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REFRIGERATION AIR CONDITIONING HEAT PUMPS

Refrigerant Safety
and
Risk Assessment for Flammable Refrigerants

Dr Dermot Cotter
Star Technical Solutions (STS)

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Topics

- DSEAR
- EN378
- Classification of Area
- Split air conditioning system

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How many here today have read the DSEAR regulations?

How many of these Refrigerants come under the requirements of DSEAR?

- R290 (Propane)
- R32
- R744 (Carbon Dioxide)
- R134a

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Dangerous Substance and Explosive Atmosphere Regulations 2002

Since June 2015 – Gases under pressure are included (CLP Regulations Classification, Labelling and Packaging)

Dangerous Substance and Explosive Atmosphere Regulations 2002

Areas covered by these regulations:

- Elimination or reduction of risks from dangerous substances
- Place where explosive atmospheres may occur – Classification of area (zoned areas)
- Arrangements to deal with accidents, incidents and emergencies
- Information, instruction and training
- Risk assessment requirement

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Elimination or Reduction of Risks from Dangerous Substances

Can you:

- Change from an A3 to a A2L or from an A2L to a A1 refrigerant
- Design to reduce the quantity of refrigerant in the system
- Keep refrigerant to the machinery room only
- Keep refrigerant to external equipment only
- Can you manage without a refrigerant – fresh air cooling
- Removal of ignition sources

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EN378 Guidance for a Flammable Refrigerant

BS EN 378-1:2016

BRITISH STANDARD

National foreword

This British Standard is the UK implementation of EN 378-1:2016. It supersedes BS EN 378-1:2008+A2:2012 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RHE/18, Refrigeration safety.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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EN378 Guidance for a 2L Refrigerants

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

Flammability class	Access category		Location classification			
			I	II	III	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		No charge restriction [c]	Refrigerant charge 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			
	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, EN 378-3:2016, 4.2 applies and, for machinery rooms, EN 378-3:2016, 4.3 applies.

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EN378 – Part 1

- Is the Flammability Class 2, 2L or 3
- Maximum Quantities Allowed to be Used

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EN378 – Part 2

- Requires Classification of Area EN60079-10-1
- Sufficient Ventilation (high air flow) to Prevent Ignition <50% LFL
- Requirements for Zone 2, Zone 1 & Zone 0
- Ventilated Enclosures & Gas Detection
- Secondary System ≥500kg

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EN378 – Part 3

- Machinery room normal and occupancy ventilation
- Machinery room emergency ventilation – extreme
- 2L removal of machinery room power supply
- Gas detection, extract fans and emergency light suitable for hazardous areas.

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Classification of Area

Is the Refrigerant:

Non-flammable

or

Flammable

Mildly Flammable is **Flammable**

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Classification of Area

- Identify the sources of release
- Determine release rates, grade of release and likely frequency and duration
- Assess ventilation or dilution effectiveness
- Determine zone
- Determine the extent of the zone

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Classification of Area

EN60079-10-1 Guidance

Type of outdoor locations	Unobstructed areas			Obstructed areas		
Elevation from ground level	≤ 2 m	> 2 m up to 5 m	> 5 m	≤ 2 m	> 2 m up to 5 m	> 5 m
Indicative ventilation velocities for estimating the dilution of lighter than air gas/vapour releases	0,5 m/s	1 m/s	2 m/s	0,5 m/s	0,5 m/s	1 m/s
Indicative ventilation velocities for estimating the dilution of heavier than air gas/vapour releases	0,3 m/s	0,6 m/s	1 m/s	0,15 m/s	0,3 m/s	1 m/s
Indicative ventilation velocities for estimating the liquid pool evaporation rate at any elevation	> 0,25 m/s			> 0,1 m/s		

Generally, values in the table may be considered with an availability of ventilation fair (see D.2).

For indoor areas, the evaluations should normally be based on an assumed minimum air speed of 0,05 m/s, which will be present virtually everywhere. Different values may be assumed in particular situations (e.g. close to the air inlet/outlet openings). Where ventilation arrangement can be controlled, minimum ventilation velocity may be calculated.

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Classification of Area

Zone 0: A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is present continuously or for long periods or frequently.

Zone 1: A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is likely to occur in normal operation occasionally.

