



eurammon Symposium 2017

***Standards and Regulations
Update for Flammable Refrigerants***

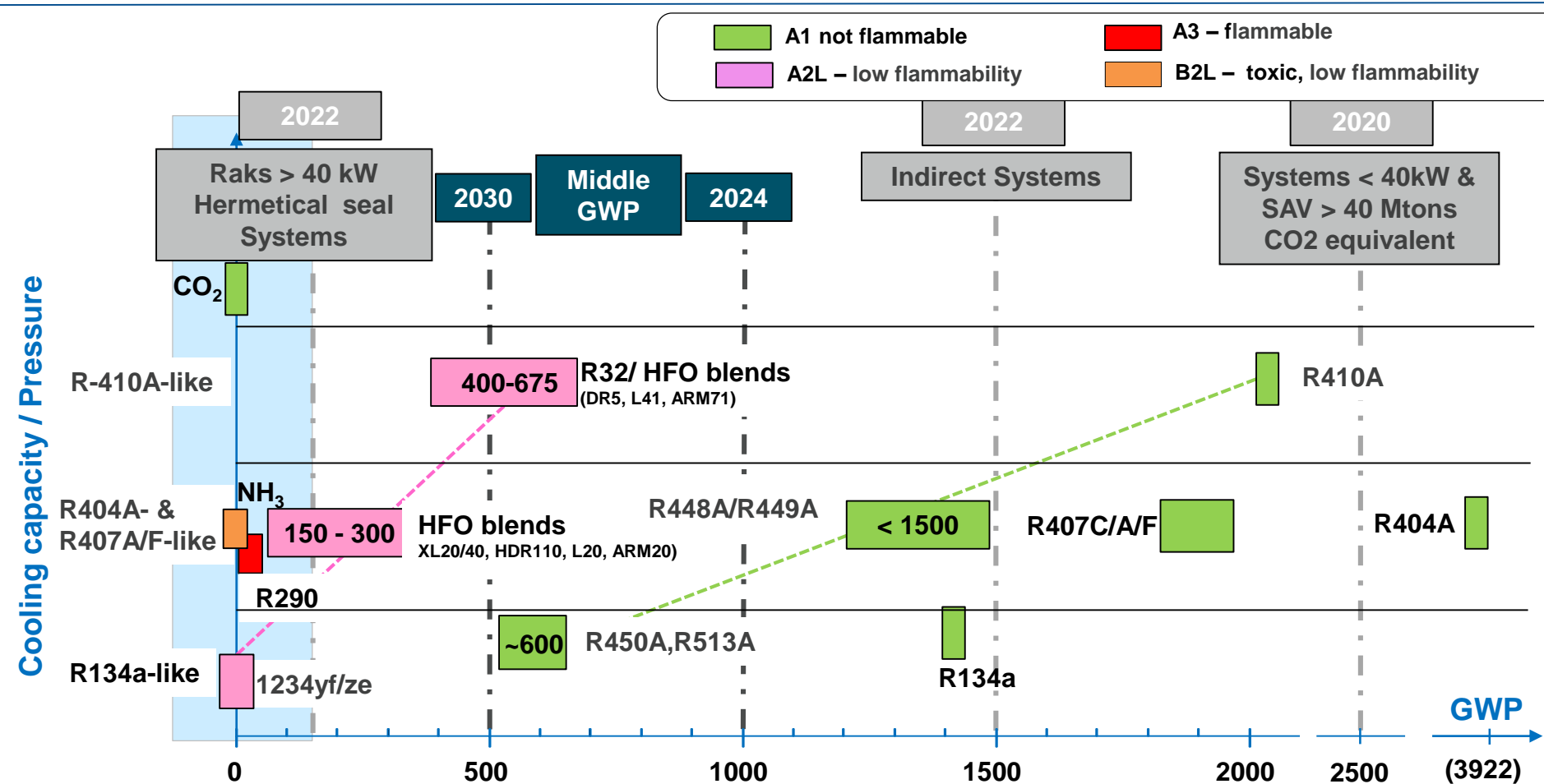
Dr. Frank Rinne

Schaffhausen, 22nd/23rd June, 2017

Agenda

- Refrigerant Overview and Classification of Flammable Refrigerants
- Standards in the Context with Regulations
- EN378
- EN60335-2-89 Charge Extension & Safety Concept
- EN60335-2-40
- Summary

Refrigerant Overview

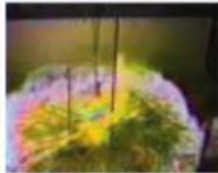



- F-Gas Regulation has an impact to the refrigerant selection
- System Architecture = f(Refrigerant Properties)

Classification of Refrigerants (1)

		Lower toxicity	Higher toxicity
Higher flammability		A3	B3
Flammable	Burning velocity $\geq 10\text{cm/s}$	A2	B2
Lower flammable	Burning velocity $< 10\text{cm/s}$	A2L	B2L ▶ New class
No flame propagation		A1	B1

