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# MILDLY FLAMMABLE REFRIGERANTS

## Working with A2Ls

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# A2L Portfolio


R-455A
GWP 148

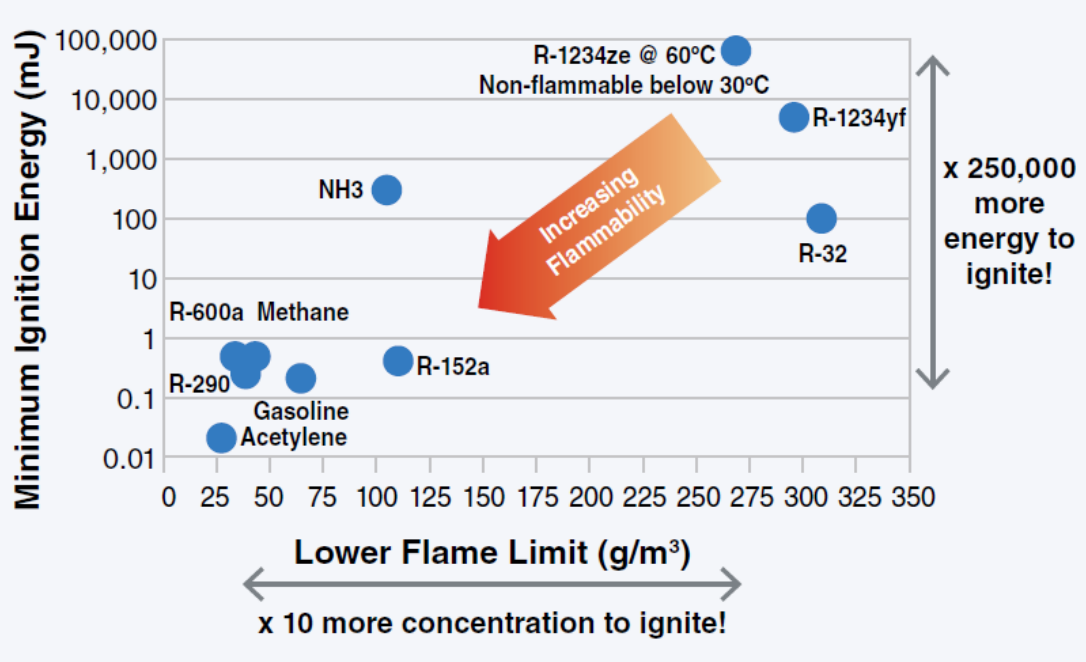

R-1234yf
GWP 4


R-1234ze(E)
GWP 6

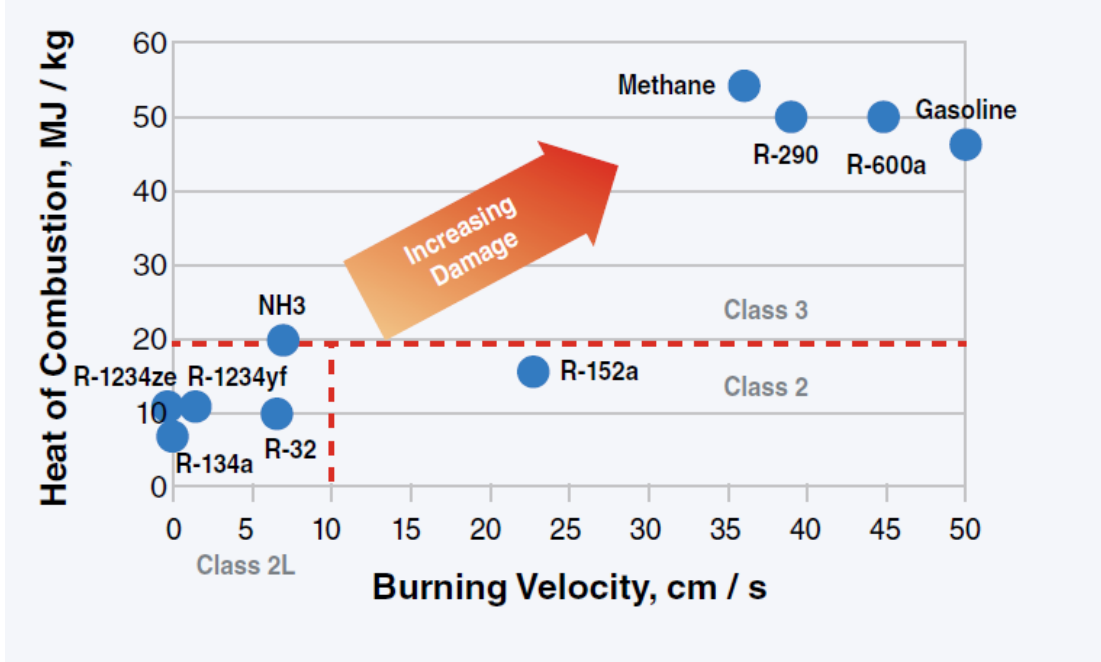

R-452B
GWP 698

All GWP values based on IPCC AR4

# Flammability Properties




**Probability of Ignition**




**Effect of Ignition**



**A2L Refrigerants are difficult to ignite**

# Safety Standards in EU – Overview

| | | Domestic Refrigeration | Commercial Refrigeration | Industrial Systems | Transport Refrigeration | Air-to-air Air Conditioners & Heat Pumps | Water Heating Heat Pumps | Heat Pump Tumble Driers | Chillers | Vehicle Air Conditioning | Refrigerated Containers |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Product Safety Standards** | EN 60335-2-11 | | | | | | | X | | | |
| | EN 60335-2-24 | X | | | | | | | | | |
| | EN 60335-2-40 | | | | | X | X | | X | | |
| | EN 60335-2-89 | | X | | | | | | | | |
| | ISO 13043 | | | | | | | | | X | |
| | ISO 20854 | | | | | | | | | | X |
| **Group Safety Standard** | EN 378 | X | X | X | X | X | X | X | X | | X |

