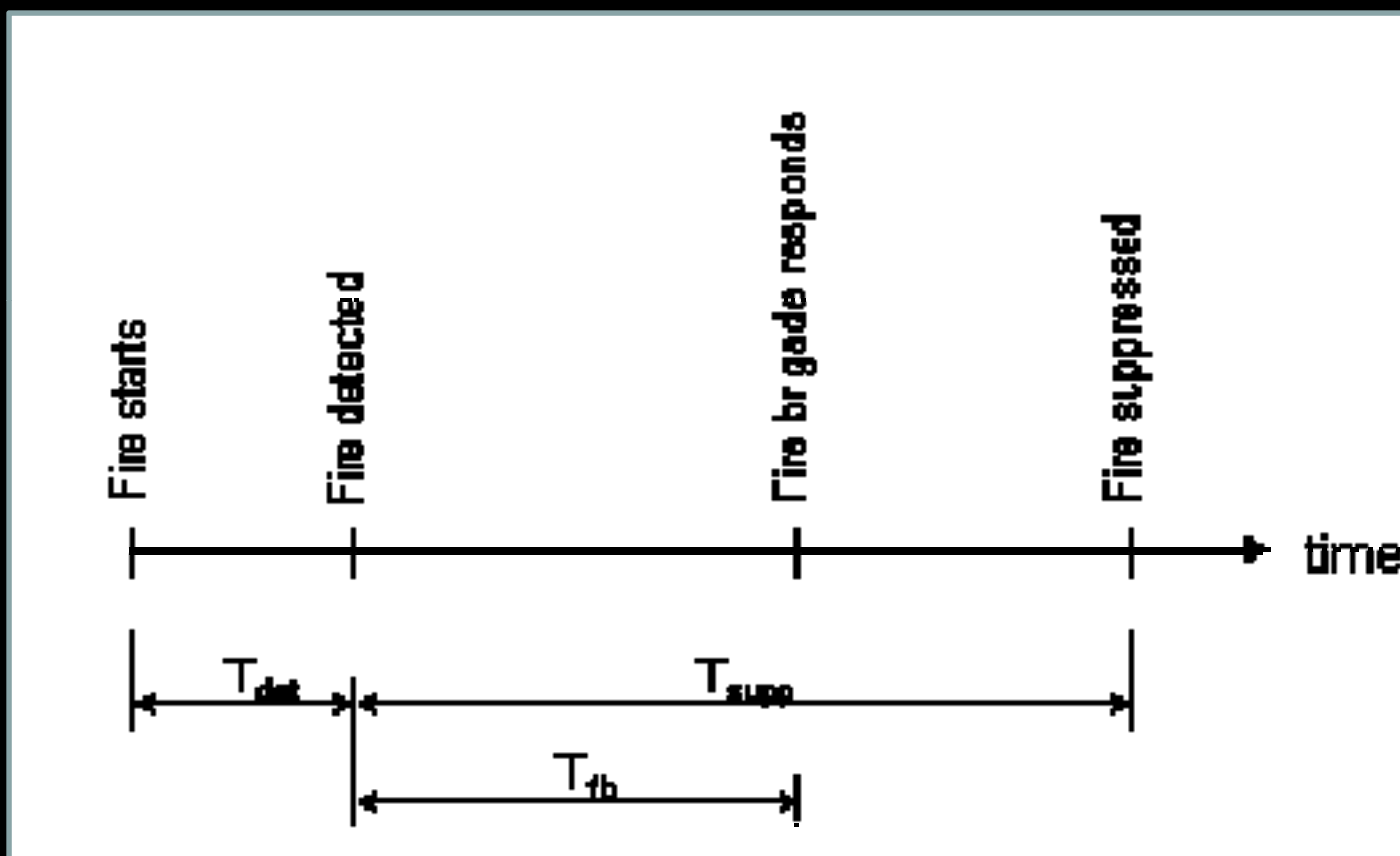
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Overview of New Approach

- New approach developed as part of NFPA 805 Frequently Asked Questions (FAQ) program: FAQ 08-0051 on manual suppression in nuclear power plants
- Motivation: Review of data from EPRI Fire Event Database showed that many fires detected and extinguished by plant personnel
- Solution consists of two phases
 - Phase 1 where fire brigade response is consistent with plant average
 - Phase 2 where scenario specific fire brigade response modifies average in phase 1
- To apply solution, must be feasible for plant personnel to perform suppression actions prior to full brigade arrival