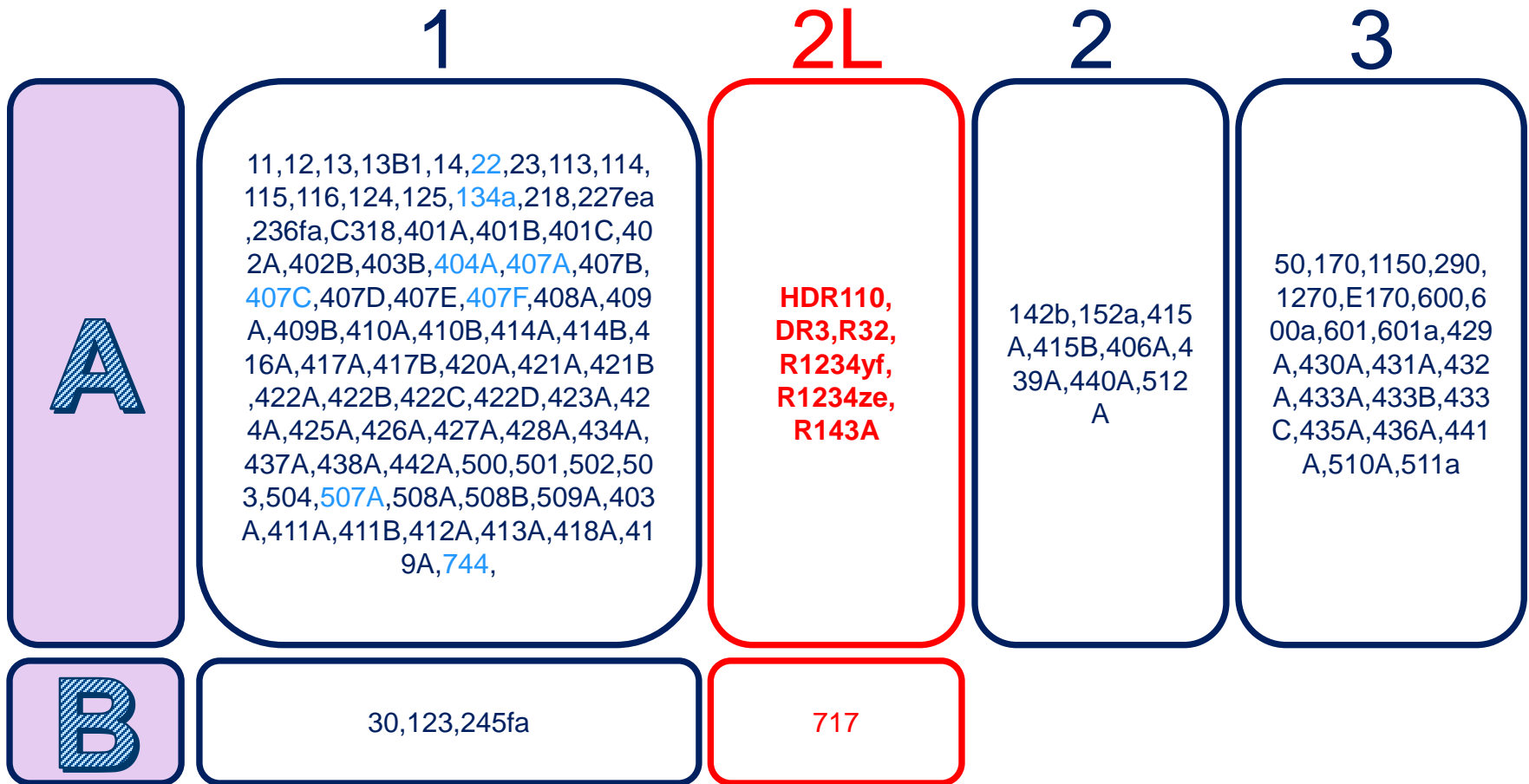
Behavior of Flames

Substance	Class A3 Propane	Class A2 HFC152a	Class A2L HFC32	Class B2L Ammonia
Burning velocity	43 cm/sec	23 cm/sec	6.7 cm/sec	7.7 cm/sec
Heat of combustion	46 MJ/kg	16 MJ/kg	9 MJ/kg	19 MJ/kg
Combustion state				

A2L refrigerants do not propagate due to their slow BV. Additionally, heat of the combustion of HFC32 is low and the range of any impact by its flame is limited.

Quelle: Daikin

Refrigerant Classification (2)



Quelle: Daikin

Safety Data sheet R32 vs R290

R32 = R290

2.2. Label elements

- Labelling Pictograms



- Signal word

Danger

- Hazard Statements

H280 Contains gas under pressure; may explode if heated.
H220 Extremely flammable gas.

- Precautionary Statements

Precautionary Statement Prevention

P210 Keep away from heat/sparks/open flames/hot surfaces. - No smoking.

Hazard Pictogram(s)



GHS02

GHS04

Signal Word:

Danger

Hazard Statements:

H220: Extremely Flammable Gas
H280: Contains gas under pressure; may explode if heated.

Precautionary Statements

Prevention:

P210: Keep away from heat/sparks/open flames/hot surfaces – No Smoking.

Response:

P337: Leaking gas fire: Do not extinguish unless leak can be stopped Safely.
P381: Eliminate all ignition sources if safe to do so.

***Classification Rules defined in the Global Harmonized System (GHS).
Industry started an initiative to change the classification in GHS in order to
differentiate between A2L and A3***

European Regulations & Standards

European Treaty

Art. 95

OEM

Single market

TBT Technical Barriers of Trade

Product Harmonisation

PED/MD/LVD/EMC

.....