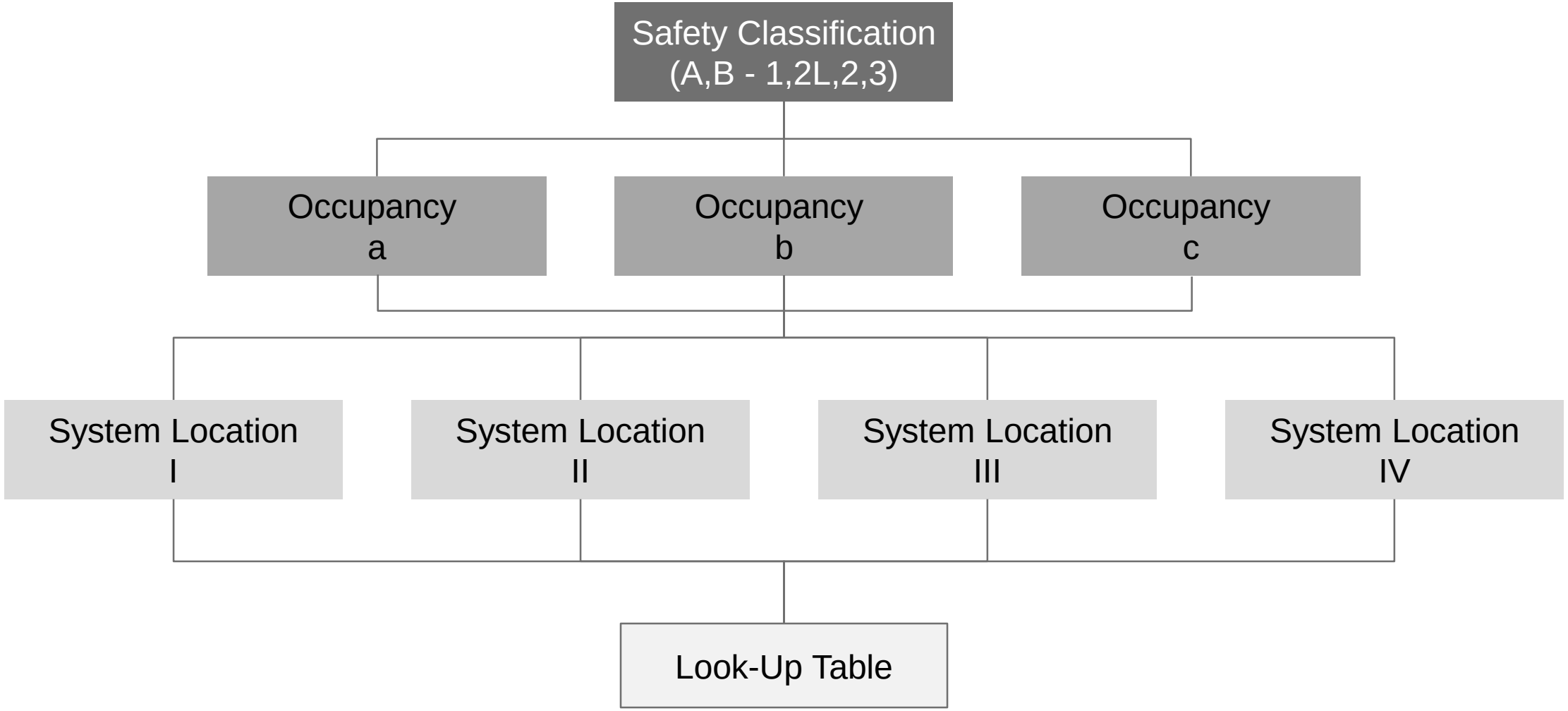


**A2L Included in most Standards**

# Interaction of Standards with Laws, Regulations & Codes

| EU | Member states | Local level |
| --- | --- | --- |
| F-gas regulation | Building codes | Fire fighting departments<br>City council, licensing |
| Adaption of standards needed | | No particular standards in place: application is limited as in general these instances look at the refrigerant type as specified in CLP (flammable , extremely flammable) |
| EN 378 | Codes **may** refer to EN 378.<br>But **not all** building codes do.<br>(MS do not necessarily follow standardisation work) | |
| EN 60335-2-40 | | |
| EN 60335-2-89 | | |
| EN 60335-2-24 | | |

# Allowable Charge Calculation



# Step 1 – Safety Classification

Increasing Hazard →

| TOXICITY ↓ | FLAMMABILITY: 1 Non-Flammable | 2L Lower Flammability | 2 Flammable | 3 Higher Flammability |
|---|---|---|---|---|
| **A** | R404A - R407F - R422D – R452A<br>R134a – R466A<br>R1233zd<br>R448A (N40)<br>R450A (N13) | R1234yf<br>R1234ze<br>R447A (L41)<br>R444B (L20)<br>R455A<br>R32 – R452B | R-152a | HC |
| **B** | R245fa | Ammonia | | |

Increasing Hazard ↓

Refrigerants with GWP <150 in red

# Step 2 – Occupancy

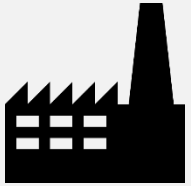
## A) General Occupancy

Hospitals
Courts
Theatres
Supermarkets
Schools
Airports
Hotels
Dwellings
Restaurants

## B) Supervised

Business
Professional Offices
Laboratories
Manufacturing Places
Work Place

## C) Restricted



Manufacturing Facilities e.g. for
Chemicals
Food
Beverage
Ice
Ice-Cream
Refineries
Cold Stores
Dairies
Abattoirs
Non-public Areas in
Supermarkets

# Step 3 – System Location

| I | II | III | IV |
|---|---|---|---|
| All refrigerant containing parts in the occupied space | Compressor & pressure vessel in machinery room or open air | All refrigerant containing parts in machinery room or open air | Ventilated enclosure |
