

Charge Limits for Hydrocarbon Refrigerants in HVACR Systems

In accordance with revised EN 378:2026 standard

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Why Hydrocarbon Refrigerants?

Near-zero GWP

R290 (propane) has GWP ≈ 0.02 vs. >2500 for HFCs — a 99%+ reduction in climate impact.

Good Thermodynamic Properties

R290 offers superior COP and energy efficiency compared to HFC's.

Rapid Market Adoption

Midea sold >1 million R290 units in 2023. Daikin expanded its R290 portfolio at ISH 2025.

EU F-Gas Regulation 2024/573

From 2025, new residential split AC ≤ 12 kW must not use F-gases, R290 is the key alternative.

The Flammability Challenge

A3

Safety Classification

R290 – Highly flammable
LFL = 0.039 kg/m³

Leakage concern:
Concentration near floor
could reach LFL

- Flammable refrigerants require strict **charge limits** to prevent ignition risk in case of leaks.
- **EN 378** is the key European safety standard covering refrigerant charge limits.
- **Draft prEN 378:2025** introduces more flexible, risk-based calculation method than the current EN 378 standard
- The draft prEN 378:2025 consists of four parts: : **prEN 378-1 (definitions, charge limits)**, prEN 378-2 (design and testing), prEN 378-3 (installation) and prEN 378-5 (refrigerant data).
- The revision is expected to be published as **EN 378:2026** in May 2026.

Key Changes in Draft prEN 378:2025

01

Four-part structure

Parts 1–3 & 5: Definitions & charge limits / Design & testing / Installation / Refrigerant data

02

New: Concentration Factor F

Replaces fixed limits with F-factor depending on location class and system type

03

New: Representative Height h^*

Height parameter used in charge formula; depends on where refrigerant accumulates

04

Location & Accessibility Classes

4 location classes (I–IV) × 3 accessibility classes (A–C) define the applicable limits

05

Room Volume Determination

Updated methodology for defining the reference room volume for safety calculations

Location Classes (I–IV)

I

Entire system inside occupied room

e.g. household refrigerator

II

Compressor outside; heat exchanger inside

e.g. split AC / split heat pump

III

All components outside or in technical room

e.g. monoblock air-to-water heat pump

IV

System inside ventilated enclosure

e.g. commercial condensing unit in enclosure

Maximum Charge Calculation – Formula

$$m = F \times LFL \times A \times h^*$$

m Maximum refrigerant charge [kg]

F Concentration factor — from Table 1 of prEN 378:2025 (depends on location class and system type)

LFL Lower Flammability Limit of the refrigerant [kg/m³] — for R290: 0.039 kg/m³

A Floor area of the room [m²]

h* Representative height [m] — from Table 1, related to refrigerant accumulation zone

⚠ The calculated value must not exceed the absolute limits defined in Table 2 (location × accessibility matrix).

Concentration Factor F and Height h^*

Table 1. Concentration factor F and representative height h^* values by location category and system type per prEN 378:2025.

System Type	Location	F	h^*
Sealed systems	I	0.20	Room height
Permanently technically tight	II	0.20	Lowest height of refrigerant-containing part
Circulation airflow (sealed base)	I or III	0.35	Room height
Circulation airflow (open base)	I or III	0.50	Room height

F-factor reflects refrigerant concentration distribution after a leak. Lower F means stricter (lower) charge limit.

Absolute Charge Limits — Location × Accessibility (Table 2)

Table 2. Charge limits for class 3 refrigerants as a function of location and accessibility category in accordance with draft pr EN378:2025

Accessibility	Loc. I	Loc. II	Loc. III	Loc. IV*
a – rooms for general use with unrestricted public access, e.g., restaurants, shops	Eq.1, max 40 m ³ ·LFL	Eq.1, max 80 m ³ ·LFL	No limit	Max 300 m ³ ·LFL
b – rooms where people work and where a limited number of occupants are present, e.g., offices, laboratories.	Eq.1, max 65 m ³ ·LFL	Eq.1, max 80 m ³ ·LFL	No limit	Max 300 m ³ ·LFL
c – technical rooms and production halls where only qualified personnel are present, e.g., industrial plants	Eq.1, max 650 m ³ ·LFL	Eq.1, max 650 m ³ ·LFL	No limit	Max 650 m ³ ·LFL

*If ventilation ensures concentration ≤ 50%, location IV charge limit may be doubled.

Practical Implications for R290 Systems

Residential Split AC (Loc. II, Access. a)

Charge calculated by Eq. 1, capped at $80 \text{ m}^3 \times 0.039 = 3.12 \text{ kg}$, significantly higher than current standard.

Ventilated Enclosure (Loc. IV)

With adequate ventilation (conc. $\leq 50\%$ LFL), the charge limit doubles.

Commercial Refrigeration (Loc. III)

No upper charge limit from the location/accessibility matrix.

Public Buildings (Access. a)

Most restrictive: location I capped at $40 \text{ m}^3 \times \text{LFL} = 1.56 \text{ kg}$ for R290.

Supermarket Cold Store (Loc. III, Access. c)

Technical room placement removes charge cap, enabling larger R290 systems.

Qualified-Personnel Areas (Access. c)

Up to $650 \text{ m}^3 \times \text{LFL} = 25.35 \text{ kg}$ in loc. I or II, allowing industrial-scale R290 installations.

Conclusions

1. The revised EN 378:2026 introduces a risk-based, formula-driven approach replacing blanket fixed limits. Unification of the previously diverse requirements of European and international standards
2. The concentration factor F combined with room area and representative height h^* enables site-specific charge calculations.
3. Location class III (all-outdoor) effectively removes charge limits - enabling large natural refrigerant systems.
4. Adequate ventilation in Location IV can double the permissible charge.
5. The standard aligns safety rules with EU F-gas regulations, accelerating the transition to R290 and other A3 refrigerants.