T87.6 Task Force

AFFTAC Modeling Subgroup: Preliminary Results

September 23, 2011
DOT Headquarters
Washington, DC

Assumptions

- Objective: to provide comparative data on fire survival for a variety of car configurations
- 30,000 gallon, 7/16”-thick A516 tank (baseline)
- Pure ethanol, 1% outage @ 115F initial temperature (105F for jacketed cases)
- 75 psi STD PRV, 35,660 cfm capacity, flow rating @ 82.5 psi per 179.15
- 1500F fire completely immersing tank

Pool vs Torch Fire

- Bare tank baseline car case was run for
  - pool fire and torch fire
  - upright and overturned (120°) positions
- Only the overturned condition in a pool fire caused tank failure
- Therefore this presentation focuses only on overturned cars in pool fires

Cases

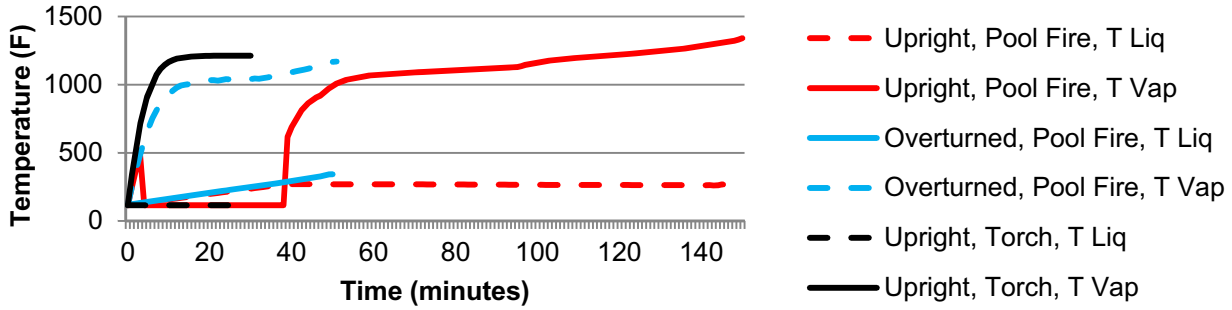
- Case 1 (baseline): Pre-T87.5 car
  (ADMX 29420 from Arcadia – bare tank, 7/16” thick, 30K gals., 2 PRV)
  - Upright torch fire, upright pool fire, overturned pool fire

Following cases for overturned pool fire only:

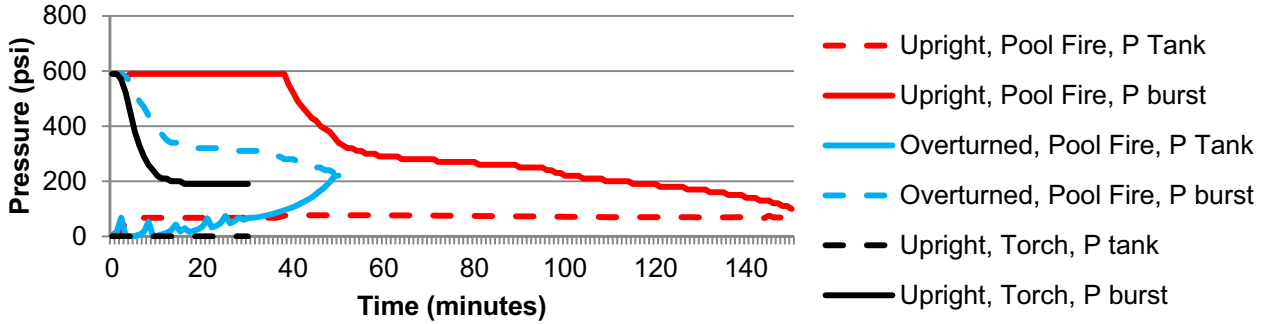
- Case 2: T87.5 (CPC-1230) car: ½” -thick tank
- Case 3: T87.5 (CPC-1230) car: ½” -thick tank, varying PRD Capacity
- Case 4: T87.5 (CPC-1230) car with 2% outage @115F, varying PRD Capacity
- Case 5: T87.5 (CPC-1230) car, plus jacket alone
- Case 6: T87.5 (CPC-1230) car, plus jacket and thermal protection

