Are high efficient HC´s if accompanied with a safety system a possible alternative to R134a in MAC´s

ATMOsphere 2011

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- **European Legal Refrigerant Situation for MAC´s**
- Current MAC Refrigerant Situation
- Refrigerant Benchmark Simulation
- Detailed Results and Conclusion
- Safety Strategy for HC MAC
- Summary

European Legal Refrigerant Situation for MAC´s

L 161/12 EN Official Journal of the European Union 14.6.2006

DIRECTIVE 2006/40/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 17 May 2006

relating to emissions from air-conditioning systems in motor vehicles and amending Council Directive 70/156/EEC

(Text with EEA relevance)

4. With effect from 1 January 2011 Member States shall no longer grant EC type-approval or national type-approval for a type of vehicle fitted with an air conditioning system designed to contain fluorinated greenhouse gases with a global warming potential higher than 150.

5. With effect from 1 January 2017, in respect of new vehicles which are fitted with an air-conditioning system designed to contain fluorinated greenhouse gases with a global warming potential higher than 150, Member States shall:

(a) consider certificates of conformity to be no longer valid for the purposes of Article 7(1) of Directive 70/156/EEC; and

(b) refuse registration and prohibit sale and entry into service.

- By 2011 no type approval for new platforms for refrigerant with GWP > 150
  (Current refrigerant R134a has GWP > 1.400)
- By 2017 no vehicle approval for refrigerant with GWP > 150

New refrigerant required by 2011 but latest 2017 !!!

GWP … Global Warming Potential
MAC … Mobile Air Conditioning

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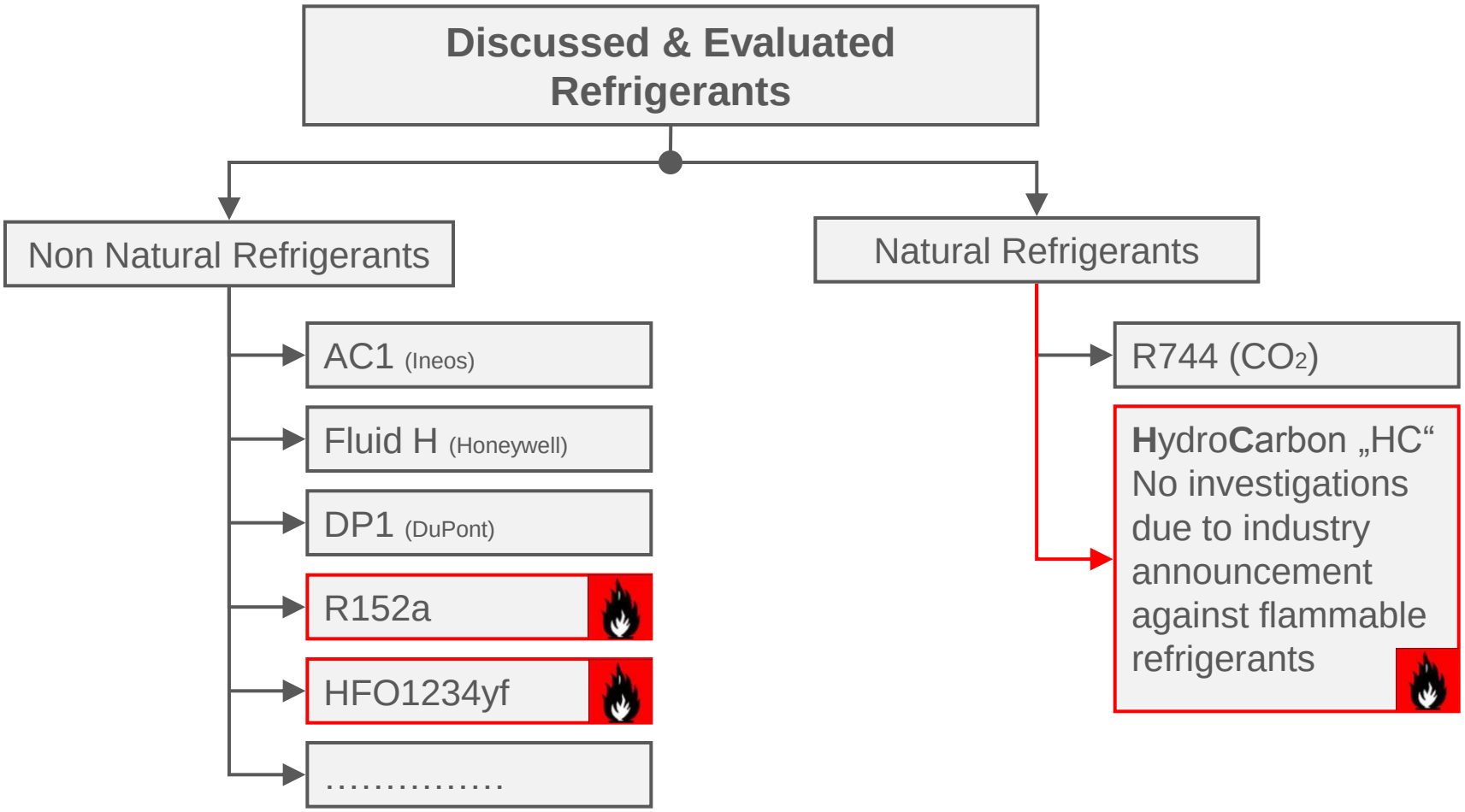
Current MAC Refrigerant Situation



Current MAC Refrigerant Situation

Currently automotive industry has decided for **HFO1234yf** (Honeywell & DuPont)
as the substitution for R134a for MAC

… because “Drop - In” solution for R134a systems !
… and refrigerant with GWP = 4 and ODP = 0

… but “Flammable” refrigerant !

