
Technical Workshop on Hydrocarbon Refrigerants; Safety and Application

Part 1: R290 for air conditioning

8th and 9th February 2018

Barranquilla, Colombia

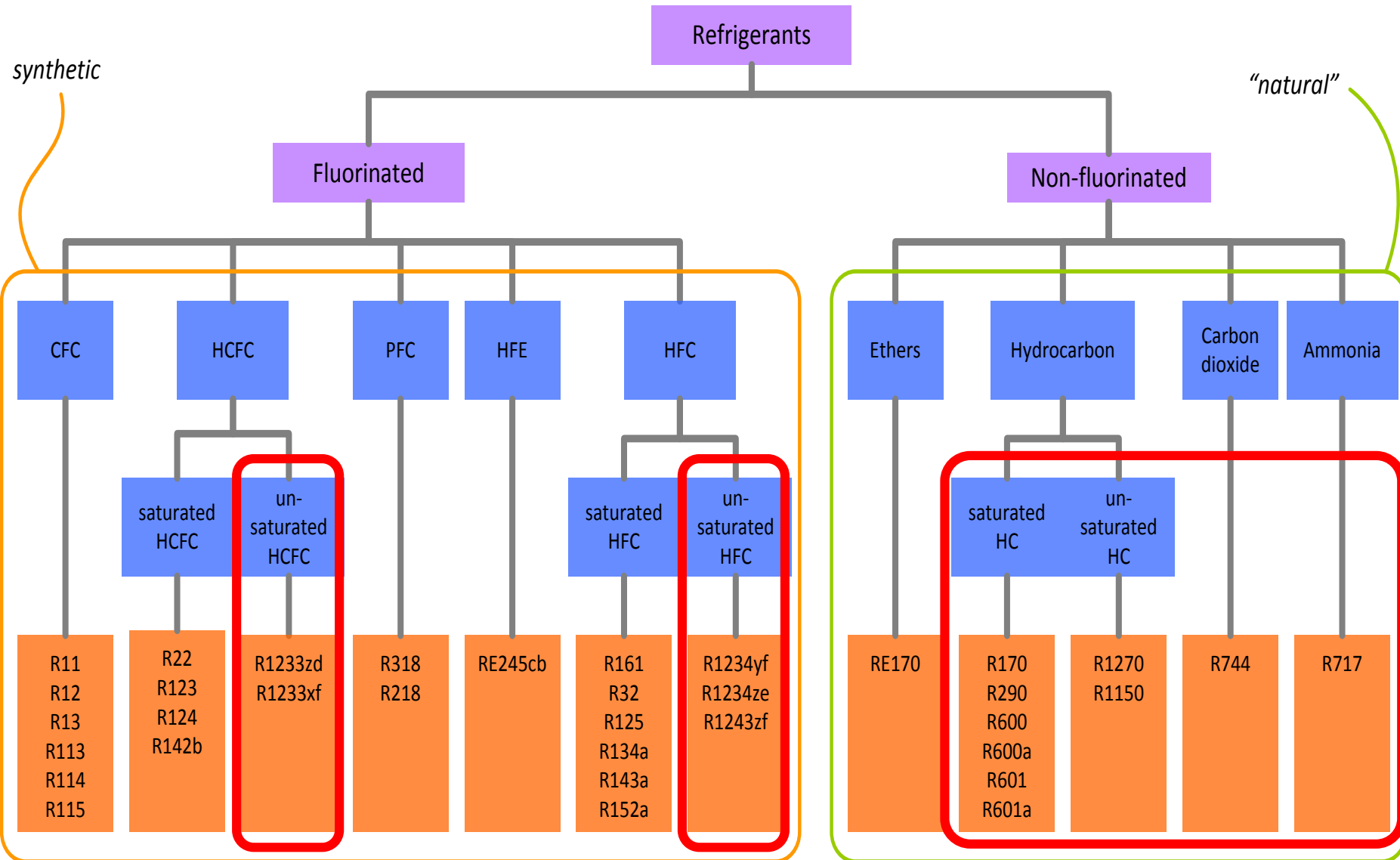
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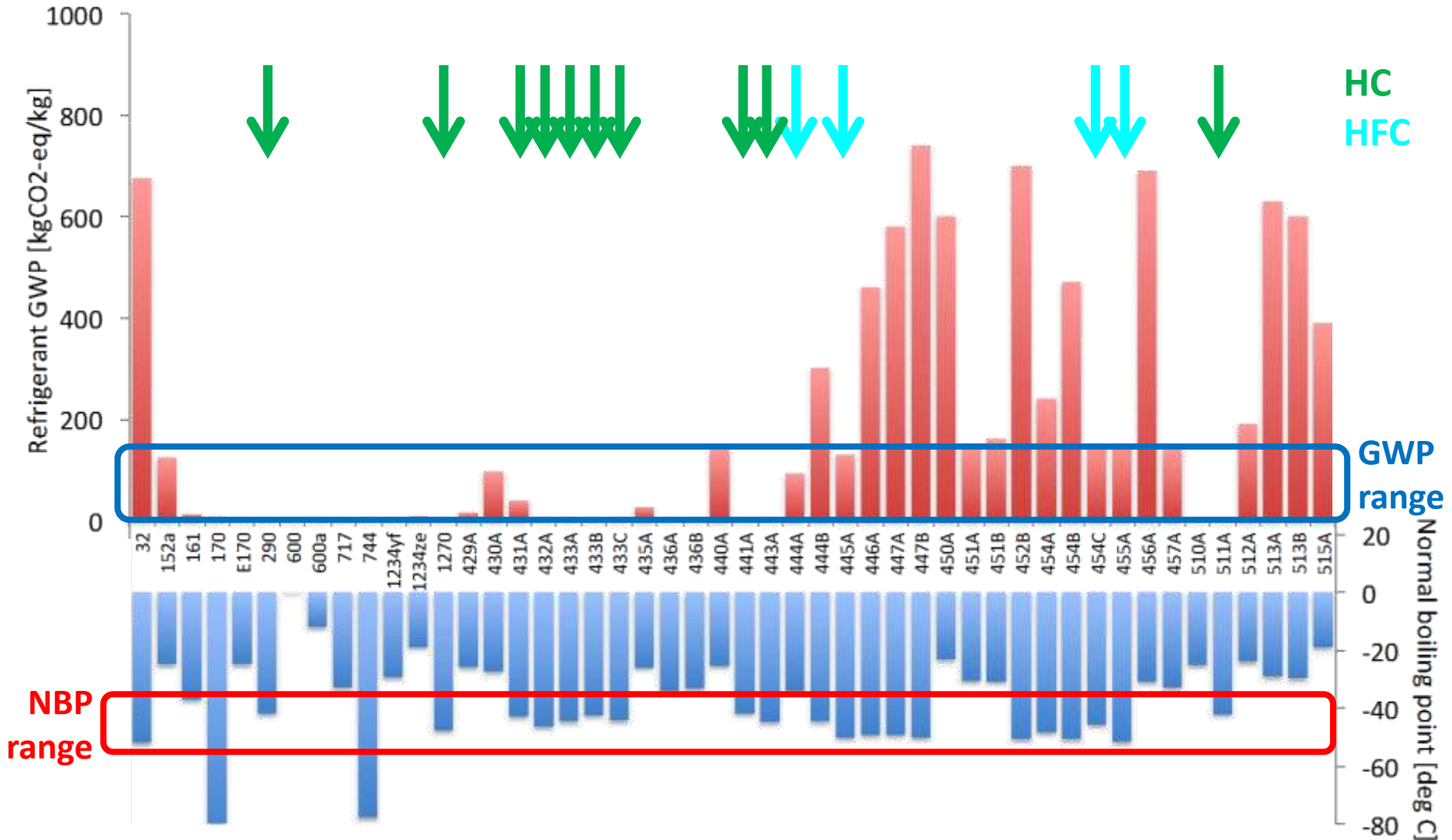
Part 1: Introduction to hydrocarbon refrigerants

