

# Refrigerants

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ENTR Lot 1 Second Stakeholder Meeting  
Brussels, Belgium, June 4<sup>th</sup> 2010

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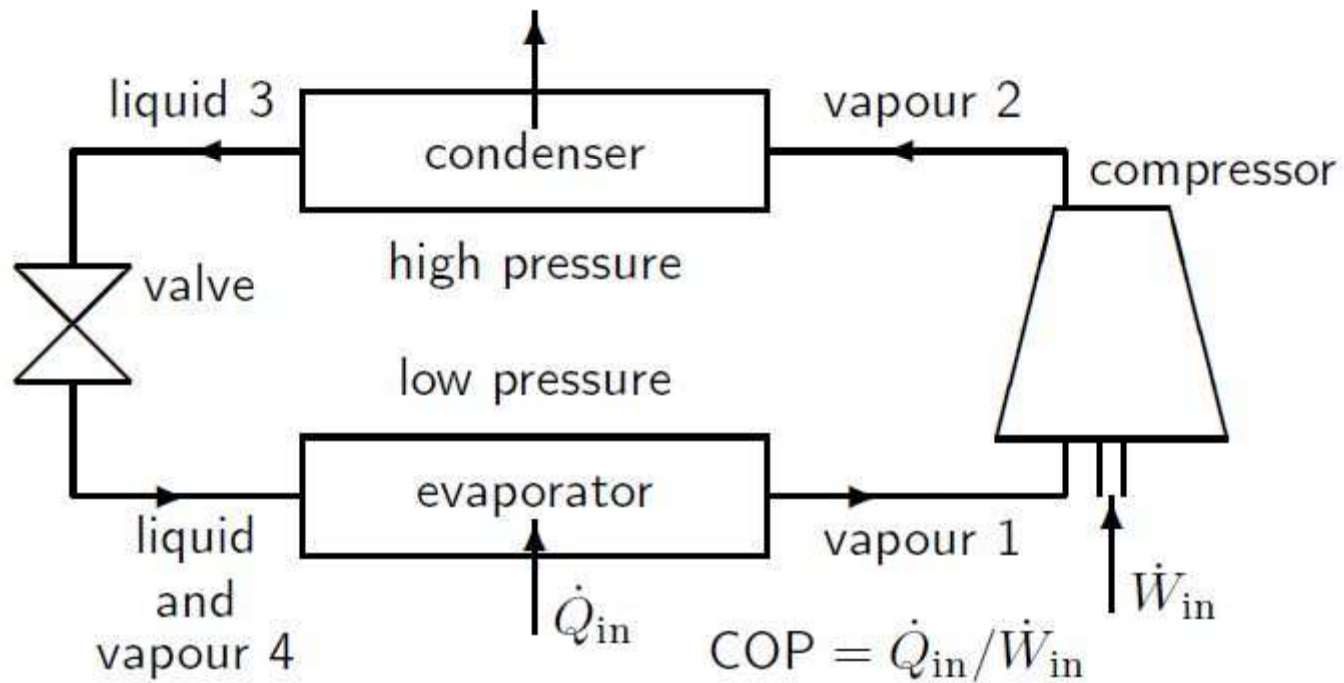
*A study being conducted for DG ENTR by BIO Intelligence Service*



10:00 – 10:20	<b>Welcome, “Tour de table”</b>
10:20 – 10:30	<b>Introduction to the Ecodesign Directive</b>
10:30 – 10:40	<b>Horizontal session: Progress update and selection of Base Cases</b>
10:40 – 11:30	<b>Product focus: Walk-in cold rooms</b>
11:30 – 11:50	<b>COFFEE BREAK</b>
11:50 – 12:40	<b>Product focus: Service cabinets</b>
12:40 – 13:30	<b>Product focus: Blast cabinets</b>
13:30 – 14:20	<b>LUNCH BREAK</b>
14:20 – 15:10	<b>Product focus: Remote condensing units</b>
15:10 – 15:40	<b>Horizontal session: Refrigeration systems</b>
15:40 – 16:00	<b>COFFEE BREAK</b>
16:00 – 16:30	<b>Horizontal session: Refrigerants</b>
16:30 – 17:20	<b>Product focus: Chillers</b>
17:20 – 17:30	<b>Conclusions, next actions and AOB</b>

## Definition and operation

- Any compound used in a heat cycle that reversibly undergoes a phase change from a gas to a liquid.