ODP … Ozone Deplezion Potential

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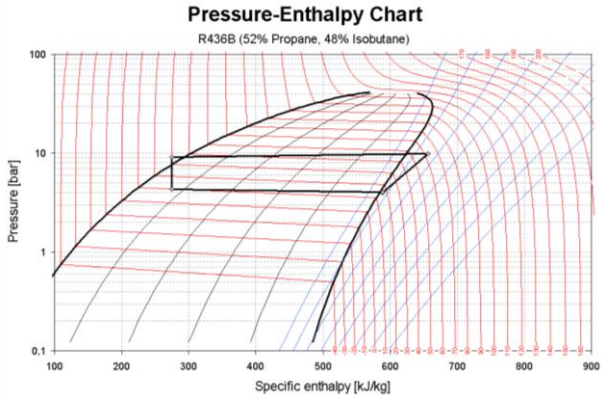
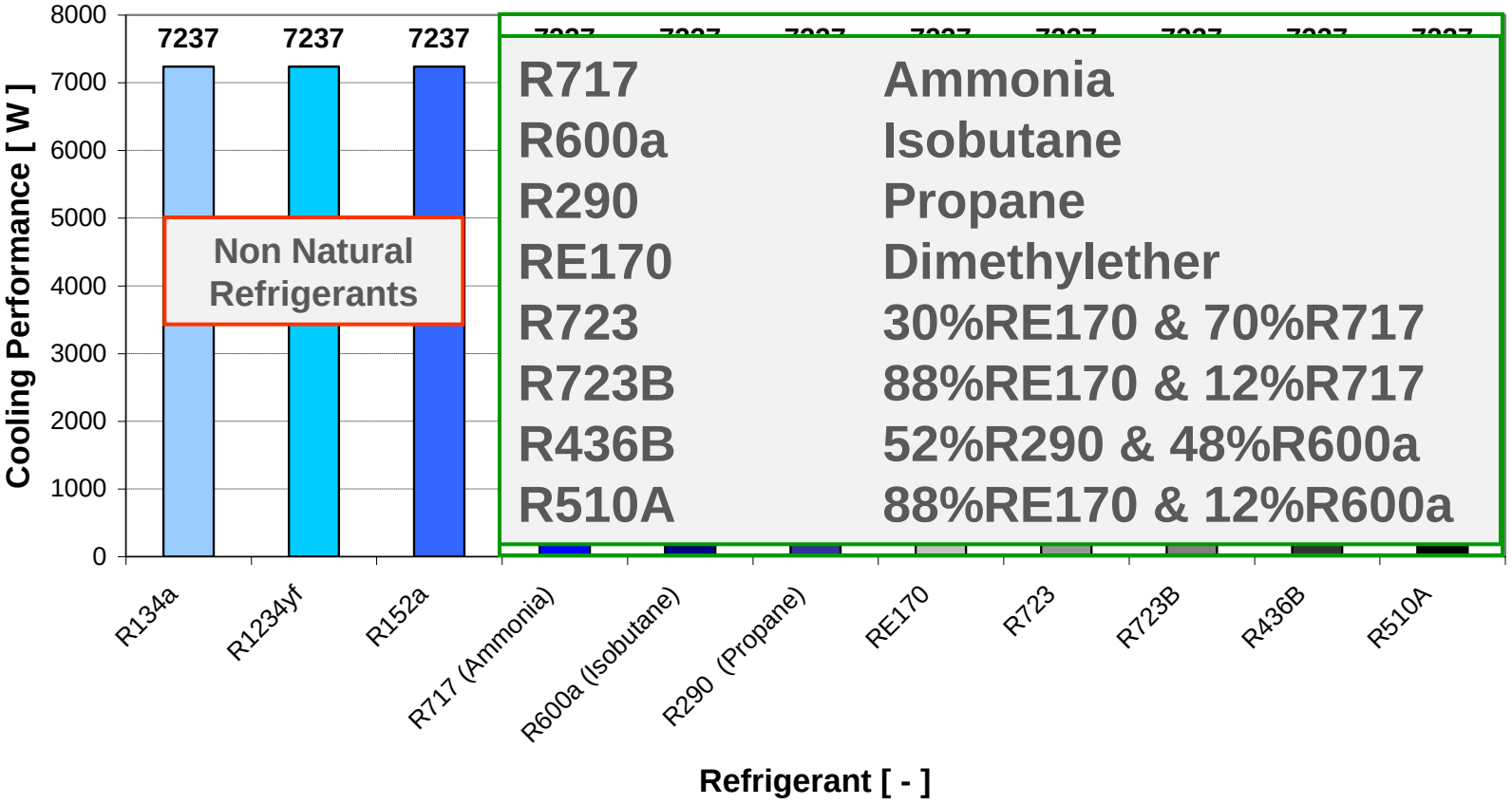
Refrigerant Benchmark Simulation