Overview of refrigerant choices



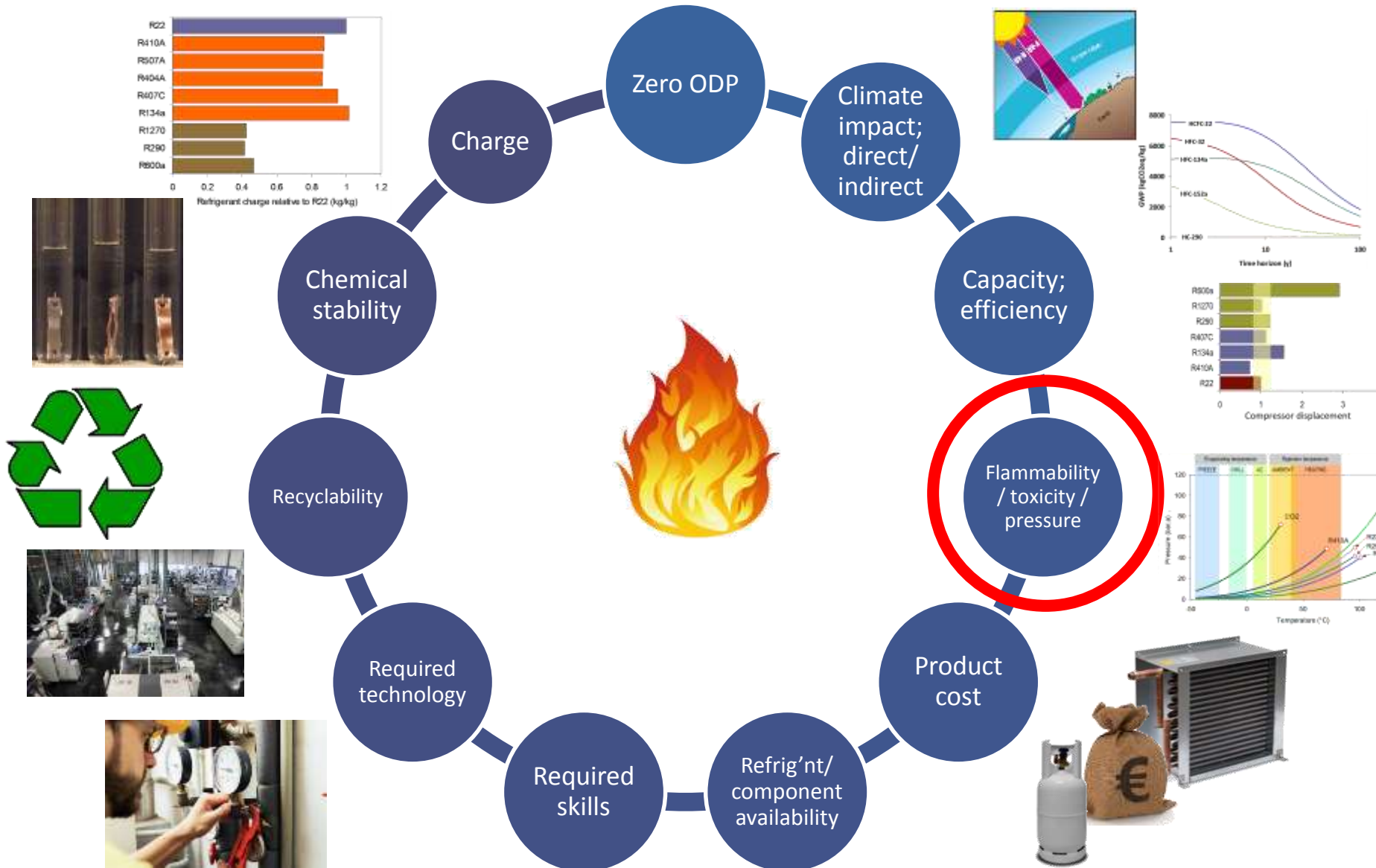
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Overview of refrigerant choices



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Implications of hydrocarbons