Zone 2: A place in which an explosive atmosphere consisting of a mixture with air of dangerous substances in the form of gas, vapour or mist is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

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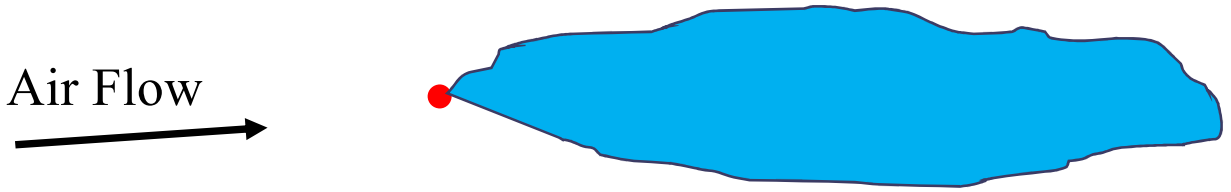
Classification of Area – When Flammable

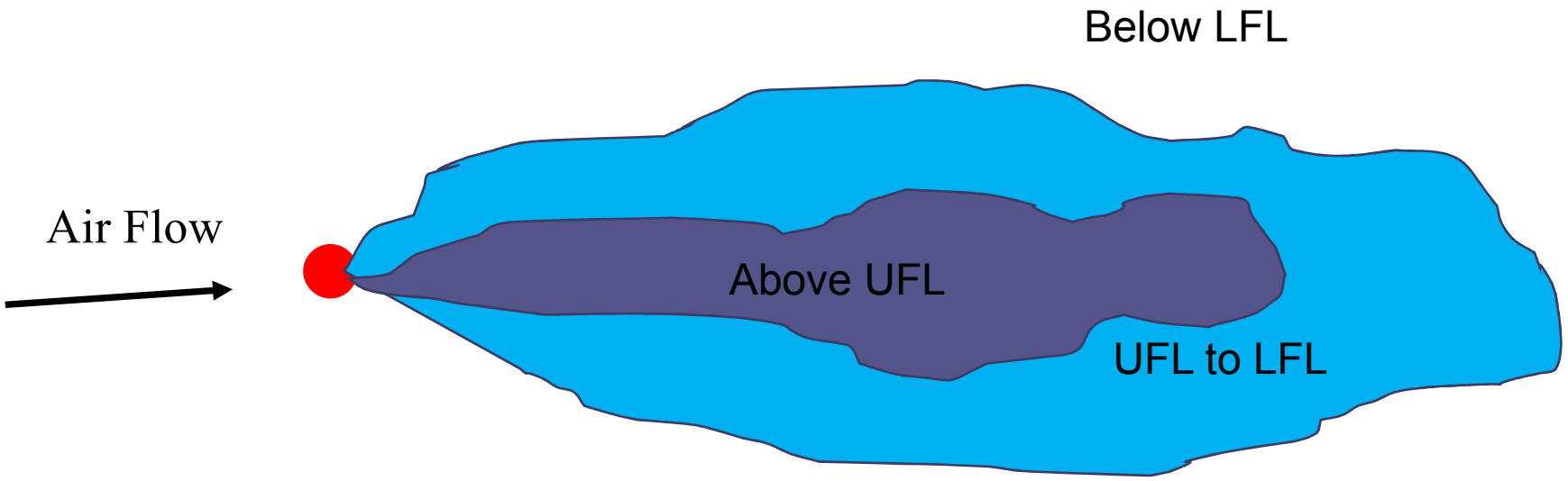
EN60079-10-1 Classification of Areas

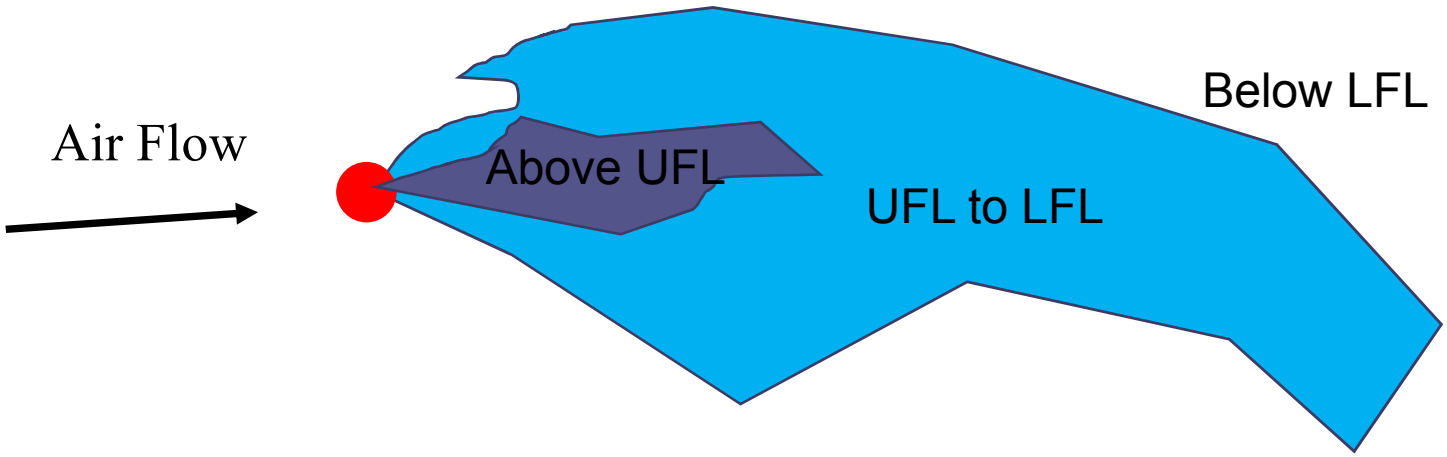
Zone 2NE

Zone 2 of Negligible Extent

$Vz_{(hypothetical\ volume)}$ of the flammable zone is $<0.1m^3$ with the average gas concentration of ≤50% Lower Flammability Level (LFL)




Below LFL
Air Flow
Above UFL
UFL to LFL


Air Flow
Above UFL
UFL to LFL
Below LFL

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Verifying If an Area Can Be Classified as Zone 2NE

- Use Software that can be purchased from the HSL
- Use a look up table if produced for the refrigerant

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Risk Assessment (DSEAR aspects)

The user/ owner is responsible for carrying out the risk assessment

The user may ask the designer/ installer for:

- Classification of area assessment/ calculations – this would often be checked by an outside DSEAR expert
- Quantity of refrigerant & refrigerant data sheets
- Provide cause and effect for safety systems
- Calibration certificate for gas detection system
- Documentation for testing safety systems
- Provide CE mark and PED conformity certificate
- Your standard working procedures for flammable refrigerants
- Your training to demonstrate competence for working with flammable refrigerants

Risk Assessment (DSEAR aspects)

The installer must not charge the refrigeration system with refrigerant until a risk assessment has been carried out and it deems the refrigeration system safe to operate

This risk assessment must include :

- Places where explosive atmospheres may occur – Classification of areas
- Arrangement to deal with accidents, incidents and emergencies
- People in the area have adequate information, instruction and training
- The design and installation of the safety systems are adequate
- Documented evidence of testing of the safety systems

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Example:
Air Conditioning Installation System Risk Assessment