Case 1 – Typical Pre-T87.5 Car

Temperatures

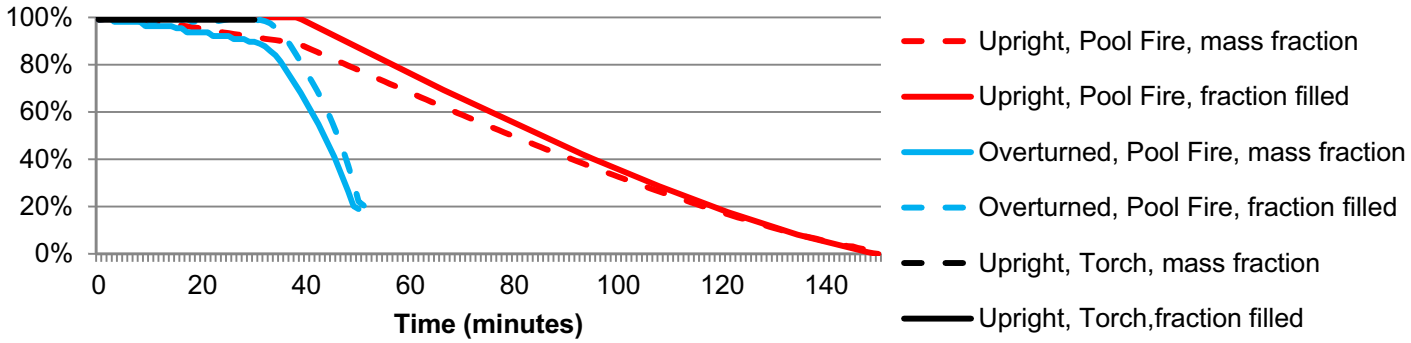


Pressures



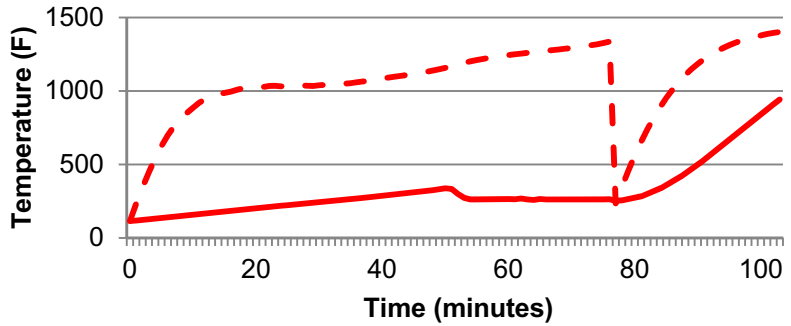
Tank Failure: Overturned, Pool Fire - 50 minutes