- With the decision to go with “Flammable” refrigerants high efficient HydroCarbons become an additional substitution for R134a
- HC are wide spread in industrial applications (e.g.: Refrigerators)
- Based on this fact we have carried out a system benchmark simulation with several HC refrigerants compared to the “Old” refrigerant R134a and the “New” refrigerant HFO1234yf
- The required compressor volume is an indicator for the “Drop - In” ability of the refrigerant
- The simulation was carried out at “High Load Conditions” to eliminate refrigerants that allow no “Drop - In”

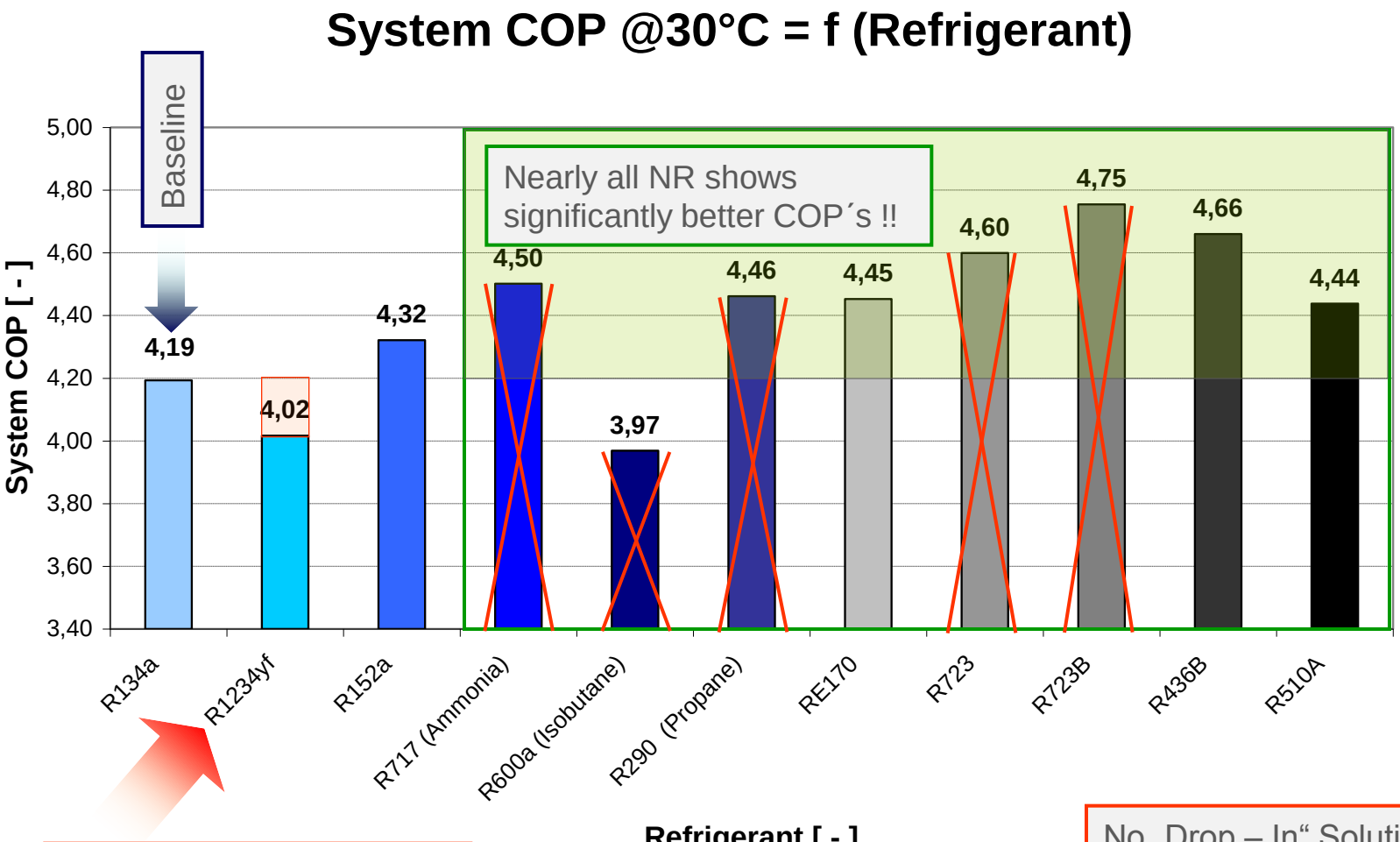


Refrigerant Benchmark Simulation

System Cooling Performance @ 30°C = f (Refrigerant)



