



Detection and Suppression

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Outline

- nature of the event data
- detection trends
- suppression trends
- fire duration insights

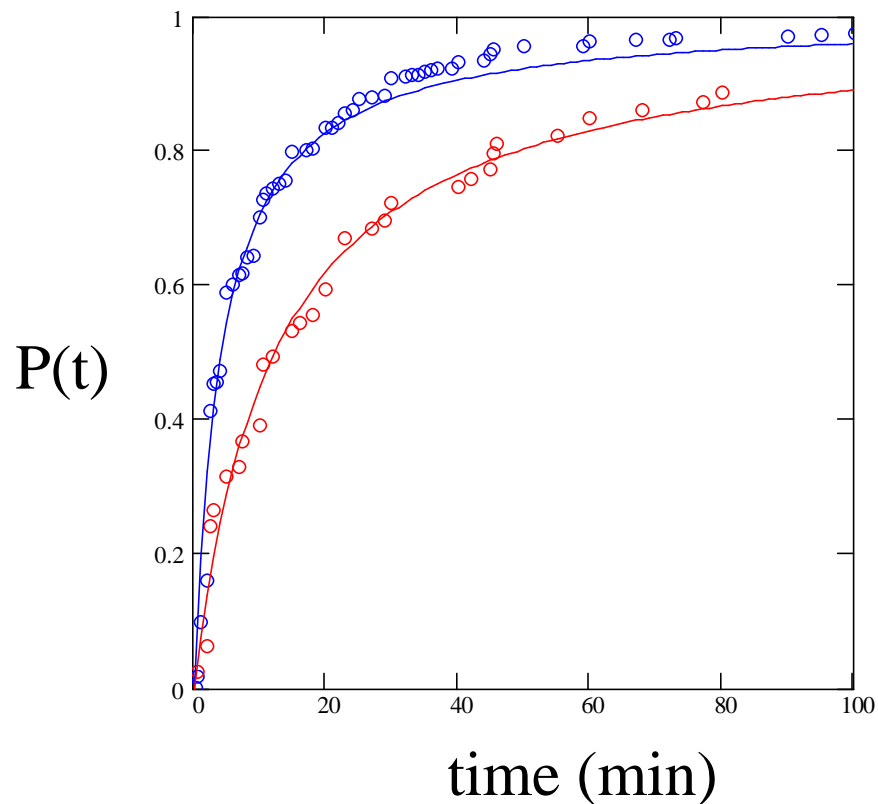


Approximately 1300 fire events at US plants have now been documented

- **EPRI Oct. 2000 + USNRC/Houghton**
 - 1965-1999
 - over 800 have estimates of fire duration
- **represents a range of fires including loss of an individual component**
- **number of events reported appears relatively flat for the last several years (post Appendix R)**
 - trends on occurrence frequency are very difficult to discern - not particularly our objective
- **reporting detail remains spotty**
 - insights are based on as reported, when reported



Overall data on fire duration: Cumulative duration probability



Blue - indoor fires
(excludes areas not
relating to power
production or
safety)

Red - all outdoor
on-site fires



Most fires are of short duration, but some are long lasting

- **Of indoor fires (excluding non-critical areas) with a duration reported (651 events):**
 - **10% last longer than 30 minutes**
 - **5% last longer than 45 minutes**
 - **3.5% last longer than 60 minutes**
- **Various reasons contribute to longer fires:**
 - **some fires are allowed to burn out**
 - **delays in application of effective fire suppression**
 - **reluctance to apply water**
 - **delays in declaring the existence of a fire**
 - **fires that require off-site assistance**



Very few events report detection time

- **often not known how long a fire burned before detection**
- **can sometimes be inferred from other information**
 - **operational upsets**
 - **system status/indication**
- **most often reported when time is short**
 - **work-specific fire watches**
 - **based on sound**
- **statistics on detection time very poor**



The majority of fires are manually detected

- **security patrols**
- **other in-plant personnel**
 - sound
 - smoke
- **operators**
 - plant effects
 - sound
- **work-related fire watches and/or the one who's work started the fire**