%



Case 2 – CPC-1230 Car

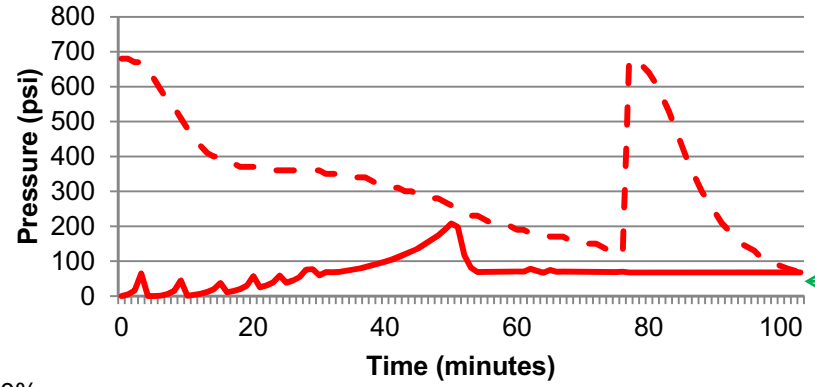
Temperatures



Overturned, Pool Fire, T Liq

Overturned, Pool Fire, T Vap

Pressures

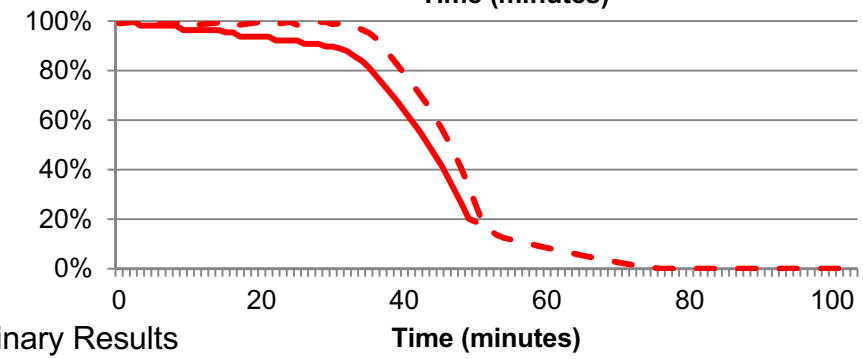


Overturned, Pool Fire, P Tank

Overturned, Pool Fire, P burst

Tank failure
103 minutes

%

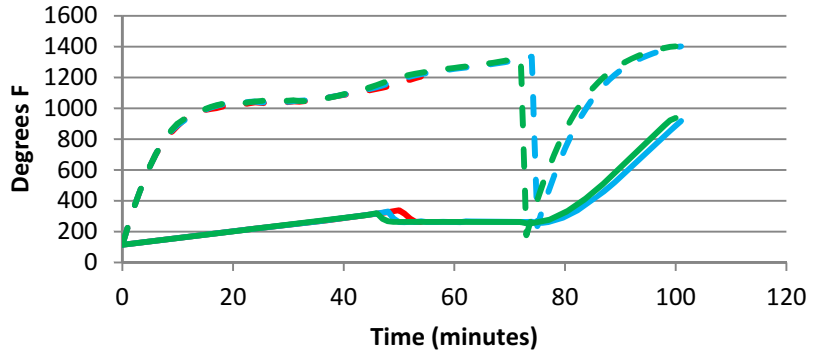


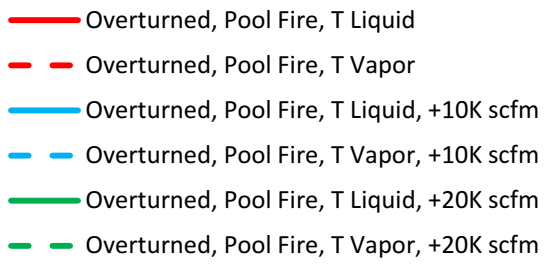
Overturned, Pool Fire, mass fraction

Overturned, Pool Fire, fraction filled

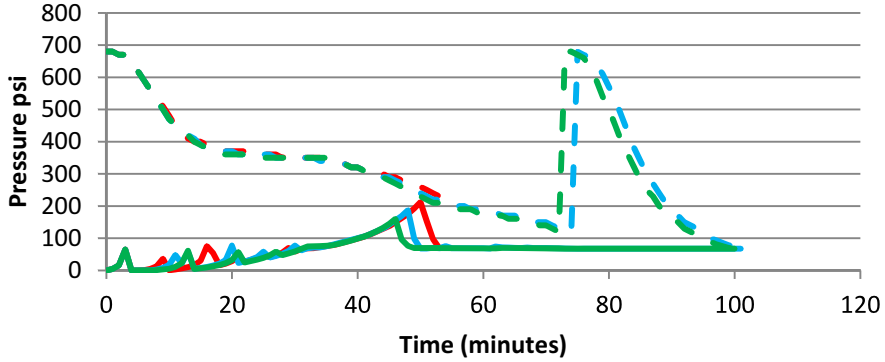
Case 3 – CPC-1230 Car & Various Pressure Relief Capacities

