A2L UNIT COOLERS:

HOW TO MANAGE THE LIGHT FLAMMABILITY OF A2L REFRIGERANTS THANKS TO RISK ANALYSIS.

AGENDA

- **INTRODUCTION**
- Regulatory context

A2L REFRIGERANTS
- Emergence of A2L
- Safety classes
- Flammability classes

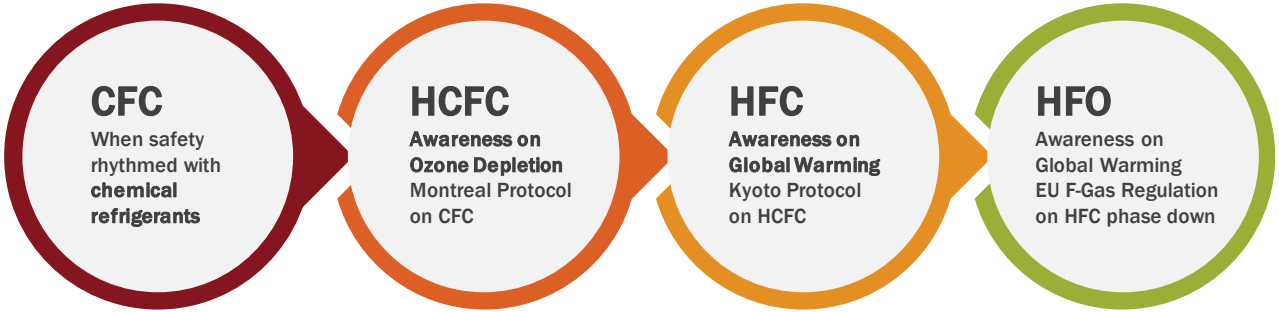
MANUFACTURER'S APPROACH
- Unitcoolers qualification

RISK ANALYSIS
- Life cycle actors
- Methodology
- Flammability risk management
- Normal operation
- Abnormal operation
- External validation

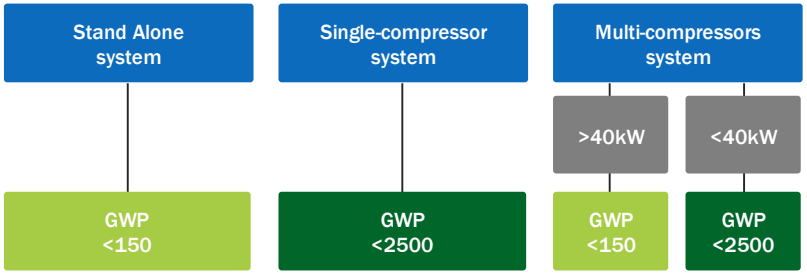
CONCLUSION
- What to remember

REGULATORY CONTEXT

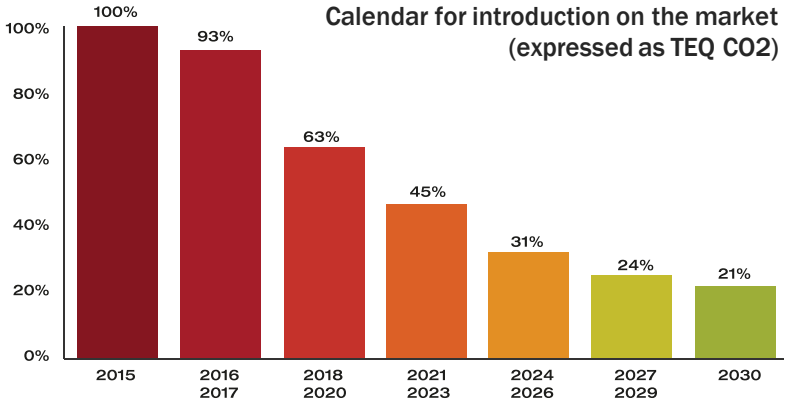
It all started with natural refrigerants
(NH3/CO2/SO2…)



F-GAS (2022)