Most automatically detected fires involve smoke detectors

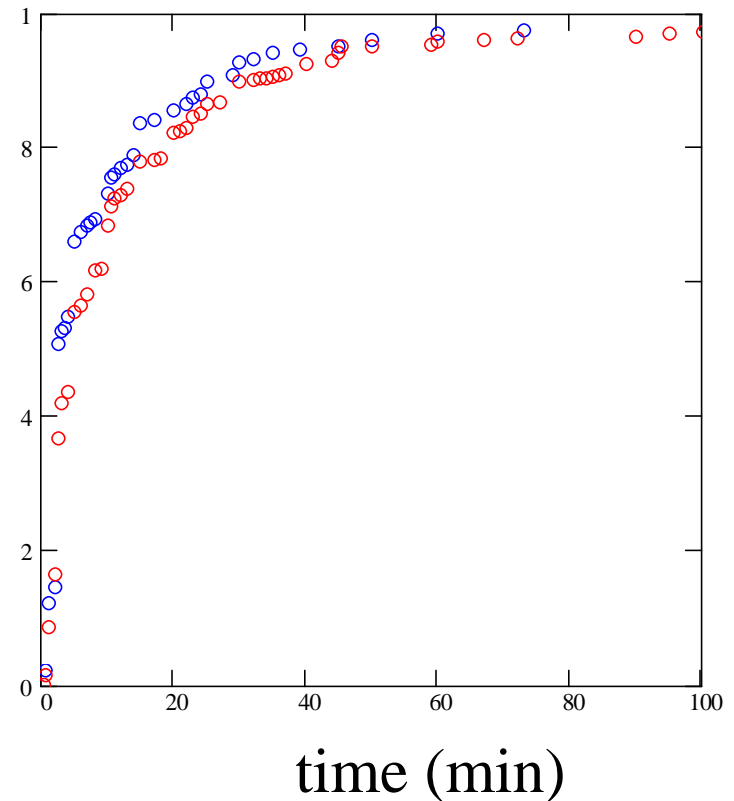
- **smoke detectors are widely used so not too surprising**
- **confirmation of detection signal commonly cited as first action taken**
 - **in some cases this has led to delay in fire fighting**
- **few cases specifically cite any other auto-detection means**
 - **e.g., heat or flame detectors, flow alarms**
 - **such systems are not as common**



The majority of fires are suppressed manually

- **plant fire brigade**
 - with or without off-site fire fighting support
- **fire watches**
 - tends to involve prompt $P(t)$ suppression
- **other plant personnel such as security**
 - not as common

Red - indoor- manual (441)
Blue - all other indoor (210)