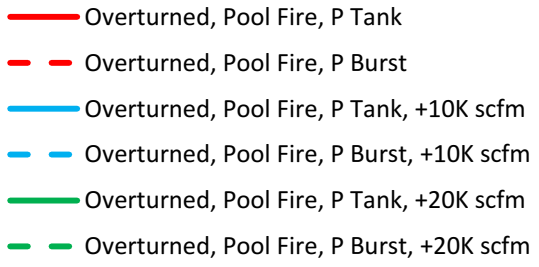
Temperatures





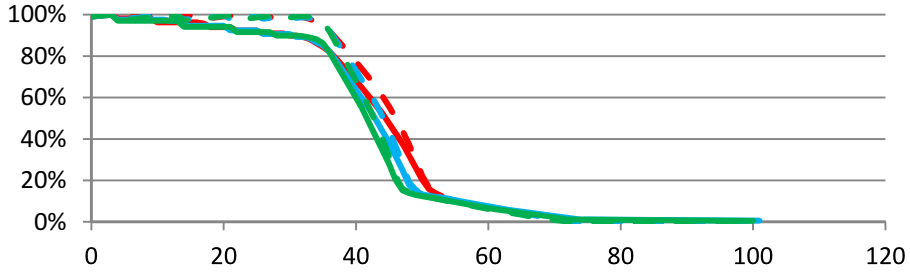
Pressures

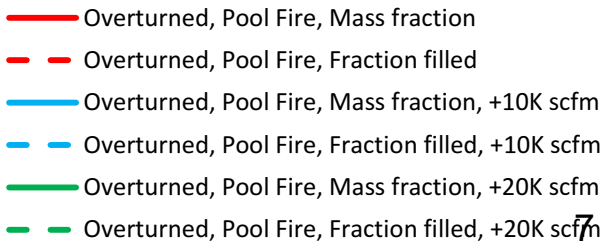




Tank Failure 99 to 101 minutes

%





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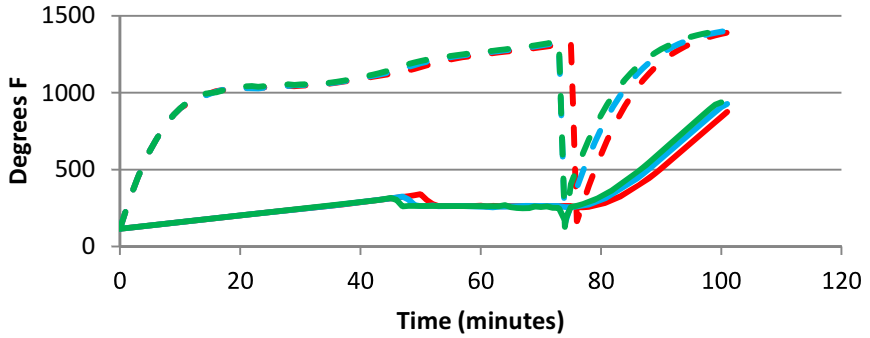
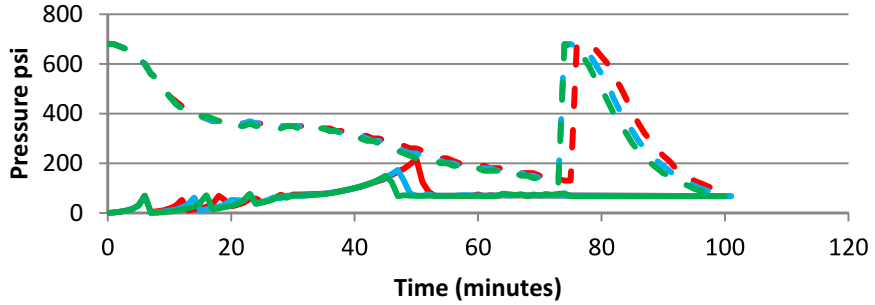
Case 4 – CPC-1230 Car &
2% Outage & Various Relief Capacities