|  |  |  | Special applications |

# Applying EN-378 to Room AC

**Step 3: Select System Location**

**Step 2: Select Occupancy**

**Step 1: Select Refrigerant Class**

Table C.2 — Charge limit requirements for refrigerating systems based on flammability

| Flammability class | Access category | | Location classification I | Location classification II | Location classification III | Location classification IV |
|---|---|---|---|---|---|---|
| 2L | a | Human comfort | According to C.2 and not more than $m_2$ [a] × 1,5 or According to C.3 and not more than $m_3$ [b] × 1,5 | | | |
| | | Other applications | 20 % x LFL × Room volume and not more than $m_2$ [a] × 1,5 or According to C.3 and not more than $m_3$ [b] × 1,5 | | No charge restriction [c] | Refrigerant charge not more than $m_3$ [b] × 1,5 |
| | b | Human comfort | According to C.2 and not more than $m_2$ [a] × 1,5 or According to C.3 and not more than $m_3$ [b] × 1,5 | | | |
| | | Other applications | 20 % × LFL × Room volume and not more than $m_2$ [a] × 1,5 or according to C.3 and not more than $m_3$ [b] × 1,5 | 20 % × LFL × Room volume and not more than 25 kg [c] or according to C.3 and not more than $m_3$ [b] × 1,5 | | |
| | c | Human comfort | According to C.2 and not more than $m_2$ [a] × 1,5 or According to C.3 and not more than $m_3$ [b] × 1,5 | | | |
| | | Other applications | 20 % × LFL × Room volume and not more than $m_2$ [a] × 1,5 or according to C.3 and not more than $m_3$ [b] × 1,5 | 20 % × LFL × Room volume and not more than 25 kg [c] or according to C.3 and not more than $m_3$ [b] × 1,5 | | |
| | | <1 person per 10 m² | 20 % × LFL × Room volume and not more than 50 kg [a] or according to C.3 and not more than $m_3$ [b] × 1,5 | No charge restriction [c] | | |

a $m_2$ = 26 m³ × LFL.