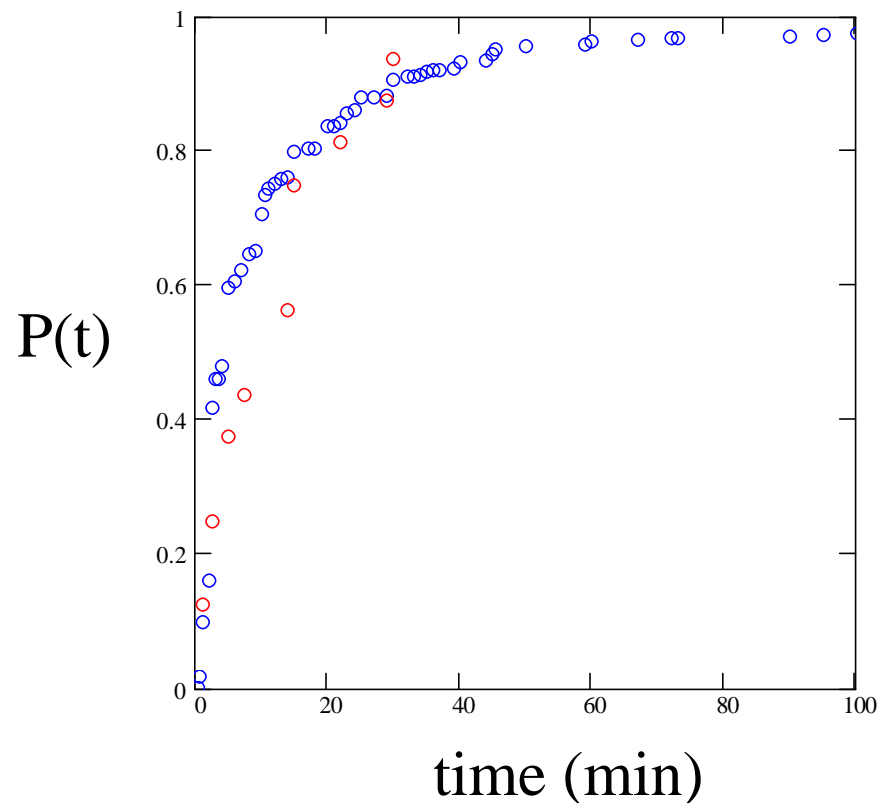




Very few fires involve actuation of fixed fire suppression systems

- we have not delved into this observation deeply
- most often involved in turbine building and transformer fires
- alternate explanations are possible:
 - generally installed in critical areas (nuclear safety or high hazard)
 - administrative controls may be reducing likelihood of fire
 - fire may not activate fixed systems

Red - indoor - fixed suppression (16 events - 1 at 160 minutes)
Blue - all other indoor (635)

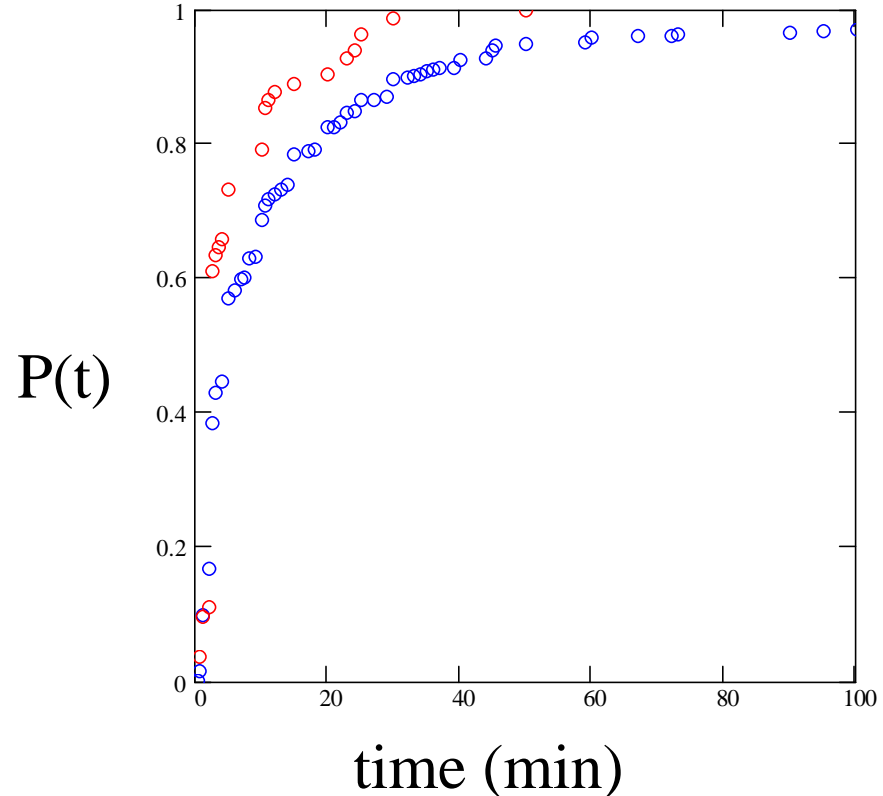




Self-Extinguished fires

- **Many electrical fires self-extinguish**
 - due to lack of sufficient energy for spread
 - due to lack of proximate combustibles
- **Some fires are allowed to burn out if no perceived threats --> longer duration**
- **Some are only discovered after the fact (no longer burning but evidence that burning did occur)**