ATEX (94/9/EC)
(product) - IEC/EN 60079

Art. 137

Customer

Safety of workers

Remark : Only minimum requirements

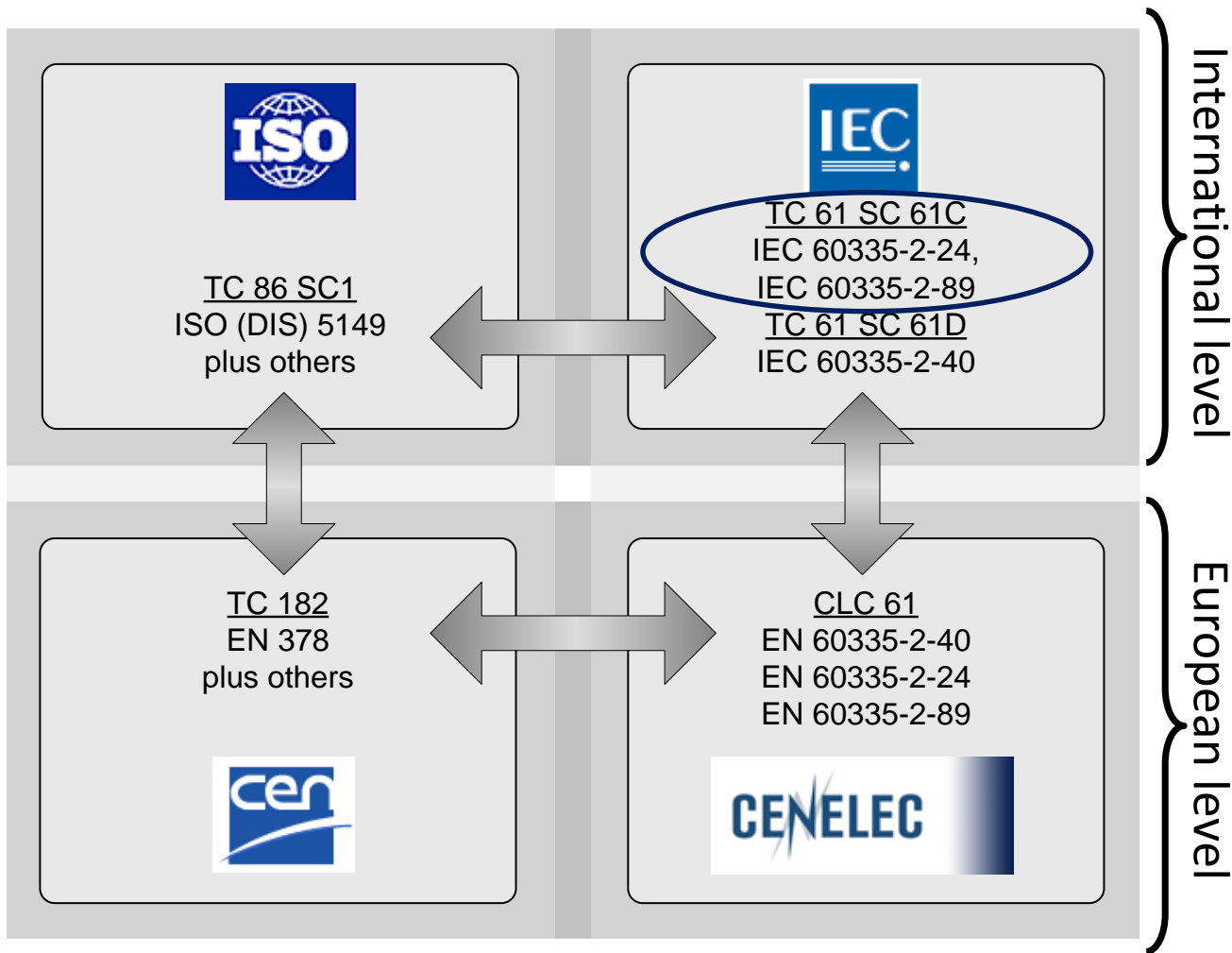
National regulations:

Dangerous Substances and Explosive Atmospheres Regulations
(DSEAR) : UK

Betriebs-Sicherheits-Verordnung (BetrSichV) : DE

ATEX (99/92/EC)
(workplace)- TRBS-2152

International and European Committees and Standards



Horizontal & Vertical Safety Standards

Horizontal Standard **For All Ref. Systems:** EN378

(Horizontal Standard Covers Fundamental Principles, Concepts, Terminology Or Technical Characteristics)