Timeline



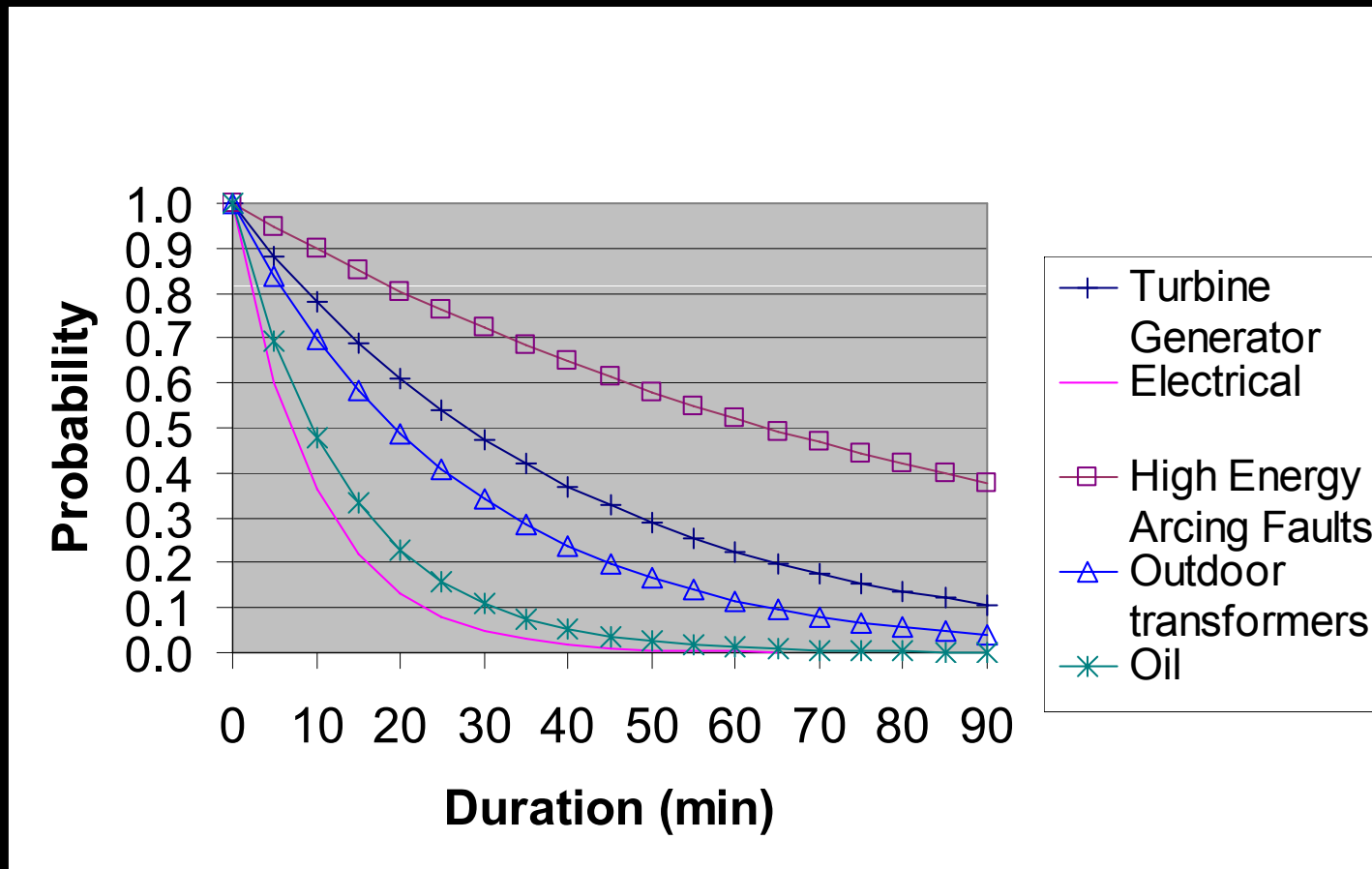


Phase 1 Approach

- $P_{ns}(t) = \Pr(T_{supp} \geq t) = e^{-\lambda t}$,
- $P_{damage} = \Pr(T_{supp} \geq [\langle T_{damage} \rangle - \langle T_{det} \rangle])$
 - $P_{ns}(t)$ is the probability of non-suppression
 - λ is the suppression rate
 - T_{supp} is the time from detection to suppression
 - T_{det} is the time from ignition to detection
 - T_{damage} is the time until damage (of cables)
- Change in FAQ 50 λ is at most 40% less than that of NUREG/CR-6850, although in most cases, is much closer (however suppression time is defined differently)