Red - Indoor self-suppressed (72)
Blue - all other indoor (569)

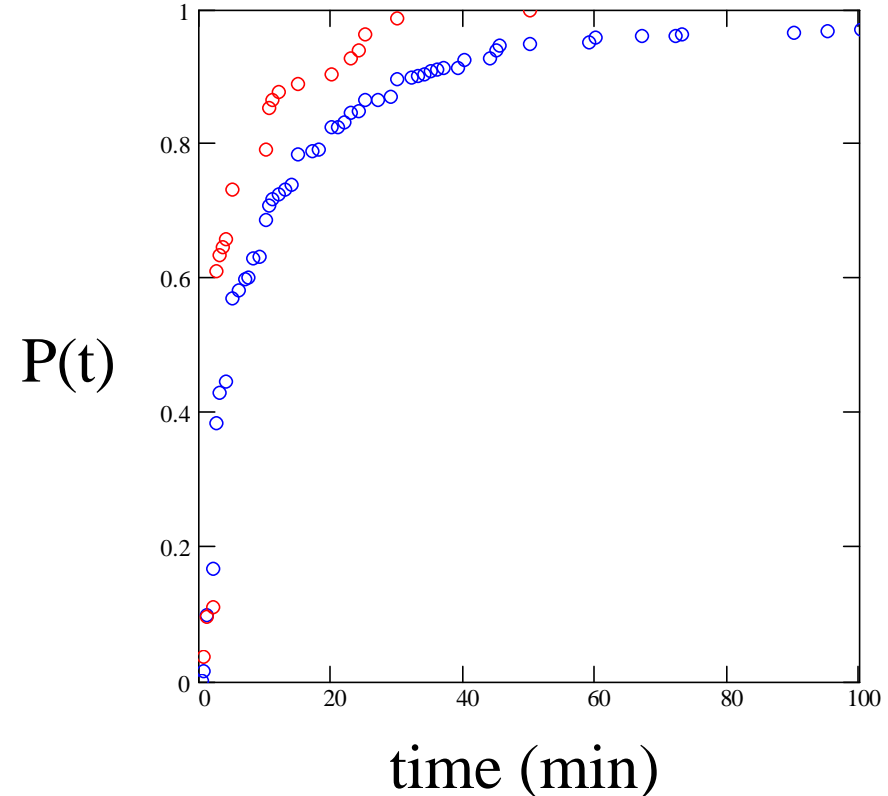




Removal of power/fuel

- Many electrical fires self-extinguish after removal of power
- Some gas and liquid fuel fires may be extinguished by cutting off fuel flow
- These fires tend to be suppressed more quickly

Red - indoor fuel removed (82)
Blue - all other indoor (569)