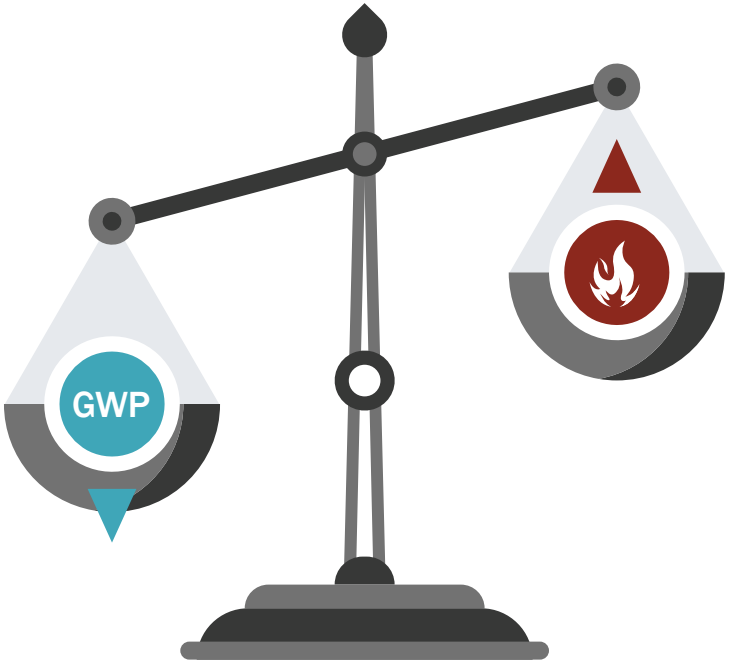


Calendar for introduction on the market (expressed as TEQ CO2)



THE QUEST FOR LOWER GWP REFRIGERANTS

There is a correlation between a lower GWP and flammability

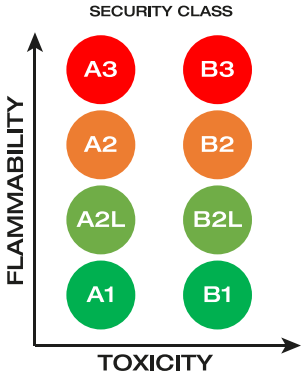


The letter indicates toxicity level

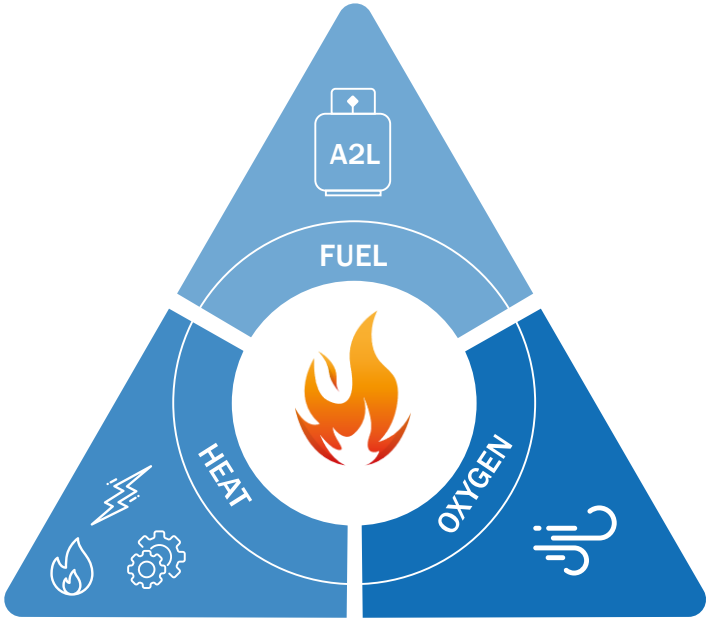
- **A** — Low toxicity level
- **B** — High toxicity level

The number indicates flammability level

- **1** — Non flammable
- **2** — Flammable
- **2L** — Slightly flammable
- **3** — Highly flammable



HOW DOES COMBUSTION WORK?