Household Appliances Or Similar Use

- Commercial Systems
- Industrial Systems

EN 60335 series

-2-24

-2-89

-2-40

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MD

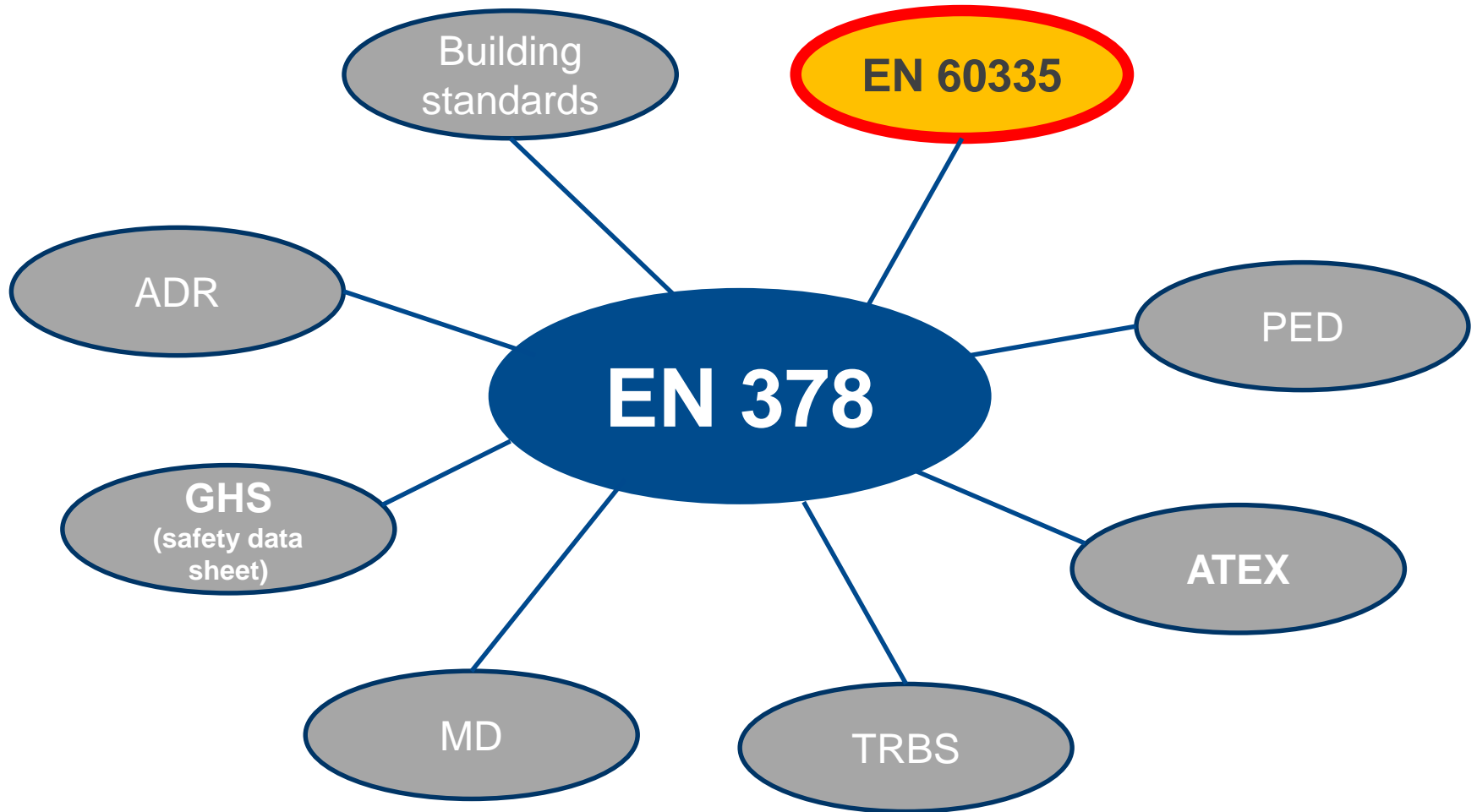
MD

PED

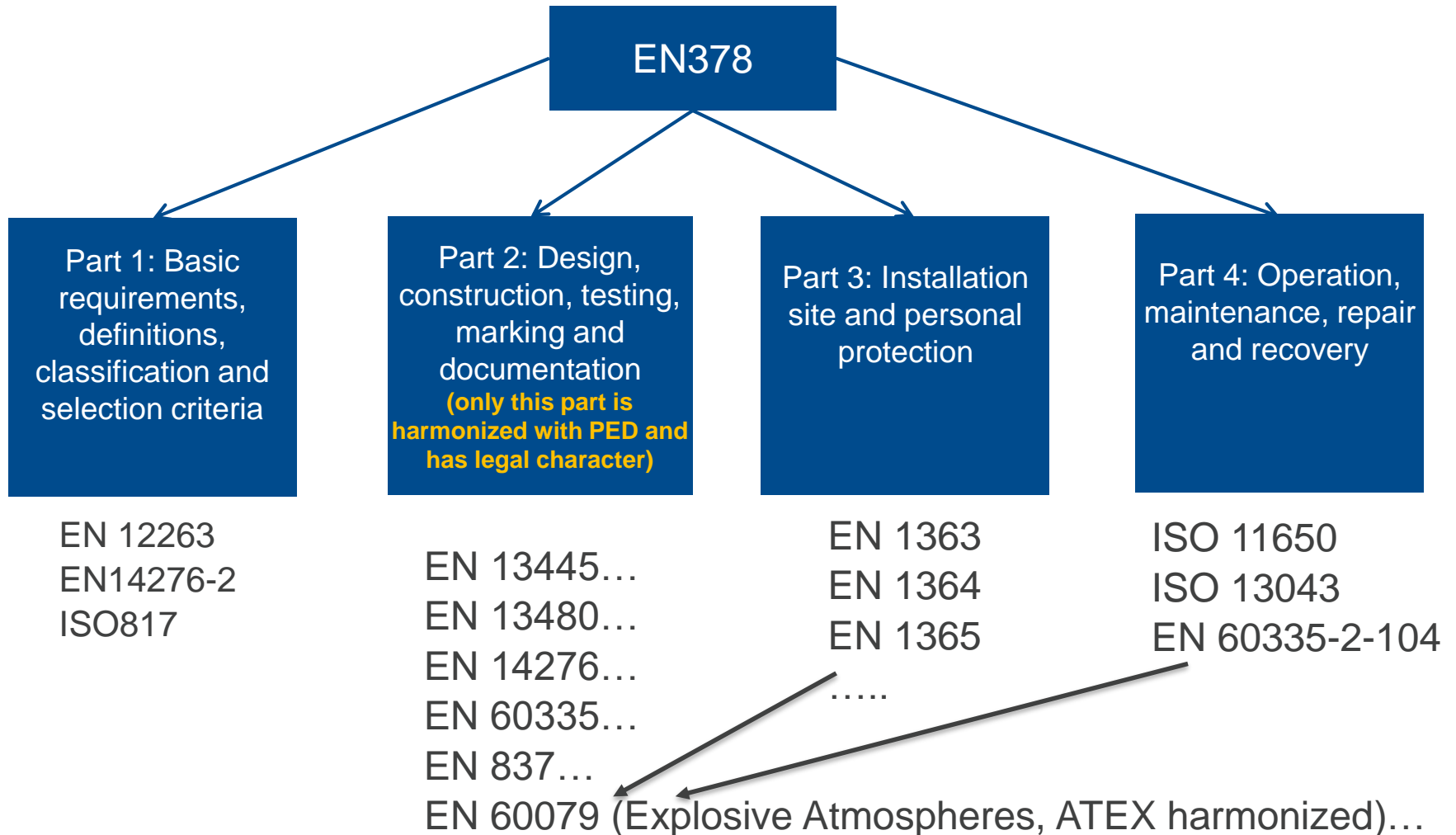
Standards Update for A2L /A3

- EN 378 is harmonized with ISO 5149
- EN 60335-2-40
 - Voting 2017 for A2L
 - WG started, A2/A3 Charge Ext. 2017
- EN60335-2-89
 - WG A2/A3 started Charge Ext. 2018
 - Target: Refrigerant Charge up to 0,5 kg

EN378 in the Context with Other Regulations & Standards



Scope EN378: Normative References



I guess all documents are more than 1000 pages, not so easy!

What is new in EN378

Part 1: Basic Requirements, Definitions & Classifications

- Vocabulary
 - Separate Machinery Room
 - Access Category
 - Open Air
- Flammability Class 2L
- Additional Calculation for human comfort
- Alternative risk management for occupied space
- Refrigerant tables updates

Determine the charge based on flammability

Flammability class	Access category	I = Occupied space		II Comp. In mach.-room / open air	III All ref component in mach.-room / open air	Ventilated enclosure
2L	a general access	Human comfort	According to C.2 and not more than $m_2^a \times 1,5$ or According to C.3 and not more than $m_3^b \times 1,5$		No charge restriction ^c	Refrigerant charge not more than $m_3^b \times 1,5$