Temperatures



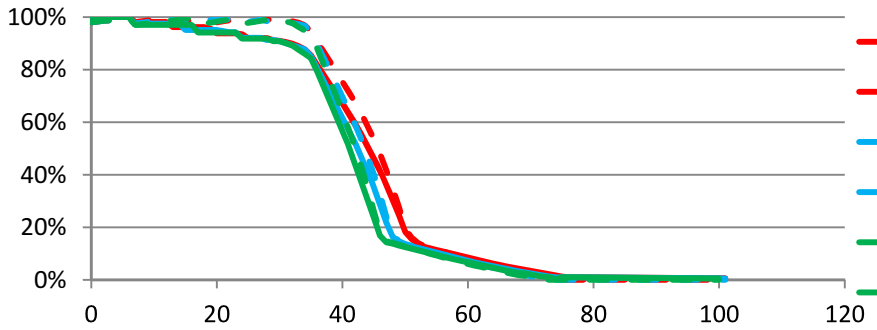
Overturned, Pool Fire, 2% outage, T Liquid
Overturned, Pool Fire, 2% outage, T Vapor
Overturned, Pool Fire, 2% outage, T Liquid, +10K scfm
Overturned, Pool Fire, 2% outage, T Vapor, +10K scfm
Overturned, Pool Fire, 2% outage, T Liquid, +20K scfm
Overturned, Pool Fire, 2% outage, T Vapor, +20K scfm

Pressures



Overturned, Pool Fire, , 2% outage, P Tank
Overturned, Pool Fire, 2% outage, P Burst
Overturned, Pool Fire, 2% outage, P Tank, +10K scfm
Overturned, Pool Fire, 2% outage, P Burst, +10K scfm
Overturned, Pool Fire, 2% outage, P Tank, +20K scfm
Overturned, Pool Fire, 2% outage, P Burst, +20K scfm

Tank Failure 101 to 103 minutes; No Failure for +20K scfm Case

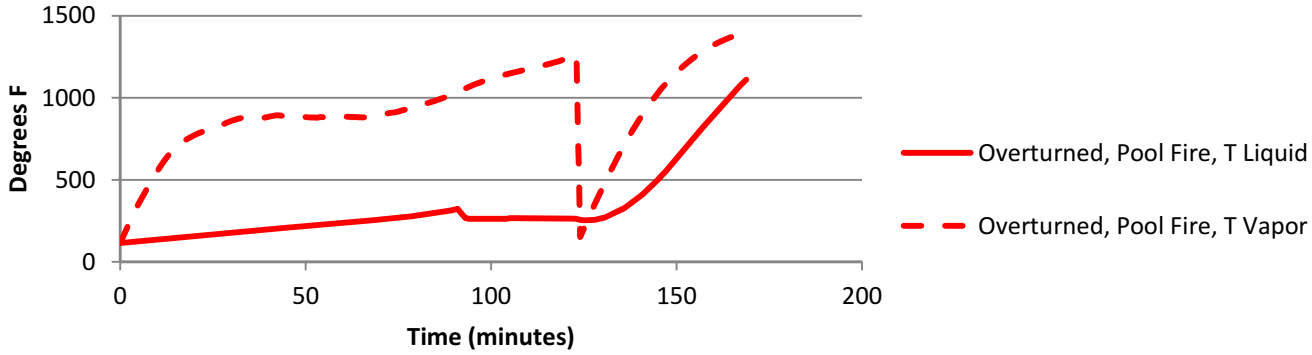


Overturned, Pool Fire, 2% outage, Mass fraction
Overturned, Pool Fire, 2% outage, Fraction filled
Overturned, Pool Fire, 2% outage, Mass fraction, +10K scfm
Overturned, Pool Fire, 2% outage, Fraction filled, +10K scfm
Overturned, Pool Fire, 2% outage, Mass fraction, +20K scfm
Overturned, Pool Fire, 2% outage, Fraction filled, +20K scfm