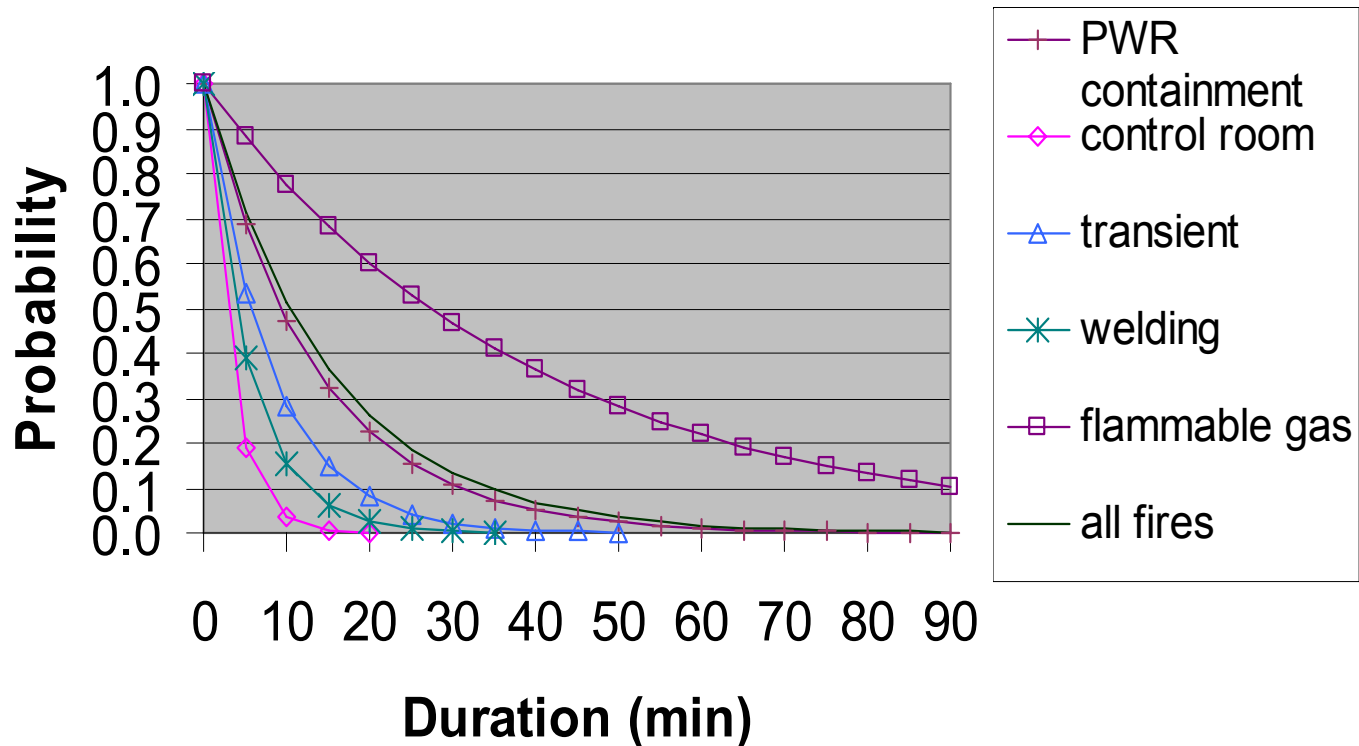


Phase 1 Results: Probability of Non-suppression





Phase 1 Results (cont.)