- Montreal protocol (1987): Ozone layer (substances with ODP)
- Kyoto protocol (1997): Climate change (substances with GWP)

Type	Refrigerant number(s)	Uses	Other issues
<b>CFCs</b>	R12 R505 211	Widely used in most applications until 1990	Now phased out of production
<b>HCFCs</b>	R22 R409a	Widely used in many applications. Not recommended for use after 1999	To be phased out of production in 2015. Their use is also regulated increasingly strictly
<b>HFCs</b>	R134a R404a R407c	Started to be used in place of CFCs from about 1990	Different compressor oil needed, performance of some HFCs not as good as CFCs. Some reliability problems.
<b>HCs</b> e.g. propane, iso-butane, propylene	R600a R290 R1270	R290 used in some industrial systems for decades. R600a now used in domestic systems.	Flammable, but are very good refrigerants with few changes needed to a CFC/HCFC system
<b>NH<sub>3</sub></b> <b>Ammonia</b>	R717	Used in industrial systems since the birth of refrigeration	Toxic and flammable, reacts with copper
<b>CO<sub>2</sub></b> <b>Carbon dioxide</b>	R744	Widely used before the 1950s, but superseded by halocarbons. Now being "rediscovered" as a primary and secondary refrigerant	Not yet widespread commercial use as a primary refrigerant, but an interesting prospect (high operating pressures requires special materials and construction)

### Related EU Legislation:

- Regulation ~~2037/2000~~ → 1005/2009: Ozone Depleting Substances (recast) (CFCs, HCFCs, HBFCs)
  - prohibition
  - leakage prevention
- Regulation 842/2006: F-Gas (some HFCs, PFCs, SF6)
  - gradually prohibition of some applications
  - leakage prevention

### Related test standards:

- EN 378:2009 “Refrigerating systems and heat pumps. Safety and environmental requirements. Design, construction, testing, marking and documentation”
- ASHRAE Standard 34-2008: “Designation and safety classification of refrigerants”

- Production/distribution as any other product
- Use phase/End of life phase:
  - **Ozone Depletion Potential** ( $\text{CCl}_3\text{F}=1$ )
  - **Global Warming Potential** ( $\text{CO}_2=1$ )
  - Flammability
  - Toxicity
  - Also take into account: lifetime in atmosphere
  - Importance on energy consumption (COP)



Refrigerants	ODP	GWP	Flammability	Toxicity
CFC	High	High	Low	Low
HCFC	Low	High	Low	Low
HFC	Low	Medium	Low	Low
HC	Low	Low	High	Medium
R717 NH <sub>3</sub>	Low	Low	High	High
R718 H <sub>2</sub> O	Low	Low	Low	Low
R744 CO <sub>2</sub>	Low	Low	Low	High