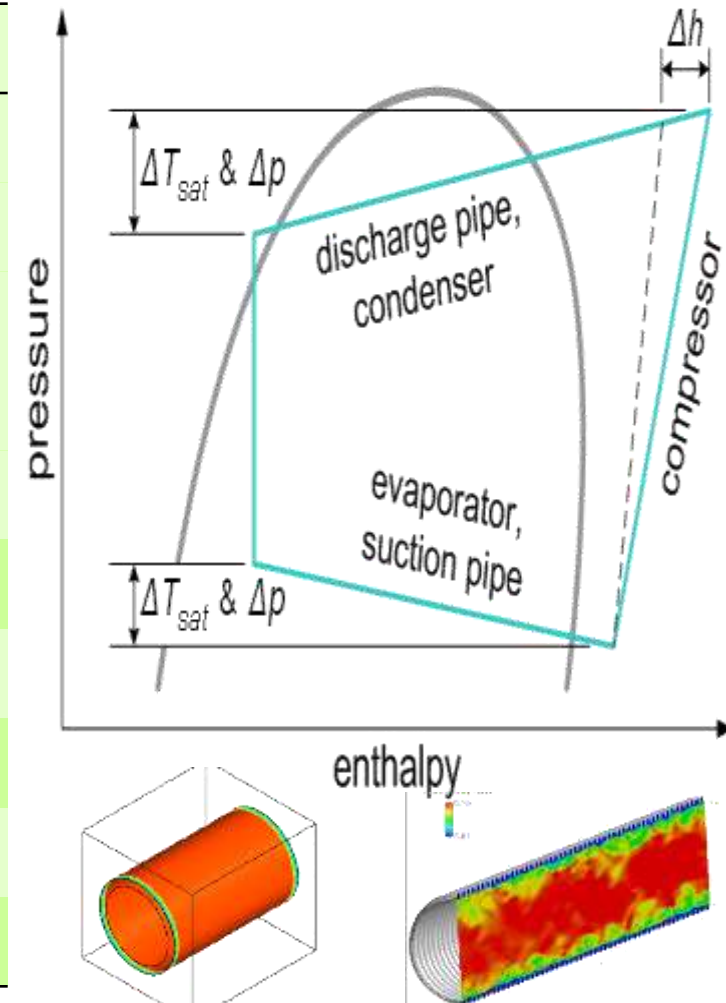


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System efficiency

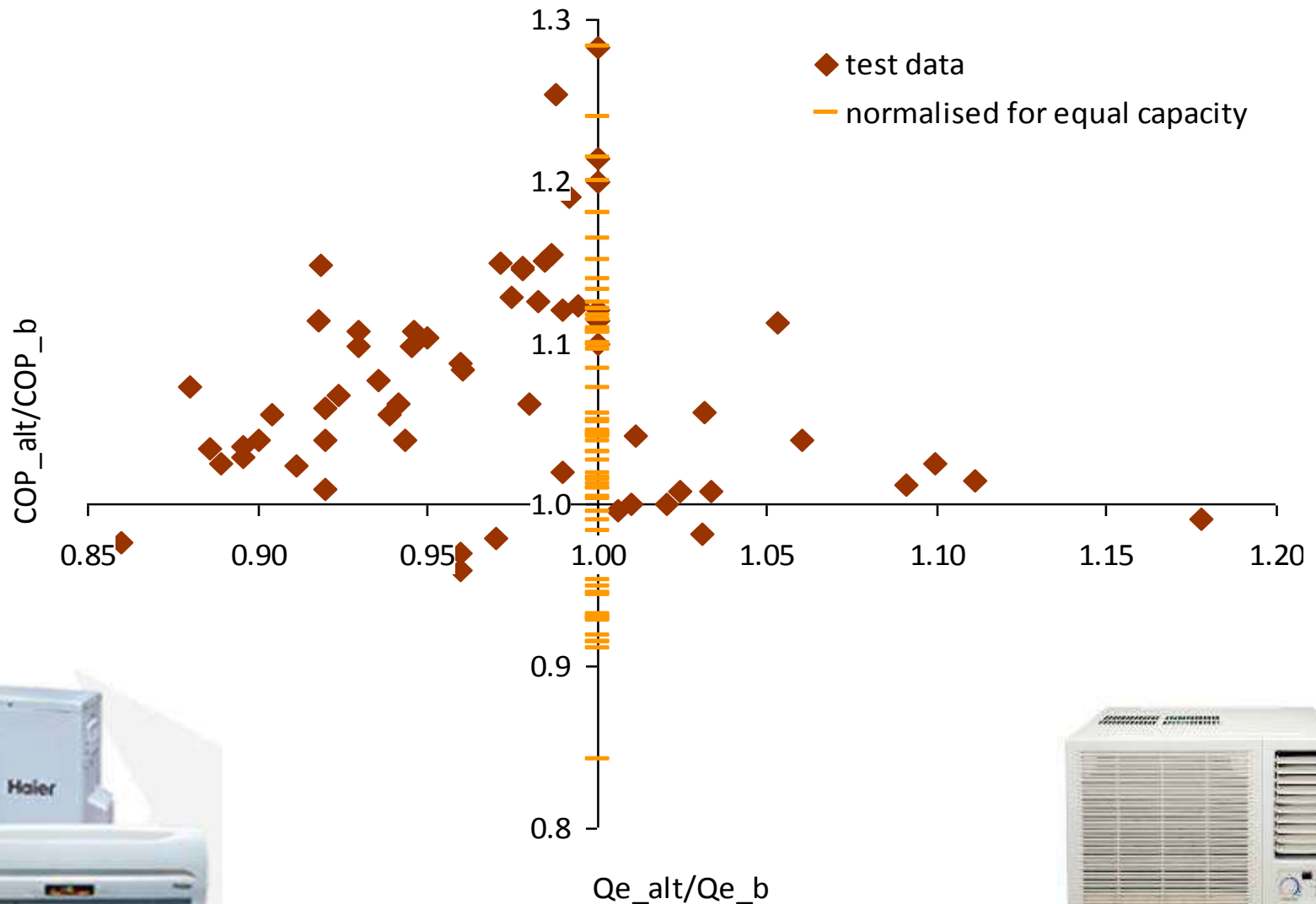
Theoretical cycle performance: $T_e = +10^\circ\text{C}$; $T_c = +45^\circ\text{C}$

Parameter	R22	R410A	R32	R290
Sat. evap press (kPa)	6.8	10.8	11.1	6.4
Sat. cond press (kPa)	19.4	30.6	31.4	17.1
Pressure ratio (-)	2.9	2.8	2.8	2.7
Relative to R22 (%)	100%	99%	99%	94%
Vol. refriger. effect (kJ/m ³)	4231	6016	6594	3581
→Relative to R22 (%)	100%	142%	156%	85%
Discharge temp (°C)	101	97	117	82
→Relative to R22 (K)	0	-3	16	-19
COP (W/W)	3.94	3.59	3.68	3.92
→Relative to R22 (%)	100%	91%	93%	99%



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System efficiency – R290 vs. R22



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Production of R290 heat pumps and air cond

Recent and planned



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R290 chillers



Many producers
throughout Europe

HFC, HC, R744 and R717

HC charges up to 25 kg
(and multiple circuits)

Most “digestible” use of
HCs in AC applications



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Considerations over equipment lifetime