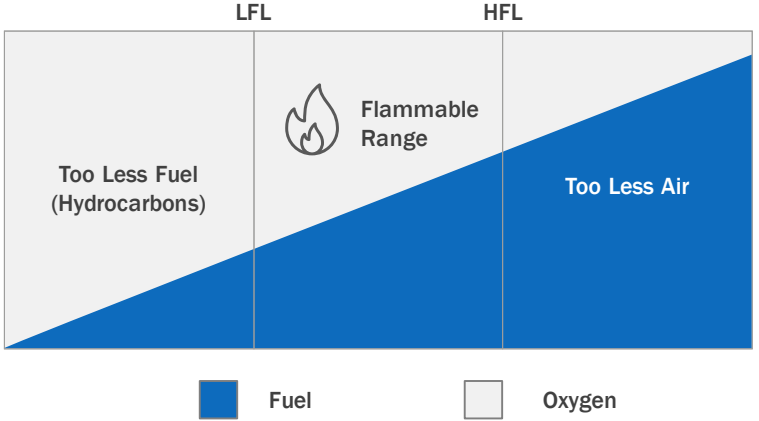


WHAT DEFINES REFRIGERANT FLAMMABILITY ?

Refrigerant physical properties :

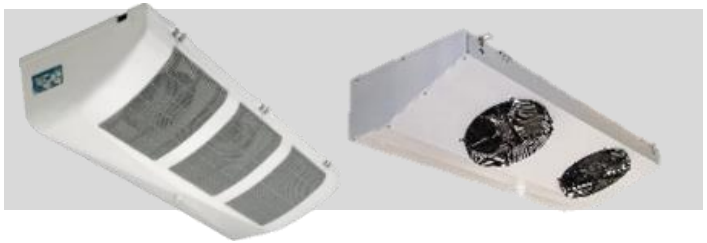
- ✓ Lower flammable limit (LFL)
- ✓ Upper flammable limit (HFL)
- ✓ Minimum ignition energy (MIE)
- ✓ Burning velocity (BV)
- ✓ Heat of Combustion (HOC)