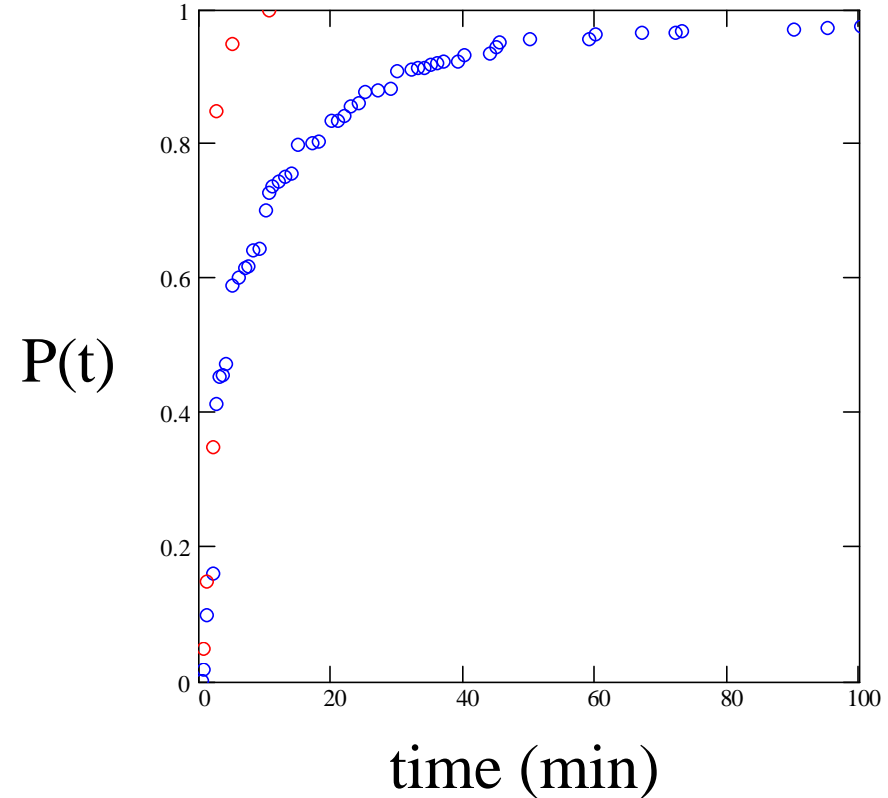




We can also look at data by location

- **Example: MCR**
 - total of 20 events
 - longest reported duration is 10 minutes

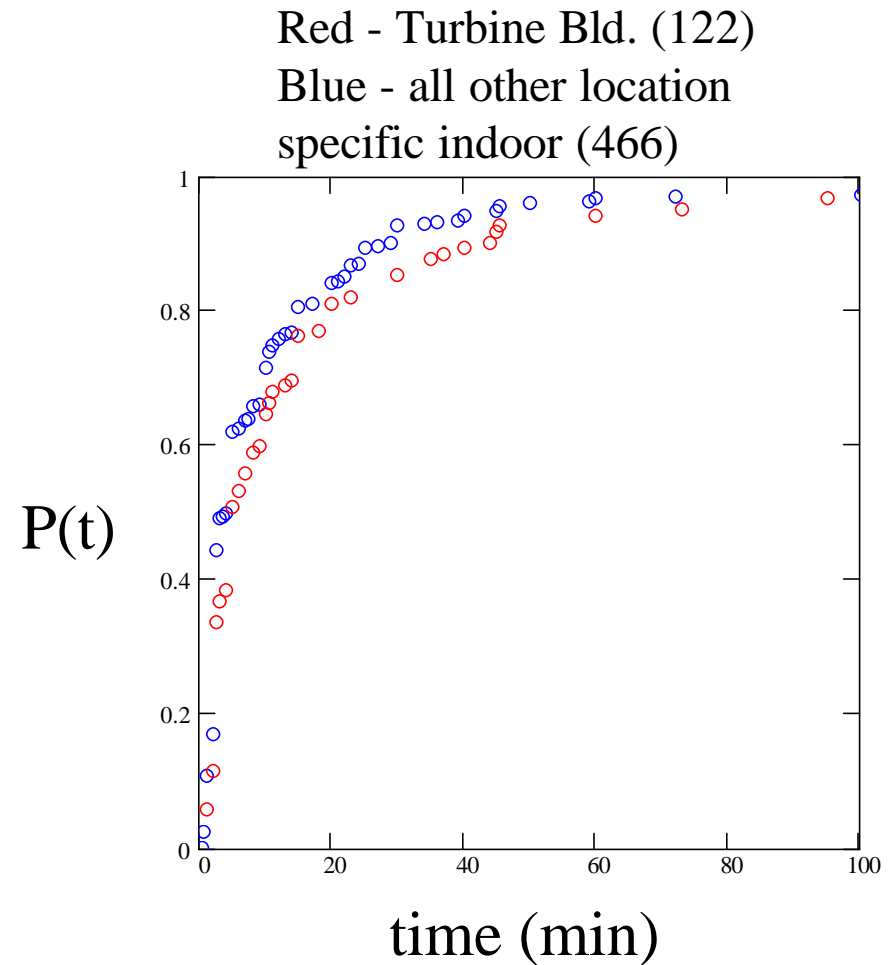
Red - MCR fires (20)
Blue - all indoor (651)