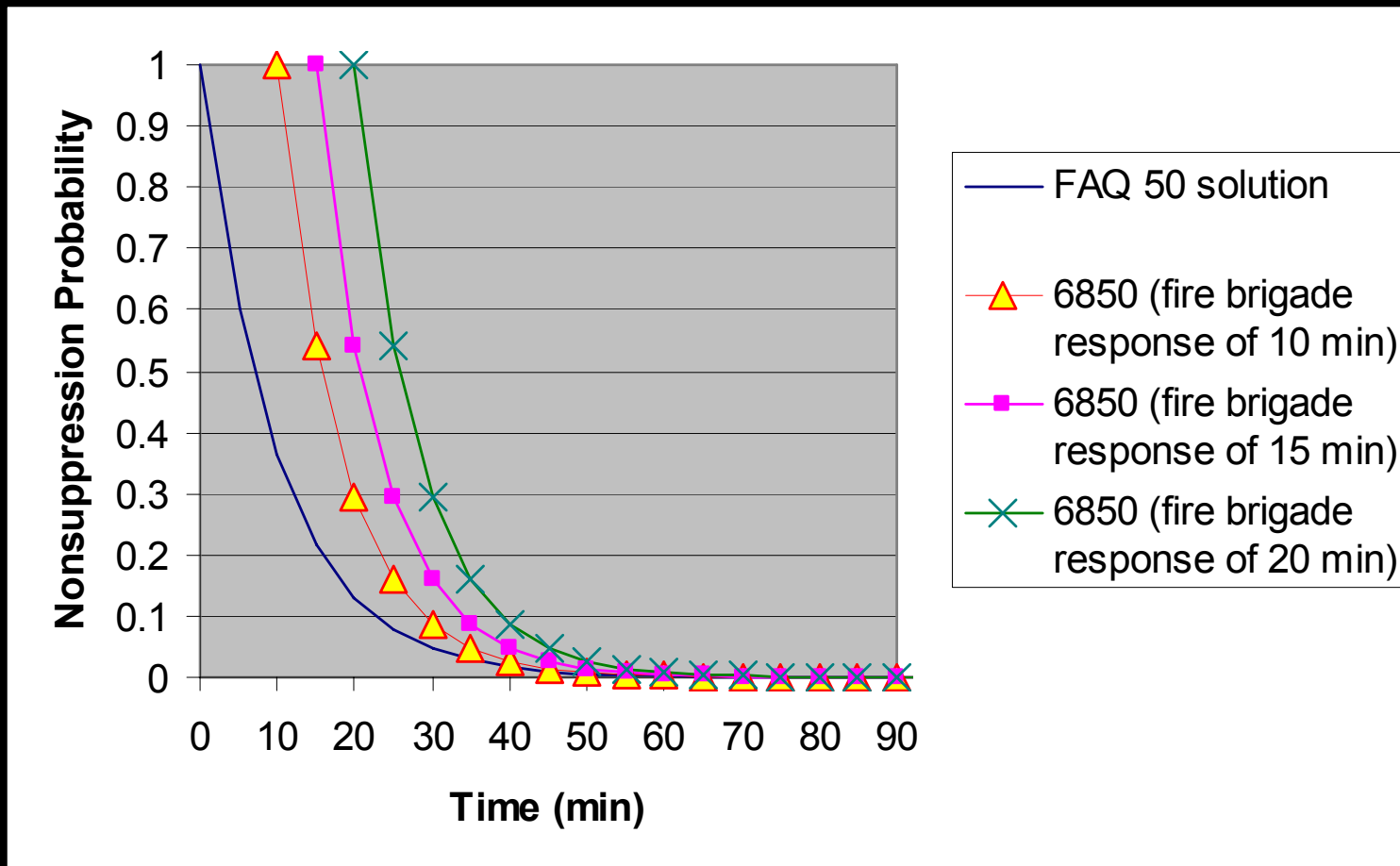




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Comparison of FAQ 50 and 6850