b $m_3$ = 130 m³ × LFL.

c For open air, 4.2 of prEN 378-3:2015 applies and, for machinery rooms, 4.3 of prEN 378-3:2015 applies.

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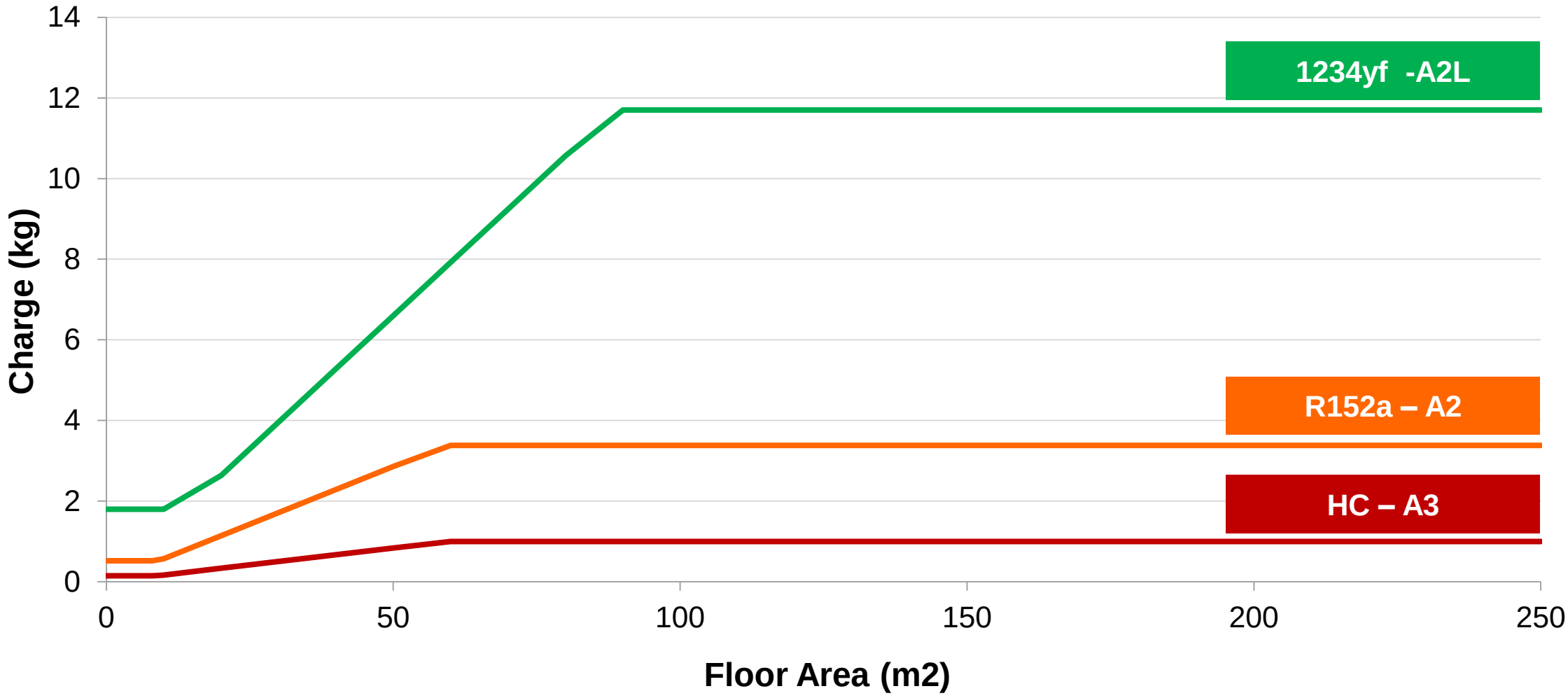
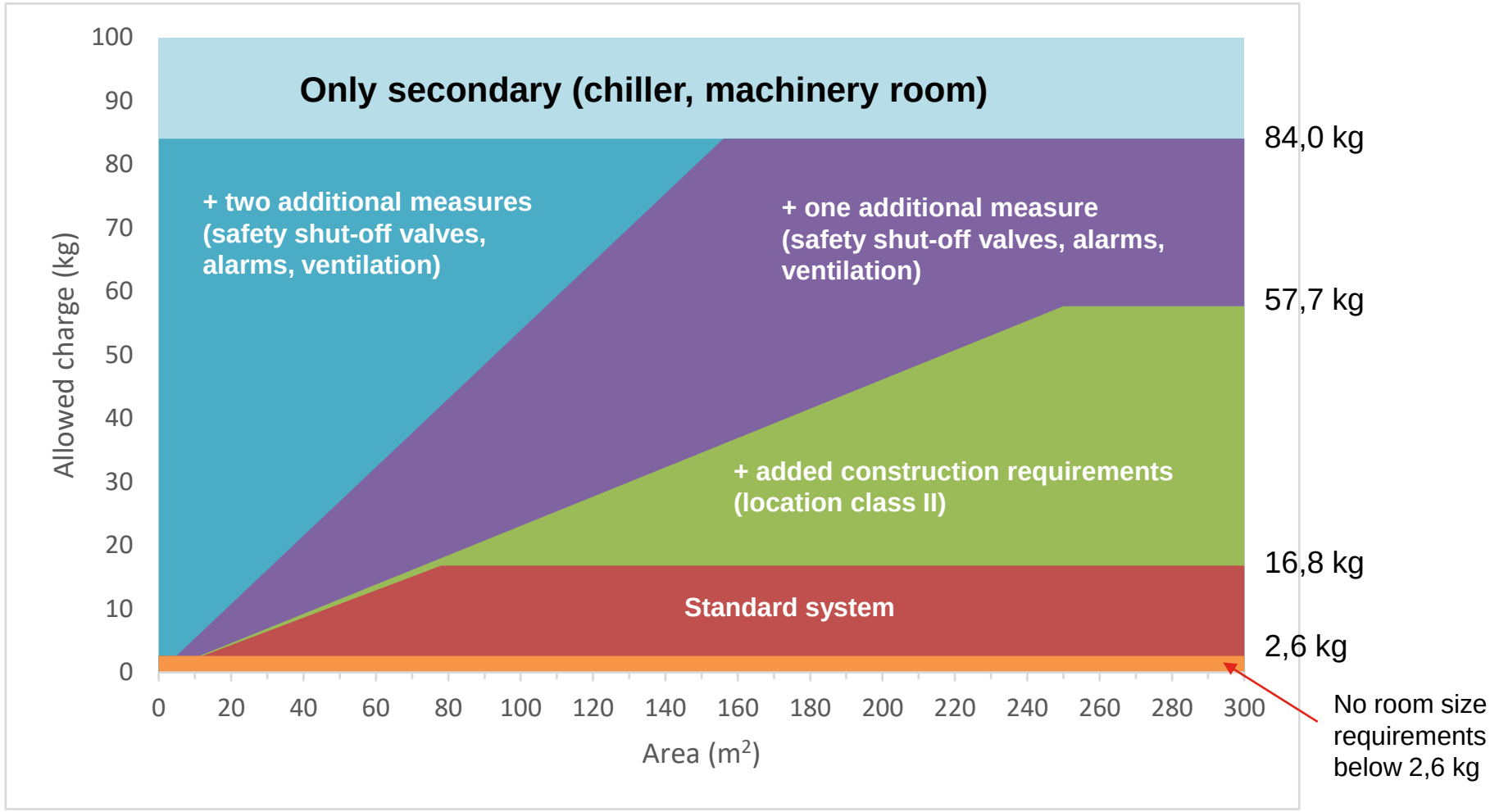
# Charge Limit Comparison