Refrigerant Benchmark Simulation



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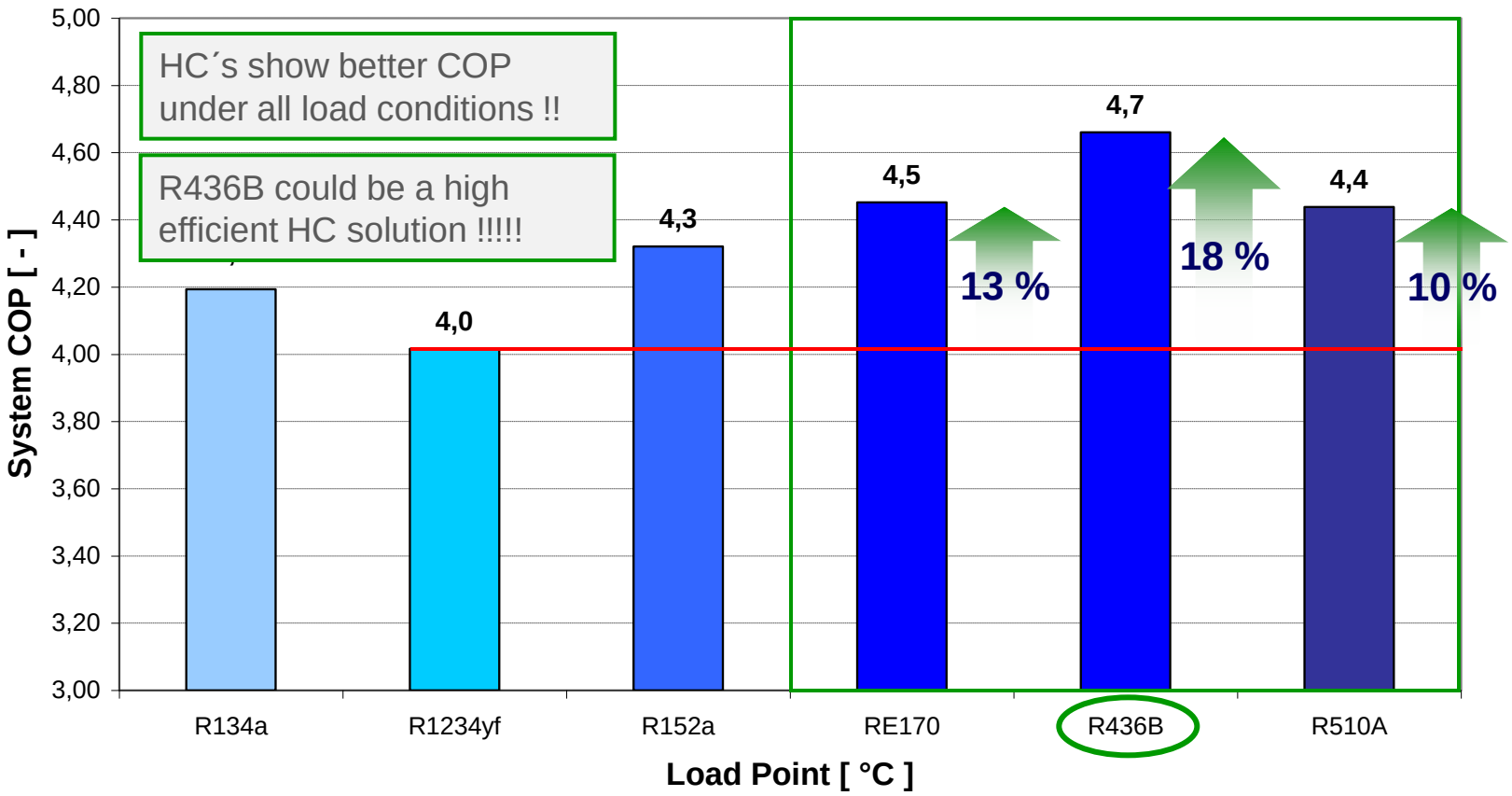
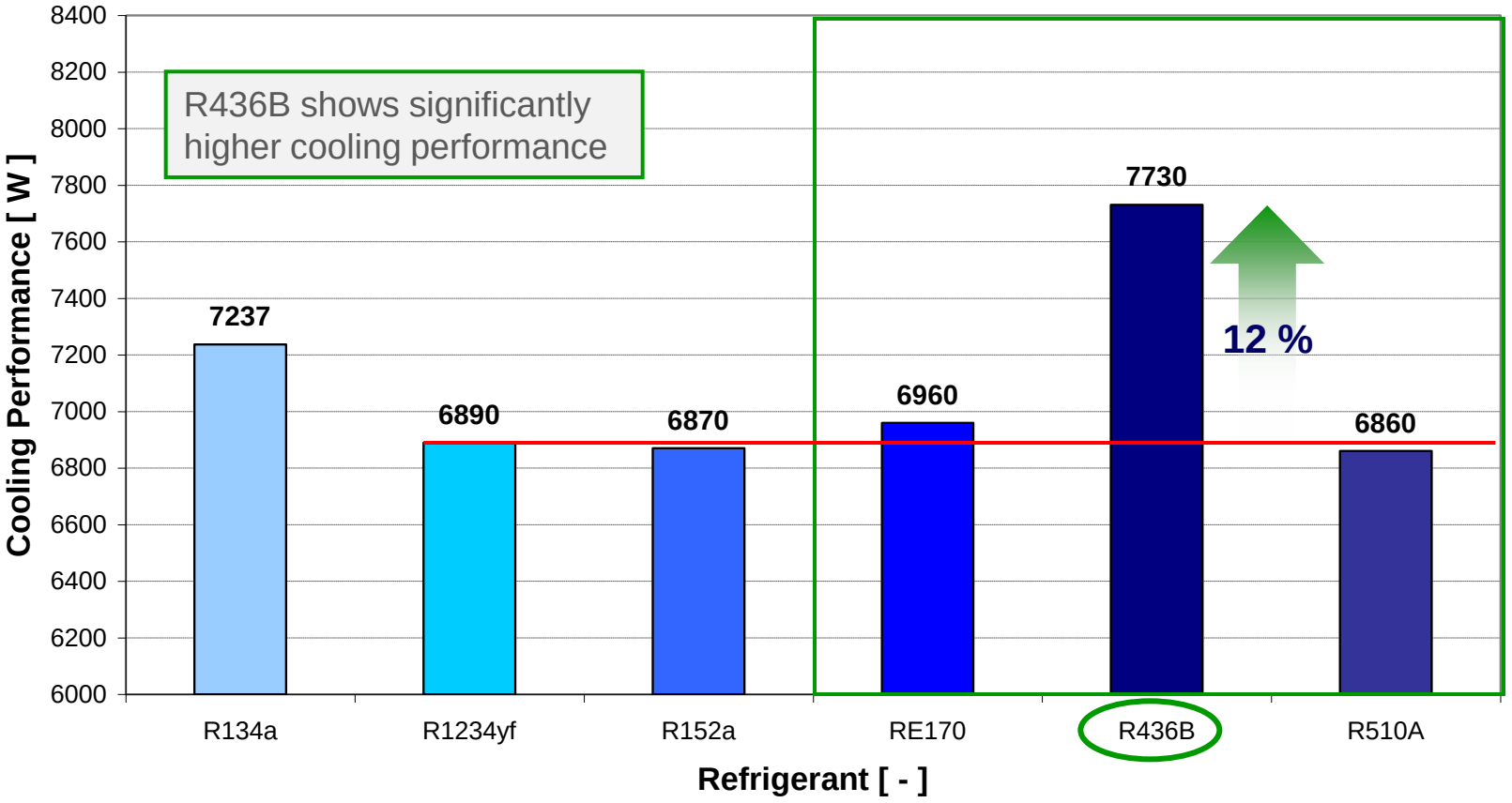
Detailed Results and Conclusion