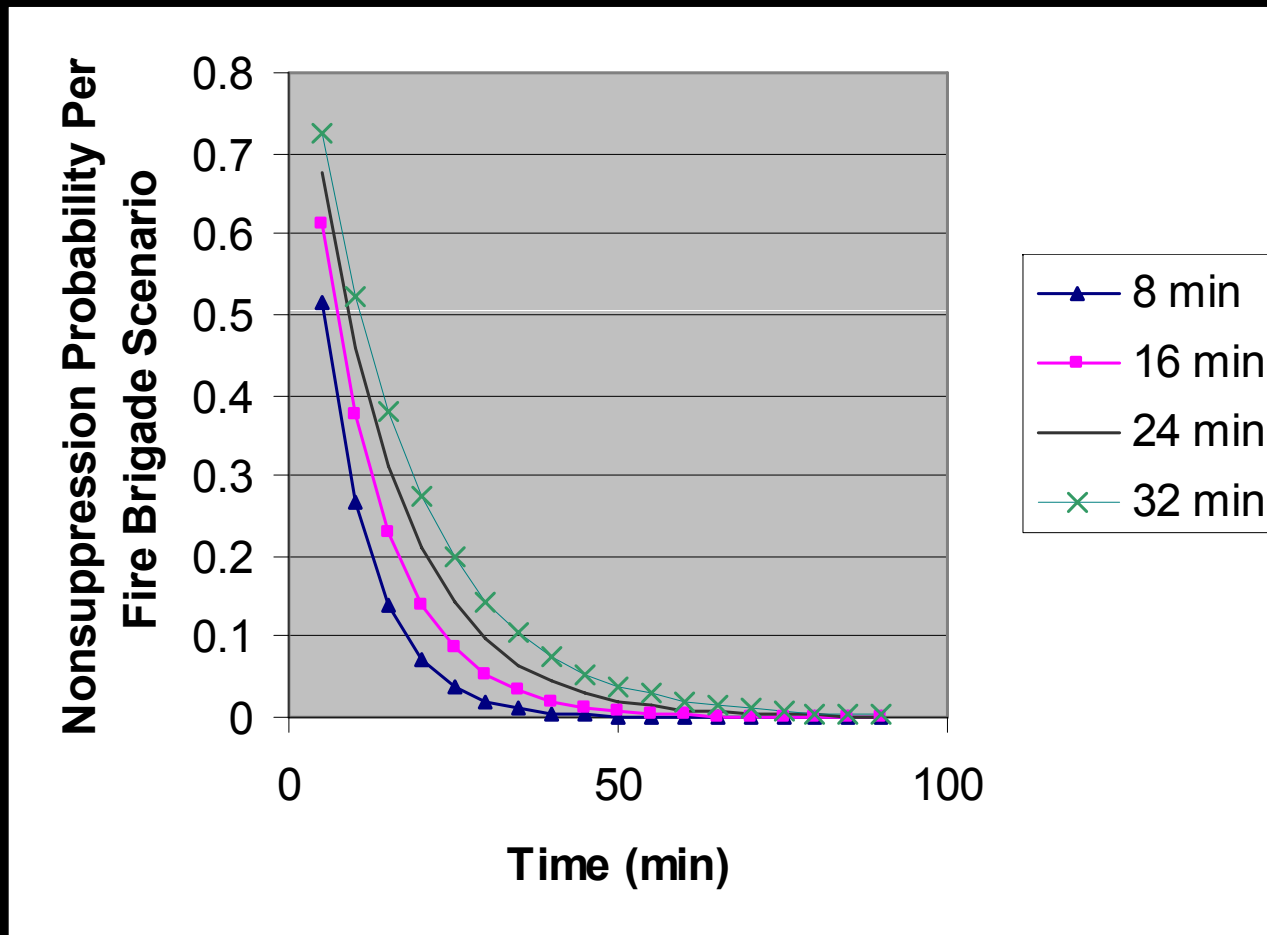


Phase 2

- Phase 2: Adjusting for fire brigade scenario specific response (in cases much different from plant average)
- $P_{ns}(t) = e^{-\lambda(t \cdot SC)}$,
- $SC = 1 - [(\langle T_{fb-s} \rangle - \langle T_{fb-a} \rangle) / (\langle T_{fb-s} \rangle + \langle T_{fb-a} \rangle)]$
- Correction factor provides correct behavior for scenario specific brigade response relative to plant average, and reflects the potential for plant personnel suppressing fire



Scenario Specific Brigade Responses





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Data Issues

- Suppression time not provided for substantial number of fire events
- Fire brigade role unclear in many events (fire brigade may have responded, but did they play a role in suppression?)
- Data provided insufficient for benchmarking intervention vs. fire growth (generally times reported only for fire discovery and extinguishment)



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Research

- RES/EPRI updating fire events database
 - Greater detail for detection/suppression
 - Anticipate suppression information to be regularly provided
- Potential future research
 - Construct parallel suppression paths
 - Plant personnel and first responder
 - Full fire brigade efforts
 - Investigate control versus extinguishment



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Summary

- FAQ 50 provides credit for suppression activities prior to full brigade
 - Removes conservatism in original NUREG/CR-6850 approach
- Scenario specific approach developed to accommodate brigade responses different from typical
- Research identified to improve modeling approach