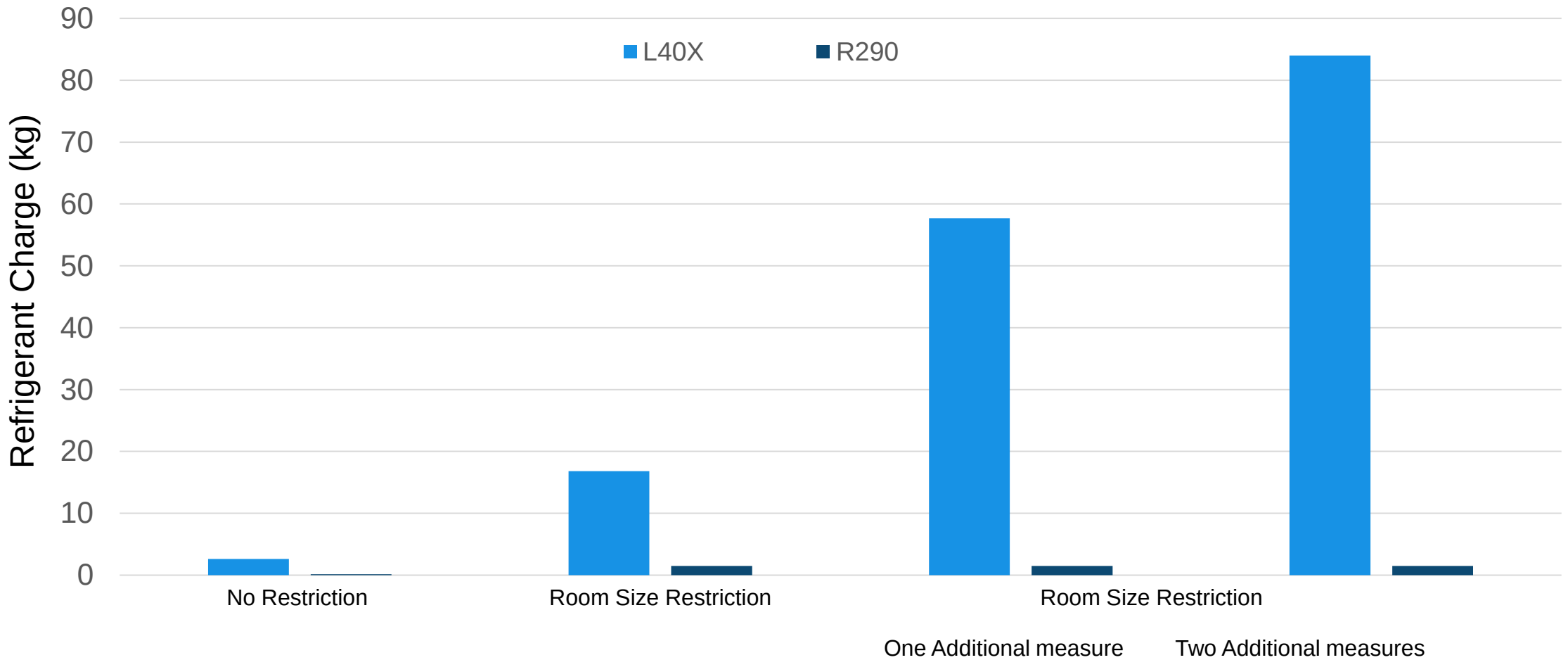

**A larger charge is allowed with 2L refrigerants**

# R-455A (A2L) Charge Limits – Refrigeration




Room height 2,5 m. LFL 431 g/m3.

# Maximum Charge Comparison A2L vs A3






**Larger Refrigerant Charge allowed for A2L**

# Additional Charge

- Additional charge for 2L refrigerants is possible with alternative risk management
- The charge limits shall be determined by multiplying room volume with RCL, QLMV or QLAV depending on measure taken.
  - RCL: Refrigerant Concentration Limit
  - QLMV: quantity limit with minimum ventilation
  - QLAV: quantity limit with additional ventilation

**The charge is capped  to 195 x LFL for HFO > 60kg**



**With additional measures, higher A2L refrigerant charges are possible**

# System Suitability Indication

| Systems | HC | HFO[1] |
|---|---|---|
| Integral System, <150gr charge |  |  |
| Integral System, =1.5kg charge |  |  |
| Cold room, monoblock system |  |  |
| Cold room cooled by remote condensing unit |  |  |
| Split AC System |  |  |
| Portable AC System |  |  |
| VRV/VRF System |  |  |
| Rooftop Chiller |  |  |
| Machinery room Chiller |  |  |
| DX process cooling |  |  |

1) A2L with LFL ~ 0.3kg/$m^3$

Table to be used as an indication only.

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# Conclusions

- The A2L Classification is implemented in most standards
- A larger charge is allowed with A2L refrigerants with additional safety measures. Covering most applications.
- Building Codes and country/regional regulations have to be taken into consideration
- The Safety Data Sheet (SDS) is the most important documentation to accompany the product, and should be referred to

# THANK YOU!

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# QUESTIONS?

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and more sustainable world

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