		Other applications	20 % x LFL x Room volume and not more than $m_2^a \times 1,5$ or According to C.3 and not more than $m_3^b \times 1,5$			
	b Superv. access	Human comfort	According to C.2 and not more than $m_2^a \times 1,5$ or According to C.3 and not more than $m_3^b \times 1,5$			
		Other applications	20 % x LFL x Room volume and not more than $m_2^a \times 1,5$ or according to C.3 and not more than $m_3^b \times 1,5$	20 % x LFL x Room volume and not more than 25 kg ^c or according to C.3 and not more than $m_3^b \times 1,5$		
	c Author. access	Human comfort	According to C.2 and not more than $m_2^a \times 1,5$ or According to C.3 and not more than $m_3^b \times 1,5$			
		Other applications	20 % x LFL x Room volume and not more than $m_2^a \times 1,5$ or according to C.3 and not more than $m_3^b \times 1,5$	20 % x LFL x Room volume and not more than 25 kg ^c or according to C.3 and not more than $m_3^b \times 1,5$		
		< 1 person per 10 m ²	20 % x LFL x Room volume and not more than 50 kg ^a or according to C.3 and not	No charge restriction ^c		

EN378 has 3 Levels of Refrigerant Charge

1. $m_1 = 4 \text{ [m}^3\text{]} * \text{LFL [kg/m}^3\text{]}$ (-> small kitchen)
2. $m_2 = 26 \text{ [m}^3\text{]} * \text{LFL [kg/m}^3\text{]}$
3. $m_3 = 130 \text{ [m}^3\text{]} * \text{LFL [kg/m}^3\text{]}$
 - Additional risk assessment and additional ventilation

Examples:

Propane, A3, LFL = 0,038 kg/m³

$$m_1 = 4 \text{ m}^3 * 0,038 \text{ kg/m}^3 = 0,150 \text{ kg}$$

$$m_2 = 26 \text{ m}^3 * 0,038 \text{ kg/m}^3 = 0,988 \text{ kg}$$

$$m_3 = 130 \text{ m}^3 * 0,038 \text{ kg/m}^3 = 4,94 \text{ kg}$$

R32, A2L, LFL = 0,307 kg/m³

$$m_1 = 4 \text{ m}^3 * 0,307 \text{ kg/m}^3 * 1,5^* = 1,8 \text{ kg}$$

$$m_2 = 26 \text{ m}^3 * 0,307 \text{ kg/m}^3 * 1,5 = 11,97 \text{ kg}$$

$$m_3 = 130 \text{ m}^3 * 0,307 \text{ kg/m}^3 * 1,5 = 59,87 \text{ kg}$$

*** 50% more refrigerant charge than A2**

C.2 Charge Limit Calculation

$$m_{\max} = 2,5 \times \text{LFL}^{5/4} \times h_0 \times A^{1/2} \quad (\text{C.1})$$

$$A_{\min} = m^2 / (2,5 \times \text{LFL}^{5/4} \times h_0)^2 \quad (\text{C.2})$$

where

m_{\max} is the allowable maximum charge in a room in kg;

m is the refrigerant charge amount in the system in kg;

A_{\min} is the required minimum room area in m²;

A is the room area in m²;

LFL is the Lower Flammable Limit in kg/m³, as defined in Annex E;

h_0 is the height factor of the appliance:

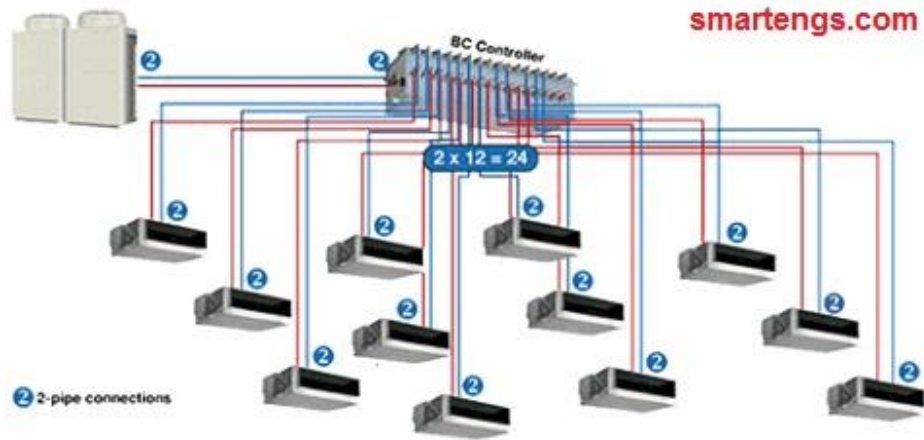
- 0,6 for floor location;
- 1,8 for wall mounted;
- 1,0 for window mounted;
- 2,2 for ceiling mounted,

where the LFL is in kg/m³ from Annex E and the molecular mass of the refrigerant is greater than 42 g/mol.

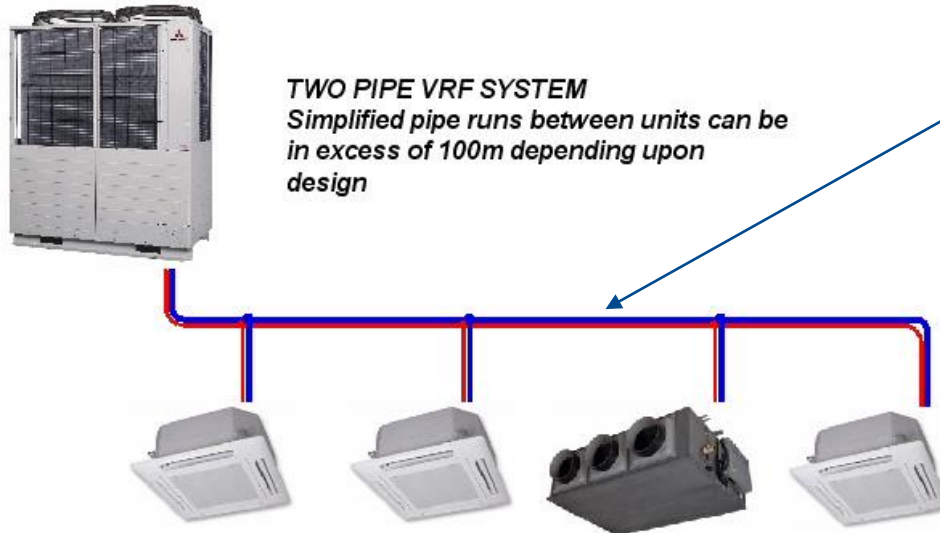
Alternative for risk management of ref.- systems in occupied spaces (C.3) - *Increase the Charge*

- These alternative provisions can only be used for an occupied space which fulfils **all** of the following conditions:
 - systems where the refrigerant is classified as A1 or A2L according to Annex E;
 - systems where the refrigerant charge does not exceed 150 kg and does not exceed $1,5 \times m_3$ for A2L refrigerants;
 - systems where the rated cooling (heating) capacity of the indoor unit is not more than 25 % of the total cooling (heating) capacity of the outdoor unit systems and where pipes serving equipment in the occupied space in question are not oversized relative to the capacity of that equipment;
 - system location is class II in accordance with 5.3;
 - systems where the heat exchanger in the indoor unit and the control of the system are designed to prevent damage due to ice formation;
 - systems where the refrigerant-containing parts of the indoor unit are protected against fan breakage or the fan is designed to prevent breakage;
 - systems where only permanent joints are used in the occupied space in question except for site-made joints directly connecting the indoor unit to the piping;
 - systems where the refrigerant-containing pipes in the occupied space in question are installed in such way that it is protected against accidental damage in accordance with FprEN 378-2:2016, 6.2.3.3.4 and FprEN 378-3:2016, 6.2;
 - alternative provisions to ensure safety are provided in accordance with C.3.2.2 and C.3.2.3;
 - doors of the occupied space are not tight-fitting;
 - effect of flow down is mitigated in accordance with C.3.2.4.