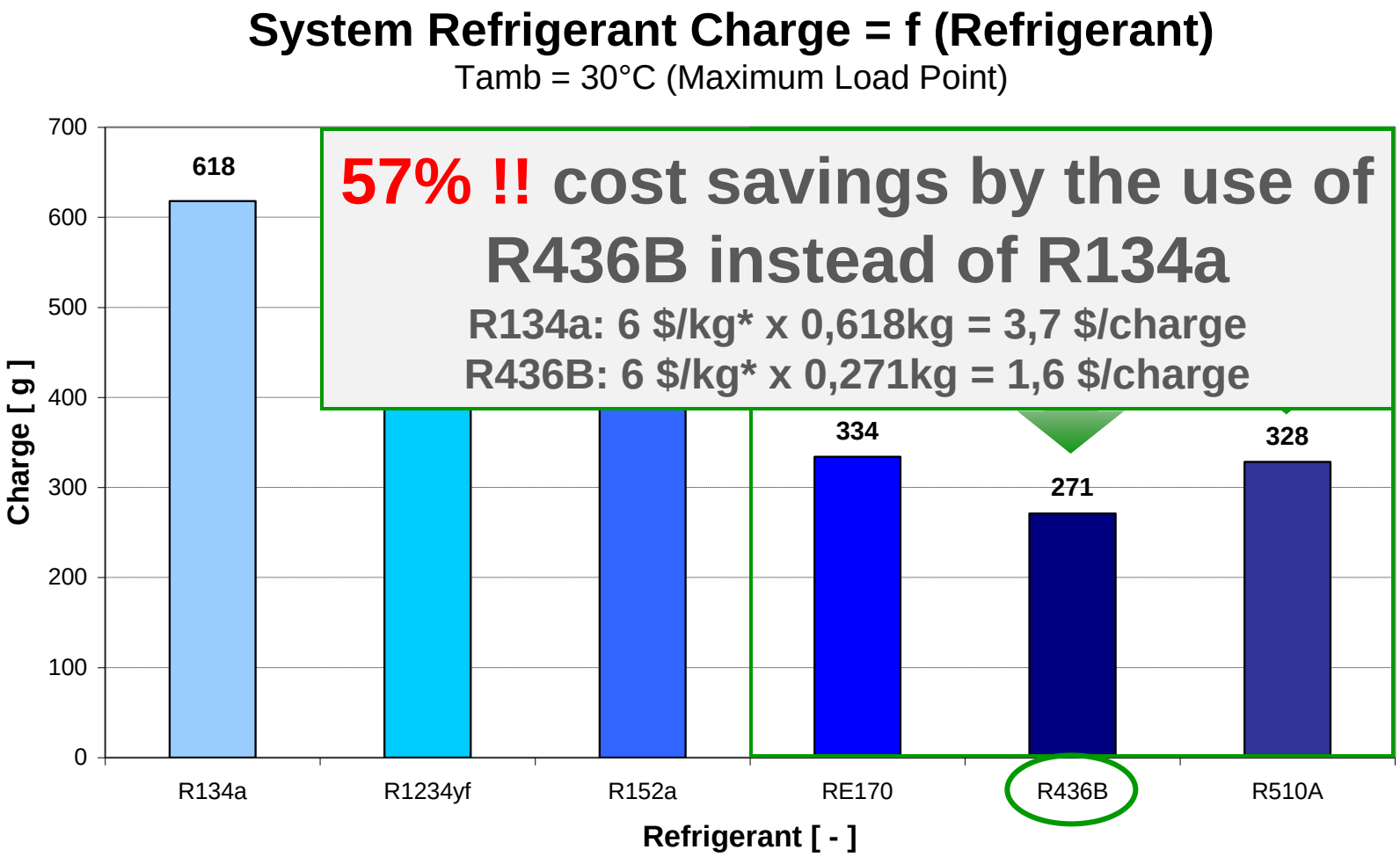


Detailed Results and Conclusion

Max. Cooling Performance @ 30°C = f (Refrigerant)

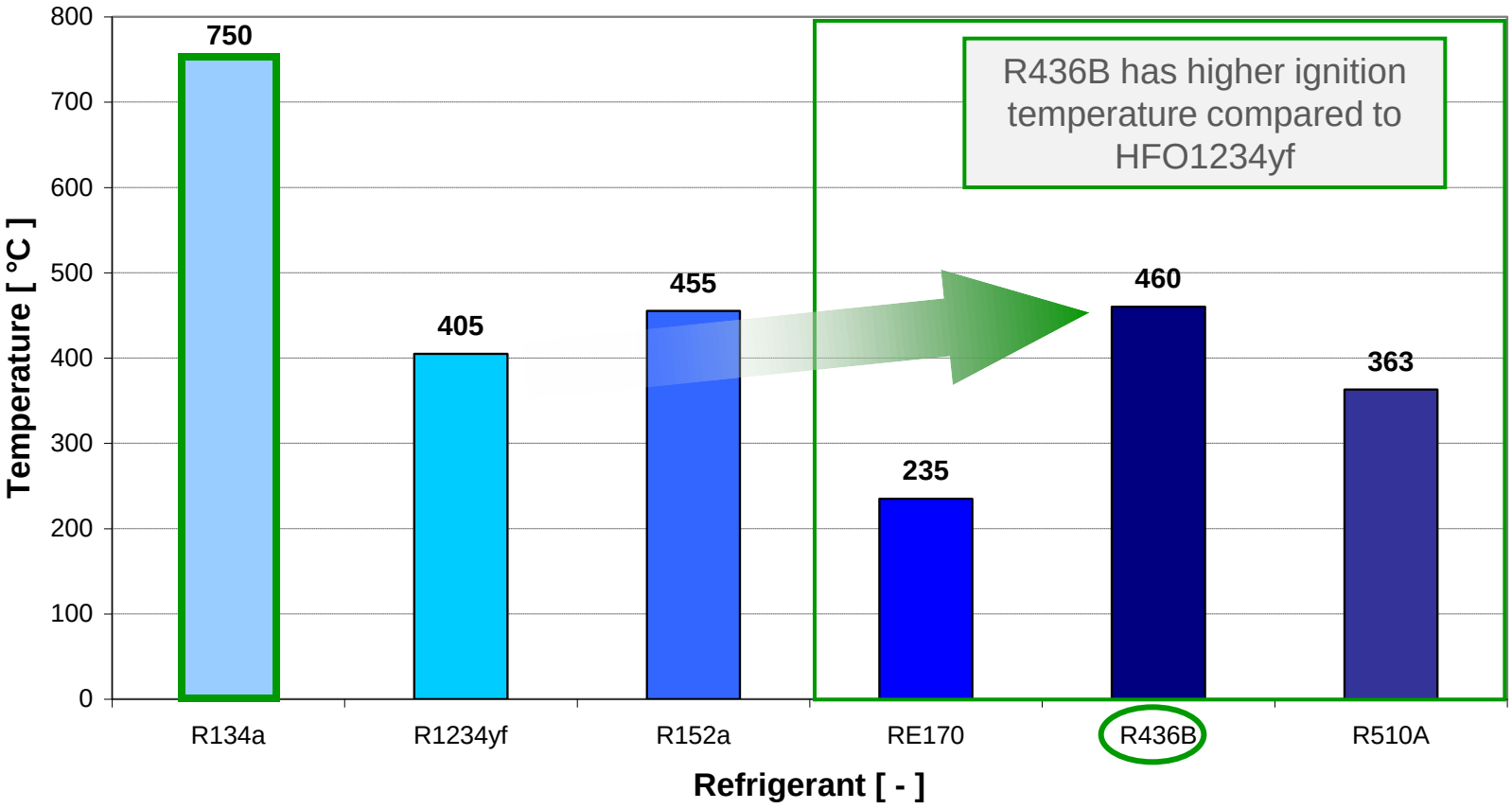


Detailed Results and Conclusion



* … Cost estimation from refrigerant suppliers for mass production volumes

Detailed Results and Conclusion



Detailed Results and Conclusion

- HC show higher system COP compared to HFO1234yf
- HC show higher cooling performance
- Significantly reduced system charge for HC and therefore reduced refrigerant costs