Equipment

- 2.5kW Split air conditioning unit
- 0.43kg of R32 Refrigerant
- Liquid line 1/4” and suction line 3/8” with 14m of pipe
- Indoor room – 8m L x 3.7m W x 2.5m H. The room doors are air tight
- Connection on units - Flared for indoor and outdoor unit

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Air Conditioning Installation System Risk Assessment

Assessment Approach – Indoor Unit

- For the room volume the maximum refrigerant quantity allowed is 11.1kg. The actual quantity is 0.43kg
- LFL for R32 is 0.307kg/m^3 which gives a 50% LFL of 0.15kg/m^3
- The internal air velocity can be assumed to be 0.05m/s when the air conditioning system is switched off (air tight room).
- The flare joints are the main source of release. The flare joints are not durably technically tight. For the size of pipe and limited quantity of refrigerant in the system, we base the size a release hole at 1mm^2.

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Air Conditioning Installation System Risk Assessment

Assessment Approach – Indoor Unit (cont)

- Using a lookup table for Classification of Area, there are two overlapping areas of Zone 2NE around the flare connections.
- The nearest electrical light fitting is 2.5m away at ceiling level and no sockets within 5m. In an extreme event the electrical fitting are outside the flammable zone.
- We therefore consider it a low risk of an explosion occurring, however if an explosion does occur it will be small due:
    - Classification of Area being Zone 2NE
    - Quantity of refrigerant

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Look and Style of Risk Assessment Document

- Introduction, Actions and Compliance to Regulations
- Regulations, Standards, Cosh and Approach
- Refrigeration Equipment, Safety Systems, Site Procedures
- Risk Assessment

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Conclusions

- A risk assessment must have a systematic approach.
- The risk assessment must be documented.
- A classification of area must be carried out for all refrigerants from all sources of releases.
- EN378 is no just about limiting the quantities of refrigerant to be used. This is only part 1. Use parts 2, 3 & 4.

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Questions to follow