System Design for Multisplit Units according Risk Assessment C.3



Each piping is not oversized, in case of leakage of one evaporator the other evaporators will still work and limit the leak amount -> preferred design



If the main pipe is installed in occupied space, the complete gas will leak, this design is not allowed.

What is new in EN378 2(2)

Part 2: Design, construction, testing, marking and documentation

- Aligned with PED and MD
- Flowchart updated
- 4 new Annexes
 - Stress corrosion cracking
 - Leak simulation testing
 - Commissioning procedure
 - Ignition sources

Part 4: Operation, maintenance, repair and recovery

- New text for evacuating procedure
- Testing halocarbon for moisture
- Handling Ammonia during service
 - When to dispose as hazardous waste
 - When to vent into water
 - How to dispose water

Part 3: Installation site and personal protection

- Separate machinery room
- Requirements for A2L's
- Equipment not in occupied space nor in machinery room
- Sprinkler in ammonia machinery rooms

Applicable types of equipment related to the IEC 60335-2-89

Types of equipment

Out of scope Investigated

Airflow to be considered
May be mounted tabletop or under counter

Beer cellar coolers

Walk-in display cooler

Walk-in coldstore

Draft beer coolers

Ice makers

Ice-cream dispensers

Reach-in cabinets

Ice cream freezer

Serve-over cabinets

Multi-deck cabinets

Gelato counters

Preparation counters

Gondola cabinets

Condensing units

Blast freezers

Water coolers

Bottle coolers

Water dispensers

Chilled produce retail areas

Different rooms to be considered
Only considered if it is used in factory sealed systems

Relevant standards and resulting amount of low GWP refrigerants

Standard	Title	Application	HC charge size limits	
IEC and EN 60335-2-24	Particular requirements for refrigerating appliances, ice-cream appliances and ice-makers	Domestic refrigeration	Up to 150 g	150 g OK
IEC and EN 60335-2-40	Particular requirements for electrical heat pumps air-conditioners, and dehumidifiers	Any air conditioning and heat pump appliances	Up to - 1kg and - 5 kg, depending upon application	1 kg or more
IEC and EN 60335-2-89	Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor	Any refrigeration appliances used for commercial situations	Up to 150 g	150 g ?
EN 378	Refrigeration systems and heat pumps – safety and environmental requirements	All refrigeration, air conditioning and heat pumps; domestic, commercial, industrial	Variable, depending upon application	
ISO (DIS) 5149	Mechanical refrigerating systems used for cooling and heating – safety requirements	All refrigeration, air conditioning and heat pumps; domestic, commercial, industrial	Variable, depending upon application	

Title of committee/working group and task

Title of committee/working group:

TC61/SC61C/WG 4



Task of TC61/SC61C/WG4:

IEC 60335-2-89-A2/Ed2: Household and similar electrical appliances - Safety - Part 2-89: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant unit or compressor

To define the maximum flammable refrigerant amount for appliances according to IEC 60335-2-89 and measures to maintain the equivalent safety level as for the present limit.

Members of the WG4:

26 Members out of 13 countries

(AT, BE, BR, CZ, DE, FI, GB, IT, JO, JP, NZ, SK and US)

EN378 vs EN 60335-2-89

Standard Supermarket System

- OEM Building the System
 - EN378
 - PED
 - MD
 - LVD
 - EMC
 - ATEX Standards

- Installation on site
 - **RISK ASSESSMENT**
 - Workplace Safety

Integrated Display Cabinet

- OEM Building the Cabinet
 - EN60335-2-89
 - PED
 - MD
 - LVD
 - EMC
 - ATEX Standards
 - Leak Simulation Test
 - **Type Approval Notified Body**

- Installation on site

What direction is TC61/SC61C/WG4 going

The risk with 500g flammable refrigerant (R290) must be the same as we have with the current limit of 150 g

In detail and out of the proposal from WG4 and comments of NC:

- Refrigerants which are lighter than air (e.g. R50) should be excluded

For appliances with more than 150 g flammable refrigerant...