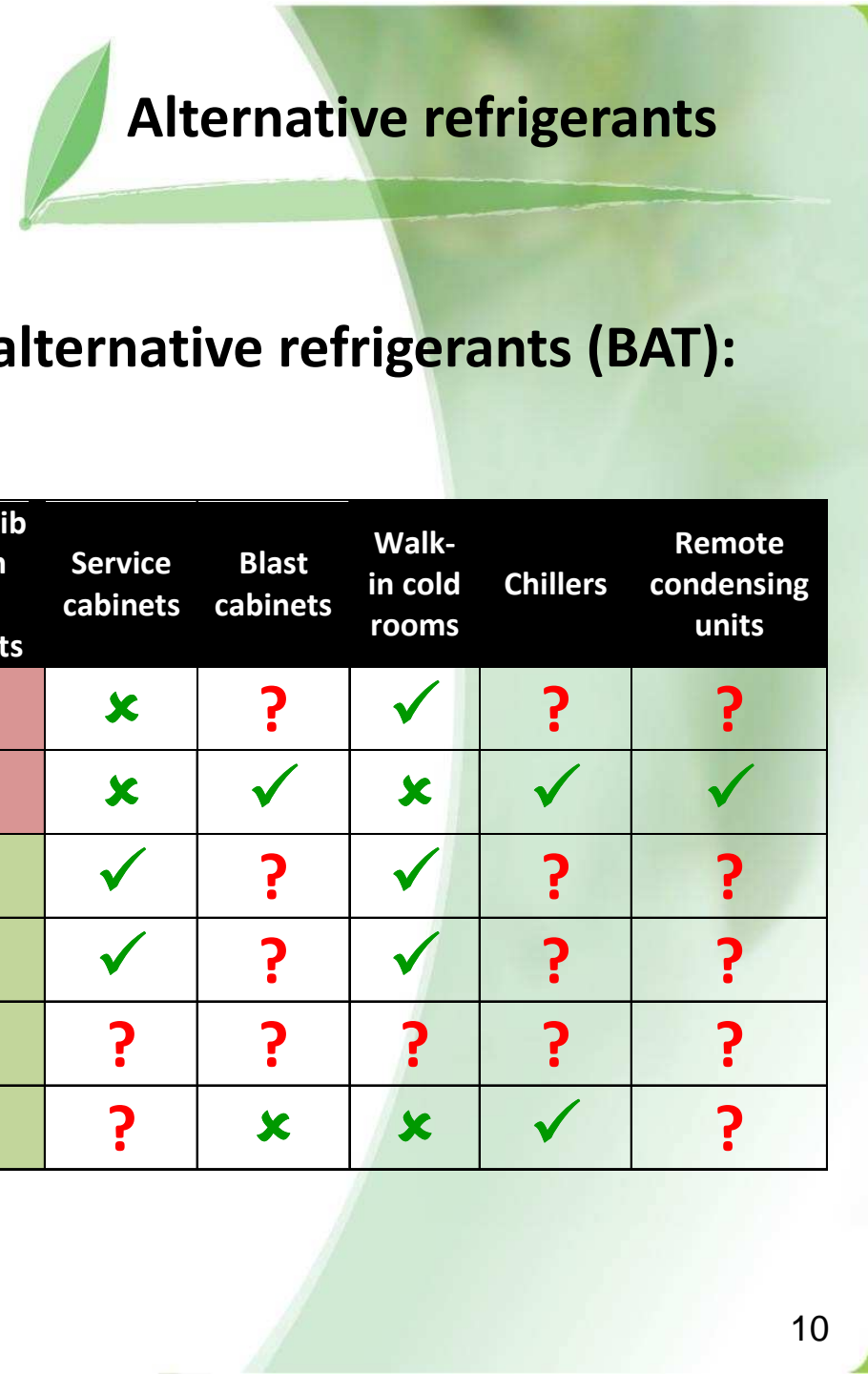
Refrigerant			COP	
			Medium temperature refrigeration (+5°C)	Low temperature refrigeration (-18°C)
R12	CFC	Dichlorodifluoromethane	3.15	1.51
R22	HCFC	Chlorodifluoromethane	3.31	1.55
R134a	HFC	Tetrafluoroethane	2.98	1.42
R404a	HFC	R125/R143/R134	2.96	1.33
R407c	HFC	32/125/134	2.88	1.37
R410a	HFC	R32/R125	3.25	1.48
R600a	HC	Isobutane	2.93	1.42
R290	HC	Propane	3.42	1.57
R1270	HC	Propylene	3.56	1.62
R744	CO <sub>2</sub>	Carbon dioxide	3.84	1.70

\*Source: MTP, Characteristics of Refrigerants in Relation to Efficiency.

Base case	Refrigerant	Refrigerant charge (kg)	Annual leakage used in base case (%)	Annual leakage proposed in latest comments (%)	GHG emissions (% of the product life cycle)
Service cabinets	R290 HC Propane	0.38	1	1-5	0.5
Blast cabinets	R404a HFC R125/R143a/R134a	1.4	1	5-10	0.01
Walk-in cold rooms	R134a HFC Tetrafluoroethane	1.1	1	5-10	0.6
Chillers	R134a HFC Tetrafluoroethane	95	1	5-10	0.6
Remote condensing units	R404a HFC R125/R143a/R134a	2.35	1	5-10	0.4

Agree with these numbers?