FLAMMABLE MIXTURE



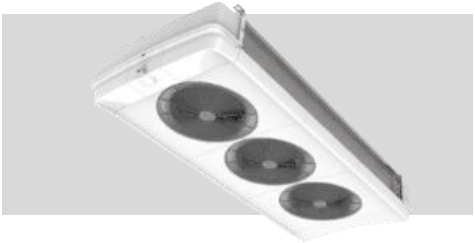
QUALIFICATION FOR A2L REFRIGERANTS

Ceiling unit



Cubic unit

Dual-discharge

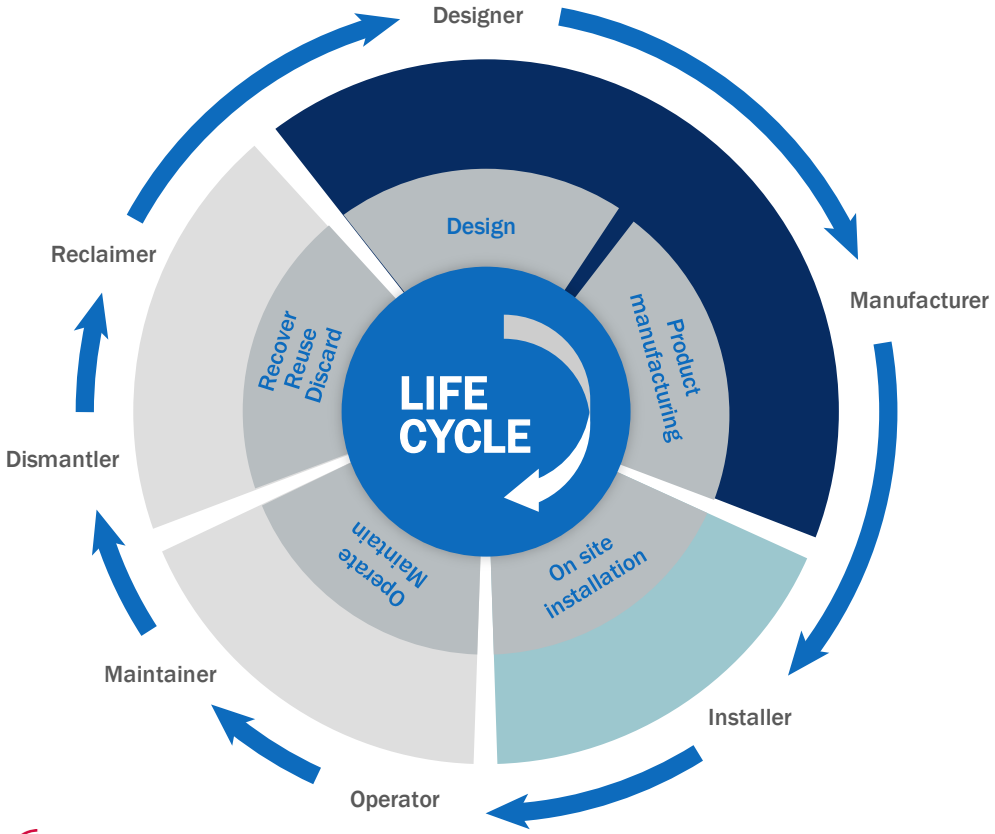


A2L COMPATIBLE

- PERFORMANCE
- SAFETY

Condensing unit

LIFE CYCLE ACTORS



Life Cycle:

The risk analysis must be done on the system as a whole

Designer / Supplier :

As the evaporator is a partly completed machine according to the machine directive 2006 42 CE, it is the responsibility of the manufacturer to put a safe product on the market.

Installer:

It is then the installer's responsibility to ensure the safety of the entire installation and therefore to perform a risk analysis.

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Extract & adapt from the Guide : Norme NF EN 378 : 2017 pour les Systèmes frigorifiques et Pompes à chaleur

RISK ANALYSIS: METHODOLOGY

RISKS ANALYSIS MAIN PARTS

1. List the different risks
2. Define their criticality level based on their severity level & probability level
3. Find solutions for the unacceptable & moderate risks

SEVERITY		PROBABILITY 1 Never occurs	2 Every 10 years	3 Every year	4 Every month	5 Every day
1	Negligible	1	2	3	4	5
2	Minor	2	4	6	8	10
3	Serious	3	6	9	12	15
4	Critical	4	8	12	16	20
5	Catastrophic	5	10	15	20	25

Unacceptable risk
Moderate risk
Acceptable risk

Source : UNICLIMA & CETIM guide « Norme NF EN 378 : 2017 pour les Systèmes frigorifiques et Pompes à chaleurs - Guide pour réaliser les analyses de risques »