- Determination of gas concentration might be necessary
- Minimum air flow for appliances between 151 g and 13 x LFL flammable refrigerant could be required or necessary
- The airflow should be guaranteed in any operating conditions
- No refrigerant-containing parts should be exposed to the outside of the appliance
- Low temperature solder alloys will be not accepted for pipe connections
- All electrical components should be non-sparking electrical apparatus
- Application should have a tested tightness control level of less than 3 grams per year

Leak Simulation Test

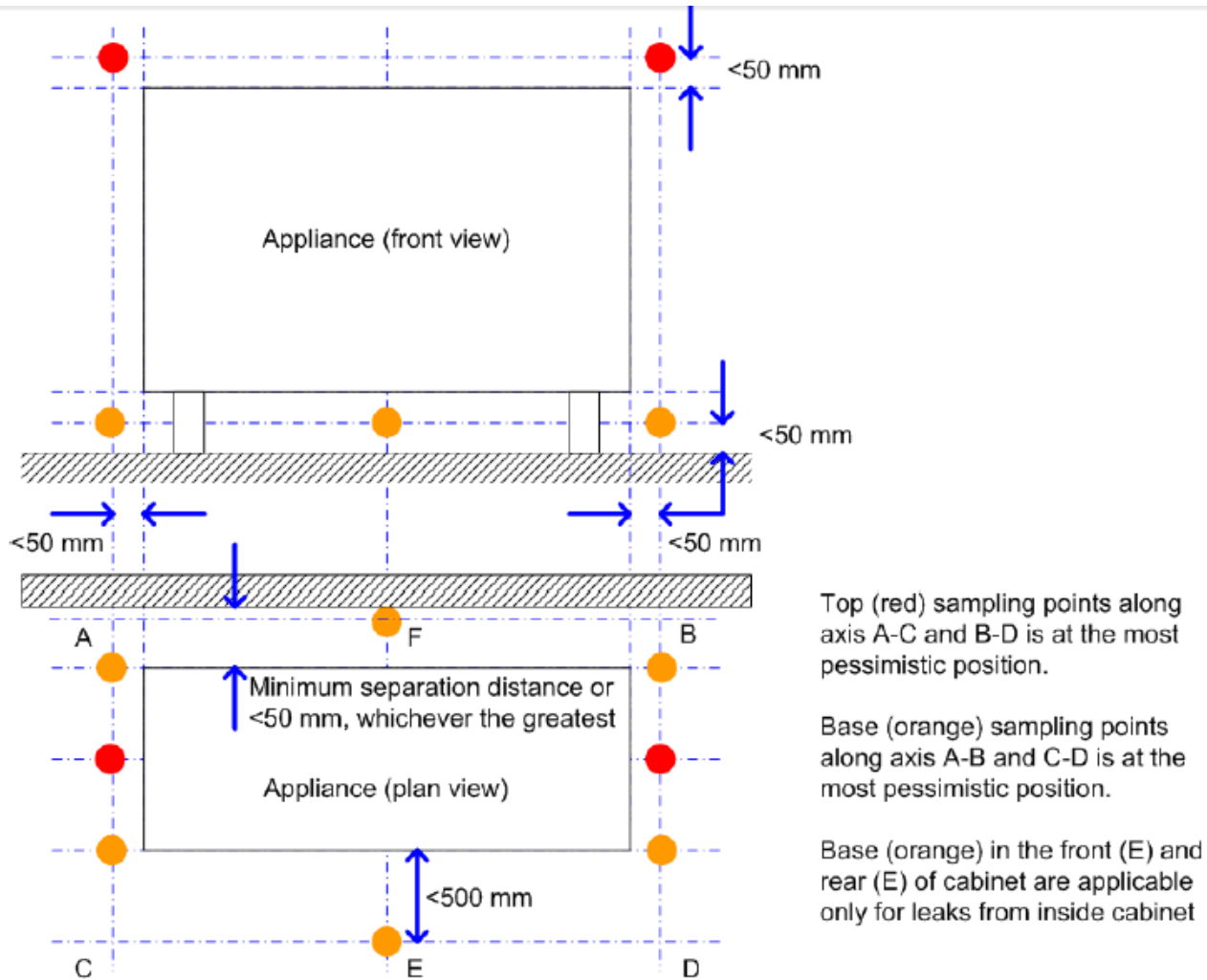


Figure YYY.1: Positioning of concentration sampling points

Possible time scale of TC61/SC61C/WG4

Time scale for including the WG4 proposal into the IEC 60335-2-89:

- **October 2016: WG4 meeting and SC61C meeting in week 40 (4th to 8th of October 2016) with work on the compilation of comments on the WG4 proposal – 61C/671/DC**
- **Q4_2016: Creation of a DC out of the compiled comments**
- **Q3_2017: Creation of a CDV out of the latest DC**
- **Q1_2018: Discussion of CDV and creation of a FDIS**
- **Q2_2018: Publishing of the 3rd edition from the IEC 60335-2-89 standard**

Residential & Commercial Comfort EN60335-2-40

- EN 60335-2-40
 - Household and similar electrical appliances. Safety. Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
 - A2L Refrigerants in current version NOT included
 - A3 Refrigerants can be used up to 1,5 kg only in indirect systems
- EN 60335-2-40 Revision will be launched end of 2017/ early 2018
 - Tailored for A2L refrigerants with a maximum charge of **80 kg A2L**
 - Separate Working Group to increase charge limits for A3 refrigerants, driven by China for small Split Systems up to 500g, release not before 2018



Propane Air/Water HP
up to 1,5 kg charge



Summary

- A2L and A3 Refrigerants are considered in PED, MD and ATEX equally (H220-extremely flammable)
- EN378 propose big differentiations in the charge limits for A2L and A3
- Human comfort for A2L's can use higher refrigerant charge as refrigeration
- Flammable refrigerants can be used only in appropriate systems, which are designed for flammable refrigerants (EN60079 – ATEX)
- Work place safety (TRBS) to be considered for installation site



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