A flammable refrigerant requires a new safety strategy for MAC`s

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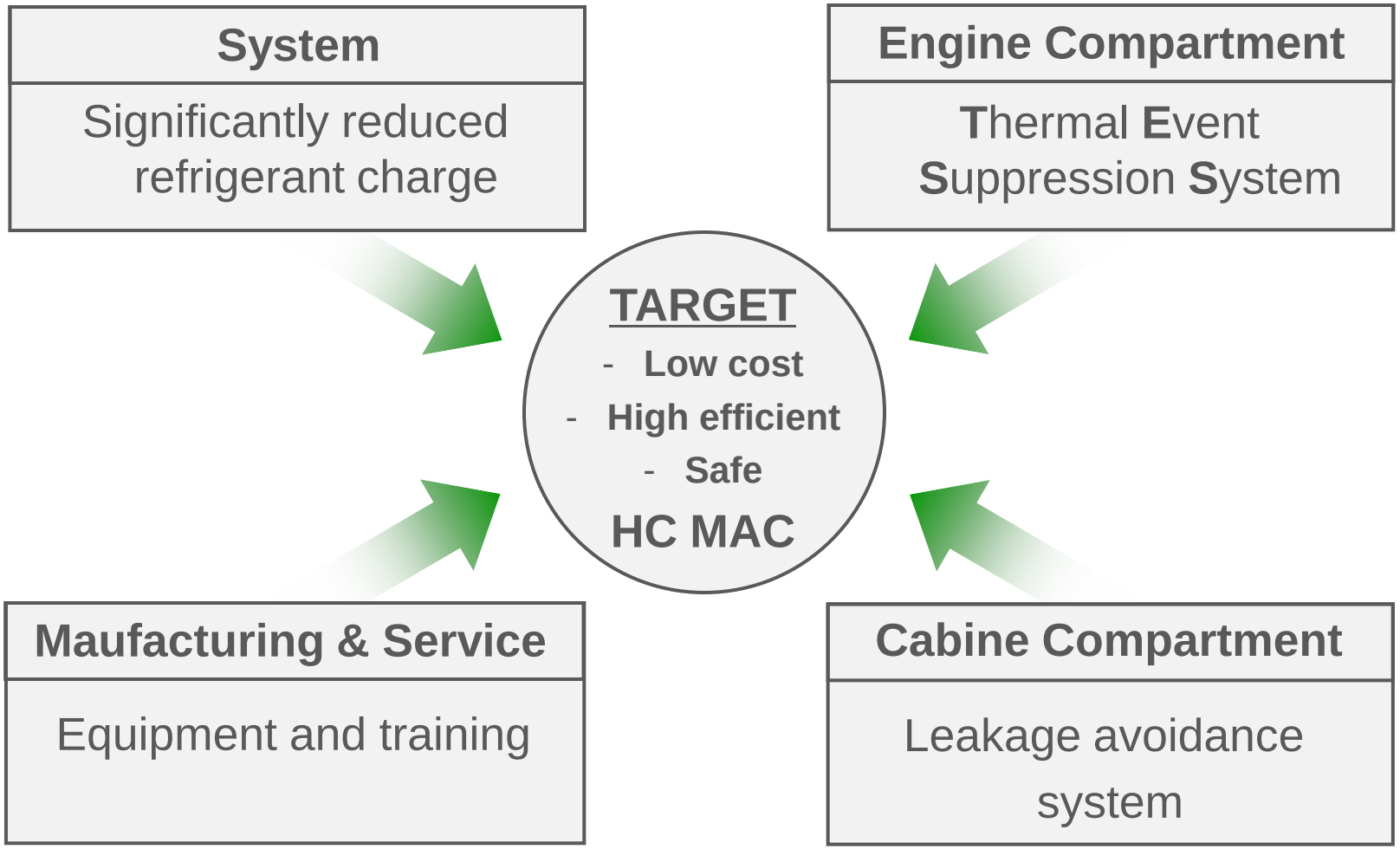
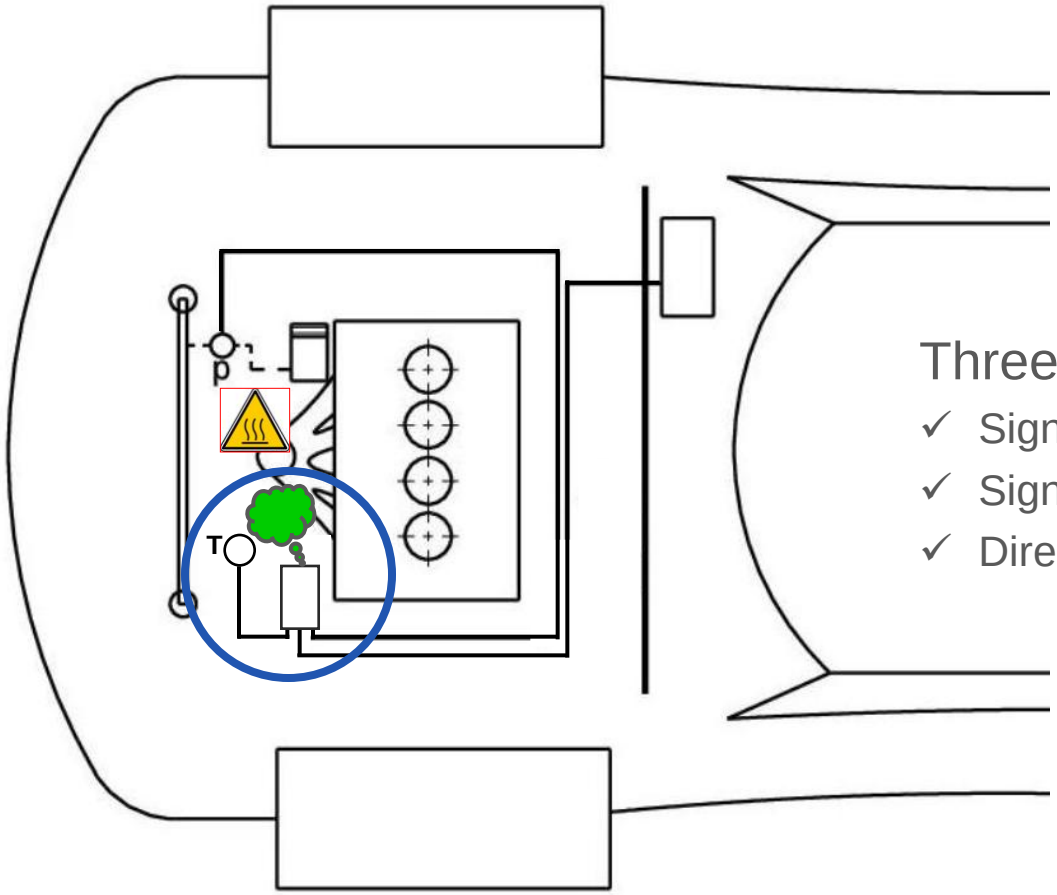
Safety Strategy for HC MAC