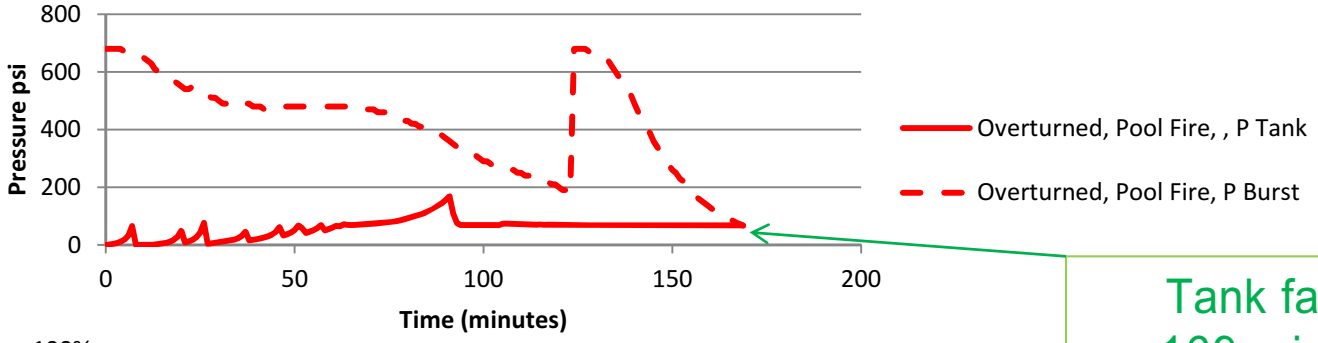
9/23/11 Preliminary Results

Case 5 – CPC-1230 Car & Jacket (Only; No Thermal Blanket)