Location Example 2

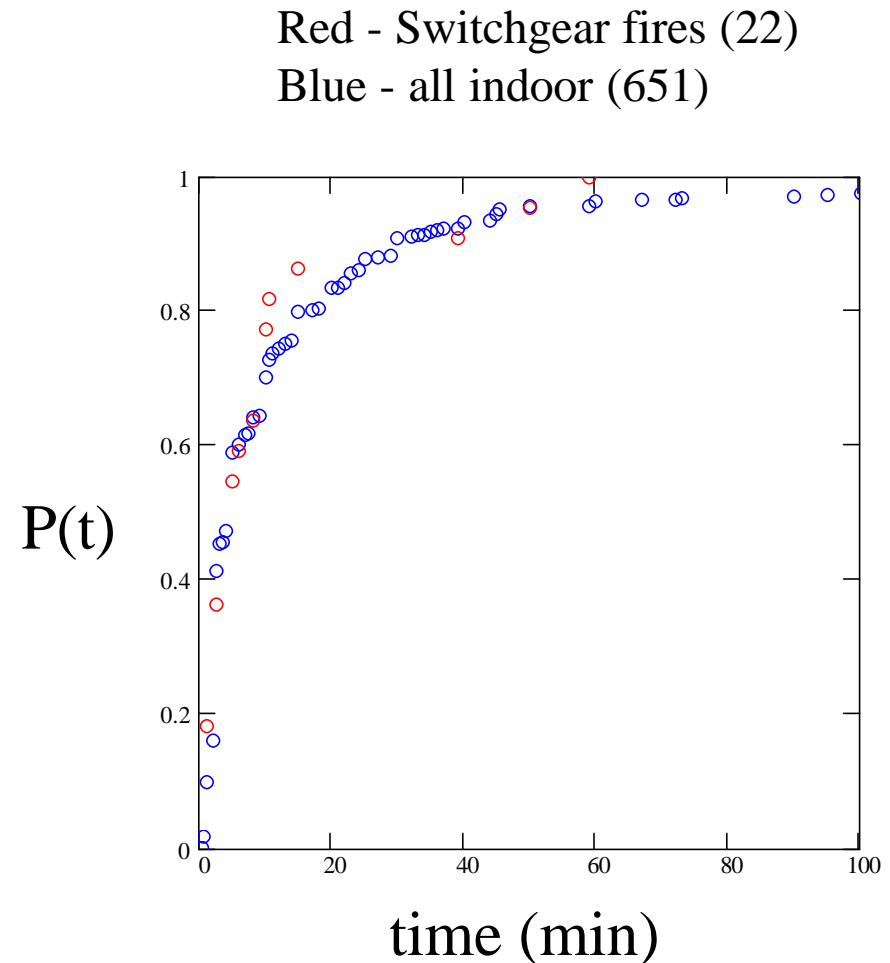
- **Turbine Building**
 - total of 122 events
 - tend to last somewhat longer than other indoor fires





We can also call out specific fire sources

- **Capability not fully developed**
 - requires additional work on fire event data base to ID sources
- **Ex: Switchgear fires**





Summary

- **Fire event data base continues to grow**
 - on the order of 1300 events now documented
- **Very little data on detection times is available**
 - generally reported only when there is prompt detection
 - likely skews data to faster detection
- **Substantial event data on fire duration is available**
 - time from detection to suppression is our interpretation of these data
 - on the order of 2/3 of reported events



Summary - continued

- **We can parse data for various means of suppression and still retain significant data sets**
 - manually suppressed
 - self-extinguished
 - automatically suppressed (rather sparse)
- **We can also parse by location and/or source, e.g.,**
 - indoor vs outdoor
 - electrical fires
 - turbine building
- **A linked MathCAD workbook and Excel spreadsheet do this automatically!**



Summary - continued

- **What next:**
 - For use in PRA, we want to implement probabilistic data analysis
 - This has been implemented using “classical” statistical methods (curve fitting - parameter estimation)
 - We want to implement Bayesian data analysis
 - A full report anticipated this fall