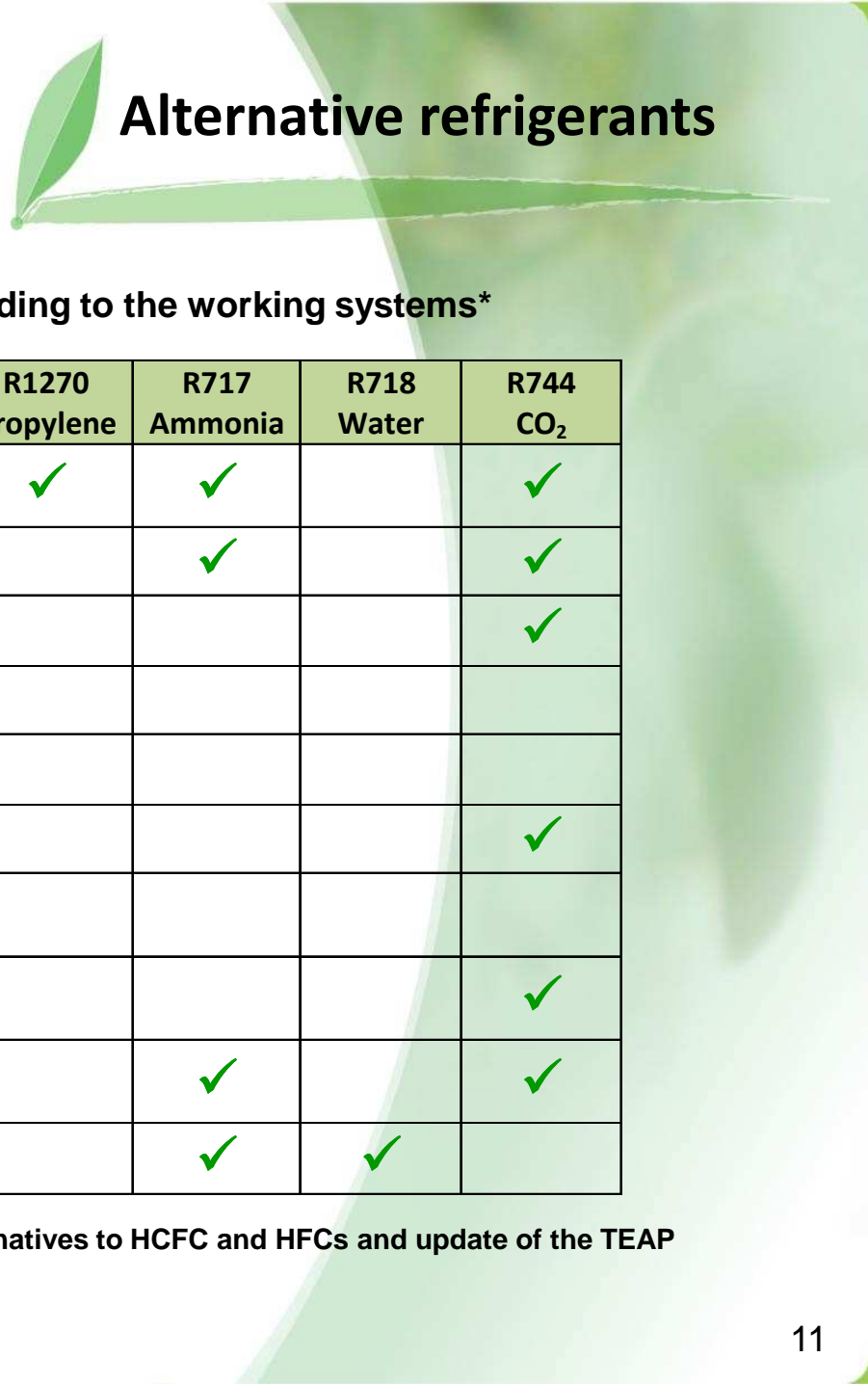
Average leakage in EU-27?



## Alternative refrigerants

### Comparative and applicability of alternative refrigerants (BAT):

Refrigerant	Flammability	Toxicity	Efficiency	Cost	Compatible with other elements	Service cabinets	Blast cabinets	Walk-in cold rooms	Chillers	Remote condensing units
CO <sub>2</sub> R744	Low	High	High	High	Low	✗	?	✓	?	?
Ammonia R717	High	High	High	Low	Low	✗	✓	✗	✓	✓
Propane R290	High	Medium	High	Low	High	✓	?	✓	?	?
Isobutane R600a	High	Medium	High	Low	High	✓	?	✓	?	?
HFO R1234yf	Low	Low	High	Medium	High	?	?	?	?	?
Water R718	Low	Low	Low	Medium	High	?	✗	✗	✓	?



## Alternative refrigerants

### UNEP recommendation for refrigerants according to the working systems\*

Systems type	R290 Propane	R600a Isobutane	R1270 Propylene	R717 Ammonia	R718 Water	R744 CO <sub>2</sub>
Large supermarket systems	✓		✓	✓		✓
Cold storage				✓		✓
Ice cream freezers	✓	✓				✓
Water fountains		✓				
Ice making machines		✓				
Vending machines	✓	✓				✓
Plug-in display cabinets		✓				
Condensing unit systems	✓	✓				✓
Spiral, tunnel and blast freezers				✓		✓
Industrial chillers				✓	✓	

\* Task force decision XX/8 Report. "Assessment of alternatives to HCFC and HFCs and update of the TEAP 2005 Supplement Report Data"



## Remaining gaps

- Contribution of refrigerants to overall efficiency
- Real efficiency of products using alternative refrigerants
- Real LCC of BAT and BNAT: technology, maintenance, end of life
- Availability of BNAT
- Leakage prevention systems