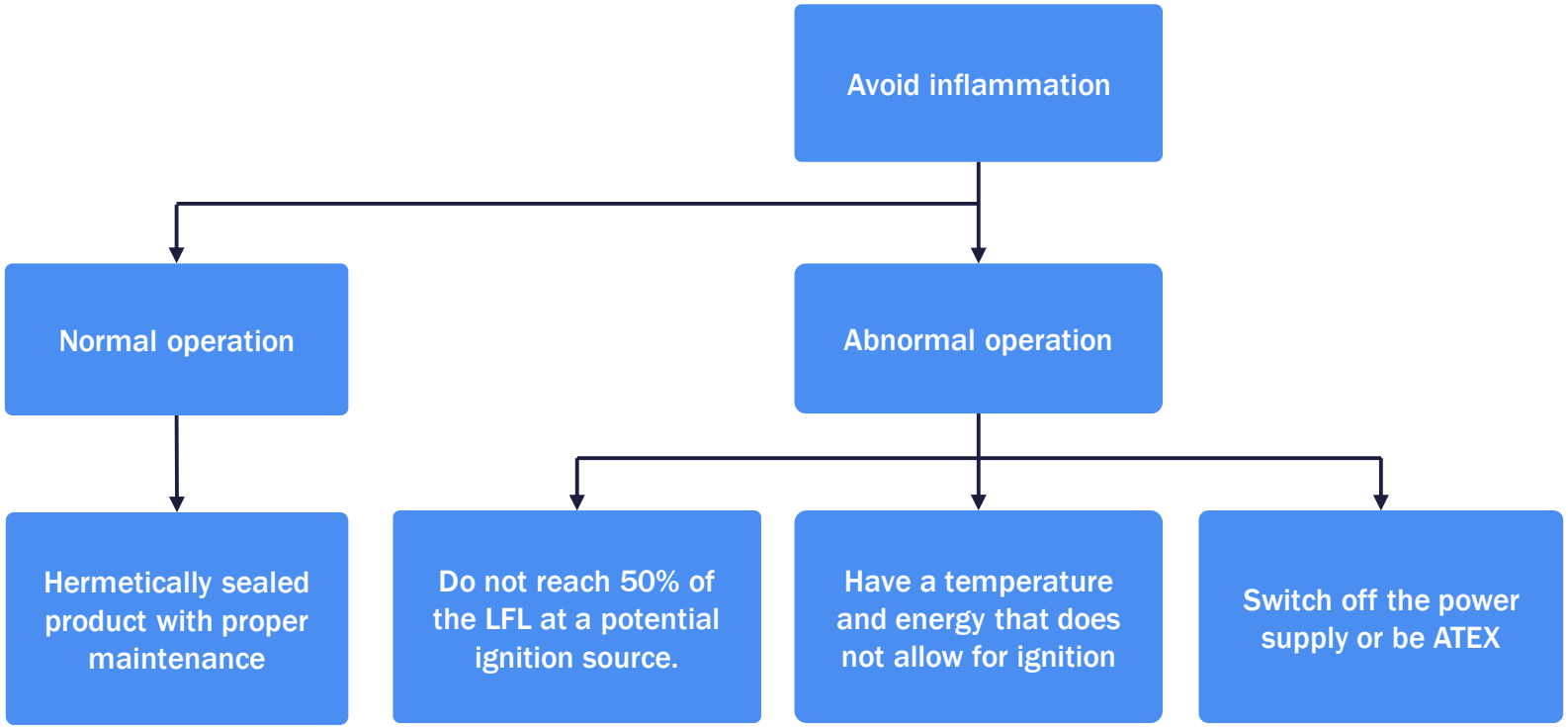
EXAMPLE

- Leakage from the expansion valve connection

- A solution could be to test the tightness of the installation

Risk	Severity	Probability	Criticality
Before			
After			

FLAMMABILITY RISK MANAGEMENT



Flammability risk according to §1.5.6 of the Machinery Directive

NORMAL OPERATION

Normal operation

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Hermetically sealed product with proper maintenance

Implement a periodic leakage inspection plan to ensure the product's sealing is maintained.

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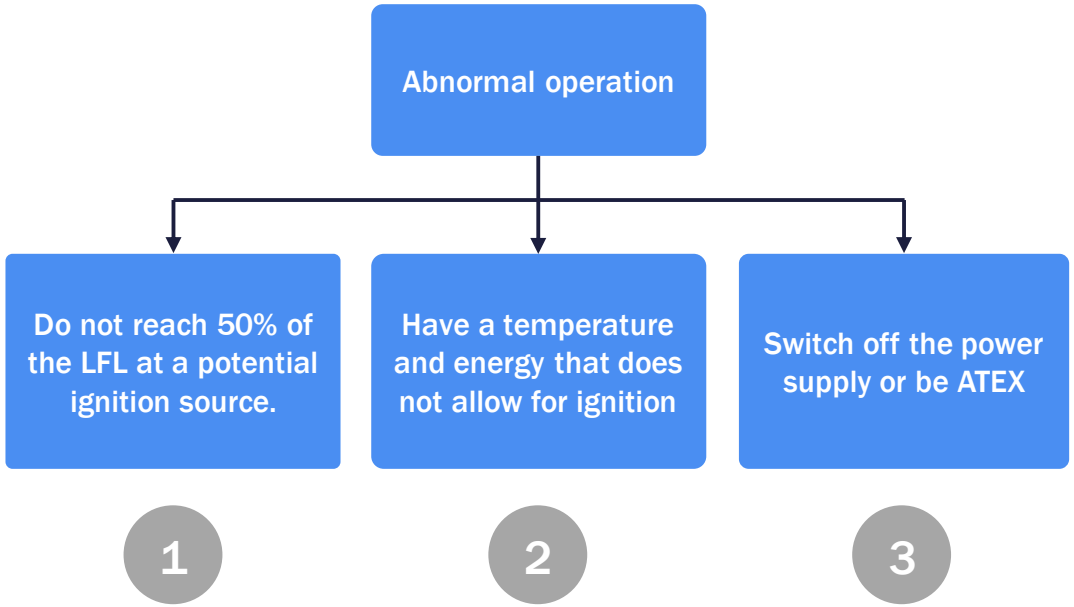
Check regularly that the coil is not frozen. Check that the defrosting system is working properly and efficiently.