Safety Strategy for HC MAC

Thermal **E**vent **S**uppression **S**ystem (**TESS** for Engine Compartment)

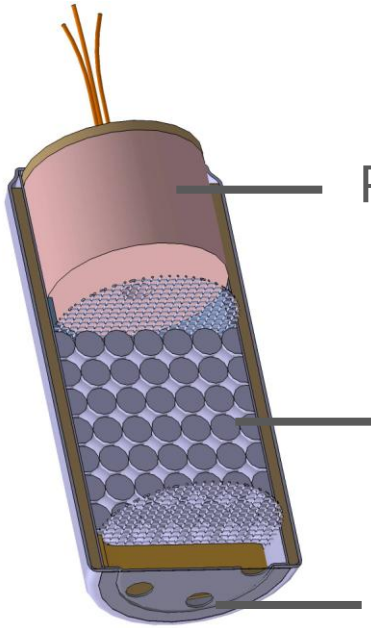


Three activation levels:

- ✓ Signal from crash sensor
- ✓ Signal from AC system (pressure release)
- ✓ Direct activation by heat (fire)

Safety Strategy for HC MAC

TESS Working Principle



Potassium Nitrate Compound & Ignitor

Cooling Zone

Exit Ports

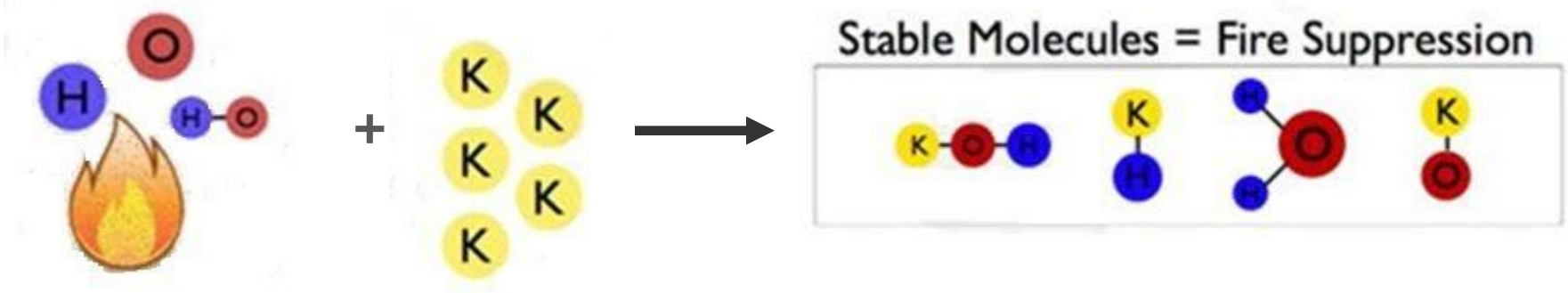
TESS bottle contains an aerosol compound, cooling zone and exit ports
The non-pressurized aerosol gets ignited by 0,5 Amps or temperatures above 280°C

Source: www.statx.com

Safety Strategy for HC MAC

TESS Working Principle

- Free radicals (O, H & OH) are essential for fire propagation
- TESS creates aerosol particles in micron size, based on potassium nitrate
- The fire is suppressed by chemical reaction of mainly Calium radicals with the free radicals in the fire zone



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Summary

- HC could be a high efficient & high performance substitution for R134a
- Overall safety system required for flammable refrigerants
- TESS has been developed for engine compartment

Overall safety system enables HC as a solution for MAC systems !!


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Thanks for your attention !!