Temperatures

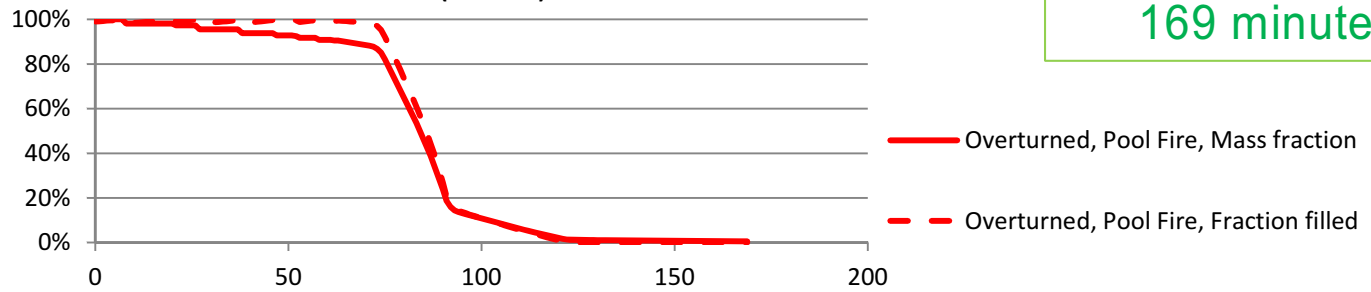


Pressures



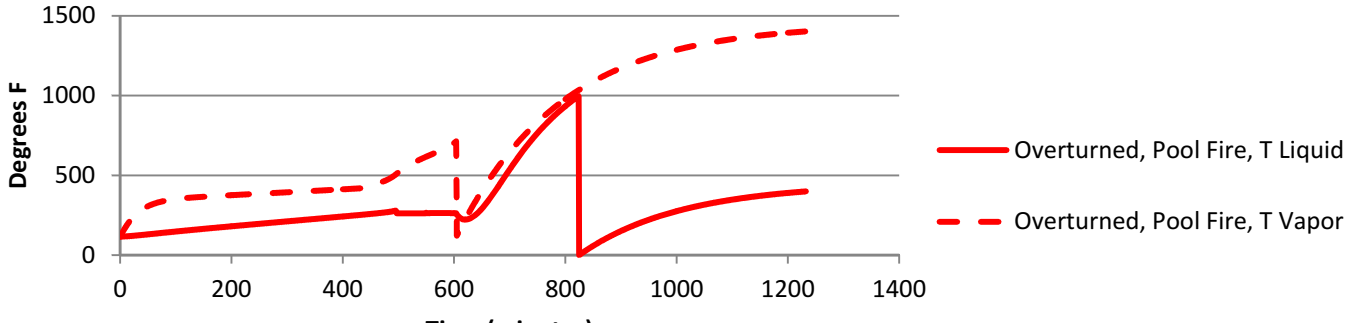
Tank failure
169 minutes

%

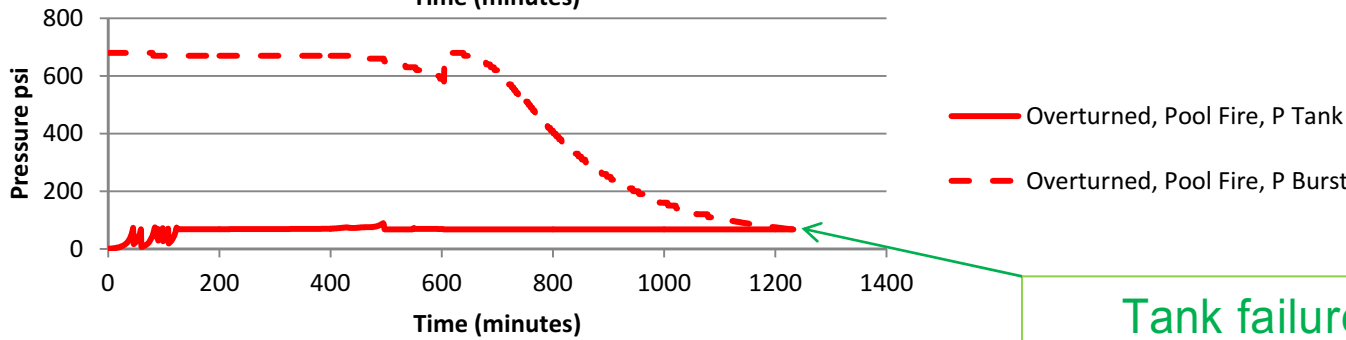


Case 6 – CPC-1230 Car & Jacket and Thermal Protection

Temperatures

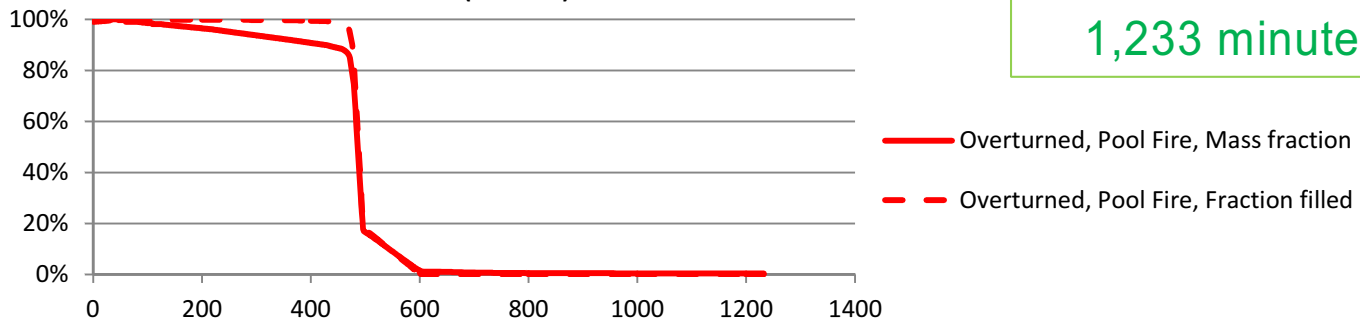


Pressures



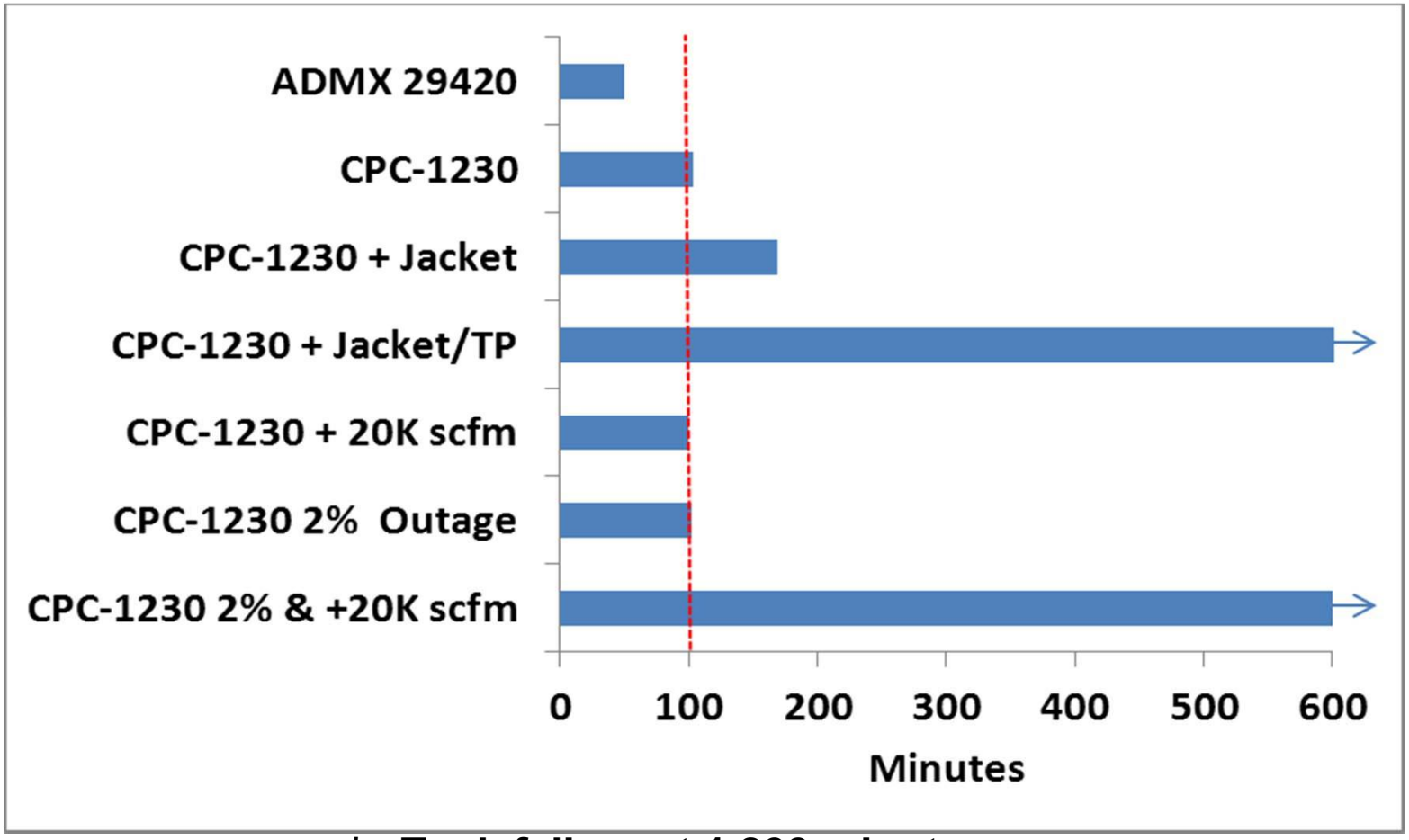
Tank failure
1,233 minutes

%



Comparison by Survival Time

Pool Fire, 120° Rollover



* **Tank failure at 1,233 minutes**

** **Tank emptied at 73 minutes and never failed**

Preliminary Conclusions

- Torch fires appear not to cause tank failure, because the vapor pressure never rises significantly with this non-pressure lading

- The existing, pre-CPC-1230 car, upright, appears to survive well beyond 100 minutes.

- The existing, pre-CPC-1230 car, rolled over 120°, does not appear to survive 100 minutes.

Preliminary Conclusions, ctd

- Increasing tank shell thickness (i.e., CPC-1230 car) appears to increase survival time significantly
- Adding PRD capacity appears to have minimal effect, by itself
- Increasing outage to 2% appears to have minimal effect, by itself
- Adding PRD capacity and increasing outage to 2% appears to have a significant beneficial effect – simulated car never failed
- Adding a jacket, by itself, shows a significant beneficial effect
- Adding a jacket and thermal protection produces extended survival (> 1,000 minutes)