ABNORMAL OPERATION



LEAK TEST

NUMERICAL SIMULATION

1

COMPONENT VALIDATION

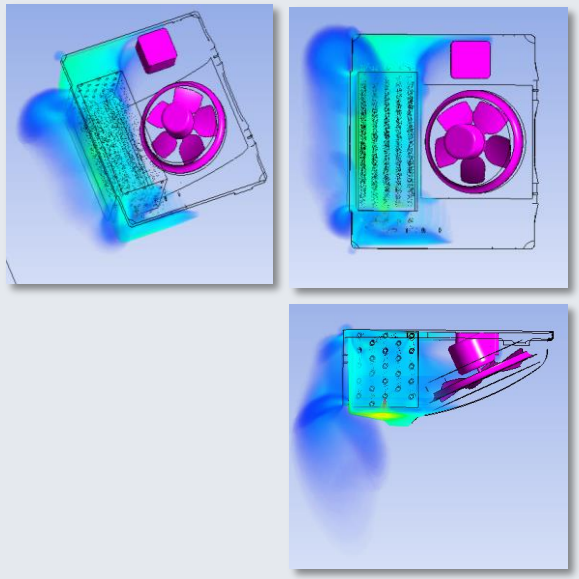
2

PRODUCT REDESIGN

3

ABNORMAL OPERATION

NUMERICAL SIMULATION



LEAK TESTS

Protocol as per annex I EN378-2:2016 :

- Fluide R1234yf
- Flow : 1 g/s
- Pressure : ¼ PS
- Leak size : 1,47mm²

life front

Pessimistic hypothesis vs. European Commission Lifefront study.
=> 99.9% confidence that the 95th percentile leakage will not exceed 0.36 mm².

EXTERNAL VALIDATION

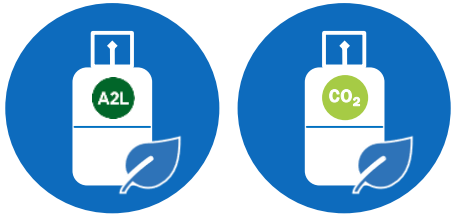
LIST OF DOCUMENTS :

- Risk analysis
- Numerical simulations
- Leak test reports
- Use of A2L fluids – regulatory and normative aspects
- Calculation of residual refrigerant quantities
- Calculation of degassing rates
- Safety instructions for evaporators

To ensure the completeness and relevance of our approach, we sought the expertise of INERIS (National Institute for the Industrial Environment and Risks) to critically review our work* on the use of A2L refrigerants in our products.

** Institut National de l'Environnement Industriel et des Risques, Verneuil-en-Halatte : Ineris - 204587 – 2718771 - v2.021/07/2021.*

WHAT TO REMEMBER



Market migration to low GWP fluids

New knowledge to be acquired and applied (risk analysis, standards…) for the whole life chain:

- Builder
- Installer
- Maintainer
- User

The slight flammability of A2L refrigerants should not be an obstacle to their use in reducing our environmental footprint. The risk will be managed by following regulations such as EN378 and using safe products.

Questions & Answers

LENNOX
EMEA

THANK YOU

HKFRIGA

CHILLVENTA

Chillventa Specialist Forums 2022
Chillventa Fachforen 2022

CONNECTING EXPERTS.