Design



Production



Installation



Operation



Repair



Read manual
or handbook



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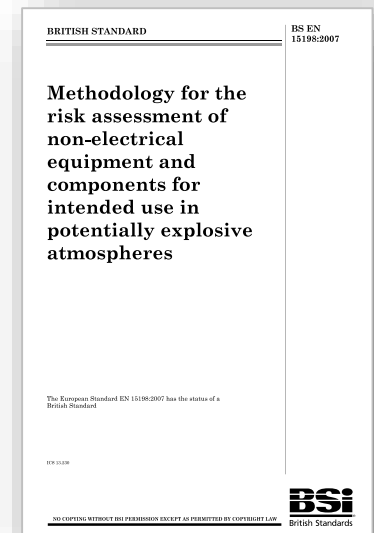
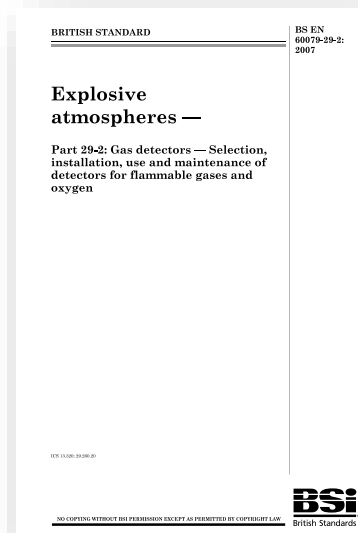
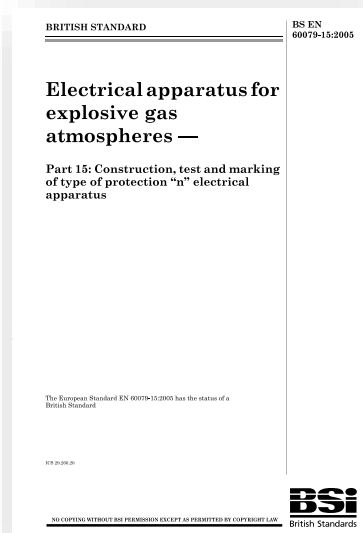
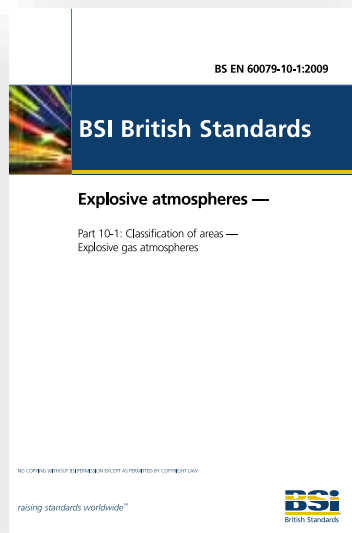
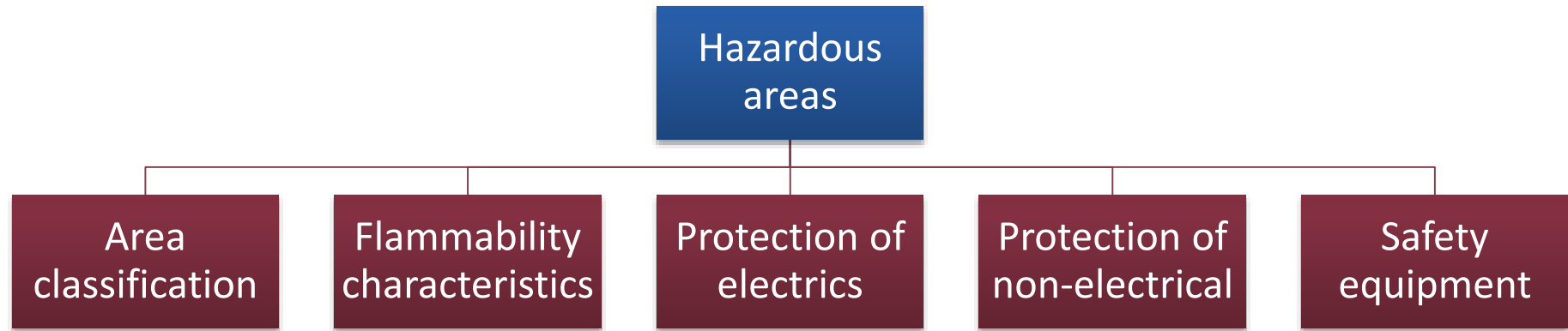
Applicable safety standards



Sector	IEC/EN 60335-2-24	IEC/EN 60335-2-40	IEC/EN 60335-2-89	ISO 5149	ISO 13043	EN 378
Domestic refrigeration	×					
Commercial refrigeration			×	×		×
Industrial systems				×		×
Transport refrigeration				×		×
Air-to-air air conditioners		×		×		×
Water heating heat pumps		×		×		×
Chillers		×		×		×
Vehicle air conditioning					×	

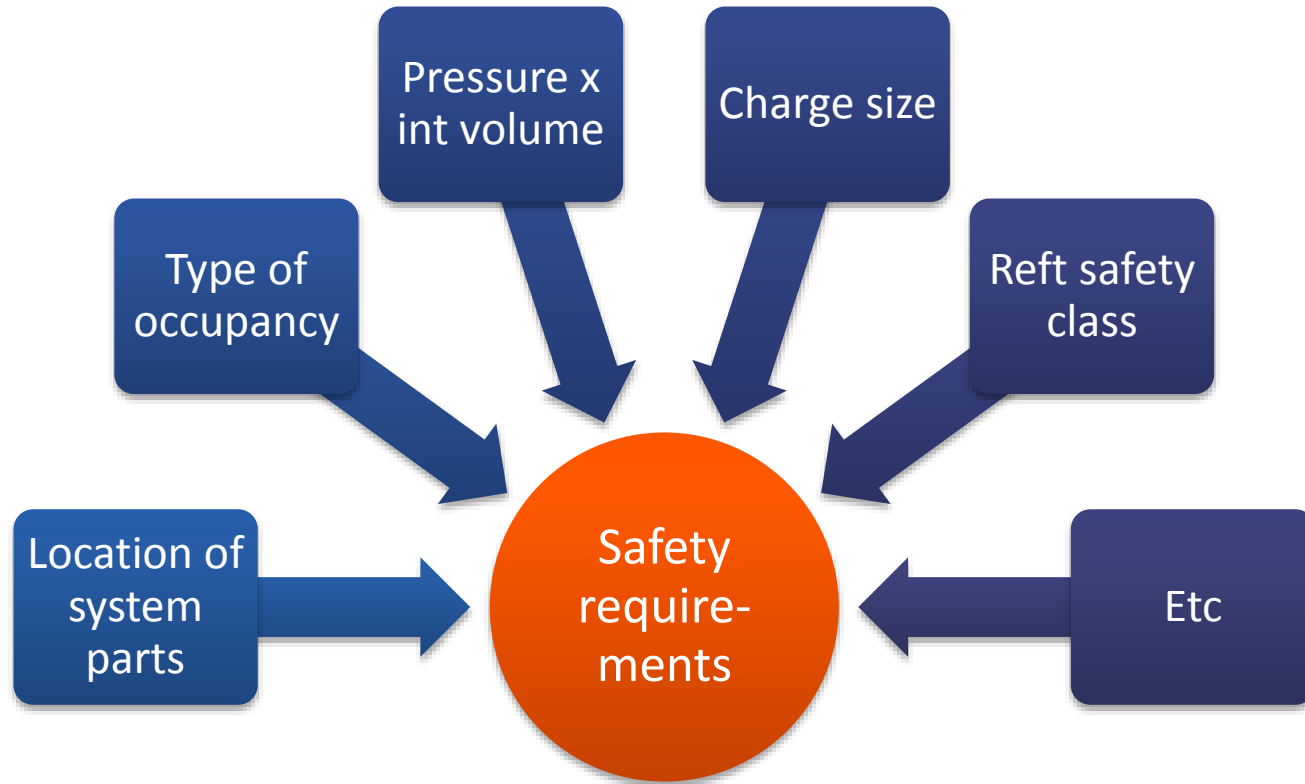
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Safety standards specifically for flammability



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Factors affecting stringency of requirements



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Summarising remarks

- More and more alternative refrigerants to choose from
 - Very few non-HC options suitable for AC
- HCs – R290 – very attractive in all respects
 - Except for flammability
 - Performance is particularly attractive
- Global production is disparate and sporadic
 - Anticipated changes to safety standards likely to change this
 - Chillers is the most steady end use
- Due to flammability, essential to encompass lifetime
 - Comply with safety standards, risk assessment, safety R&D

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Part 1: Introduction to refrigerants with a focus on hydrocarbons

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