



*Tecumseh*

## Q&A A2L Tecumseh 2020

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## I. Current regulations related to A2L fluids

### 1/ What does A2L mean?

The safety classification of refrigerant fluids is defined according to the international ISO 817 standard and taken up by the US standard ASHRAE 34 and the European standard EN 378 according to their toxicity and flammability;

The letter indicates the level of **toxicity**:

- A - Refrigerant with low toxicity
- B - Toxic refrigerant

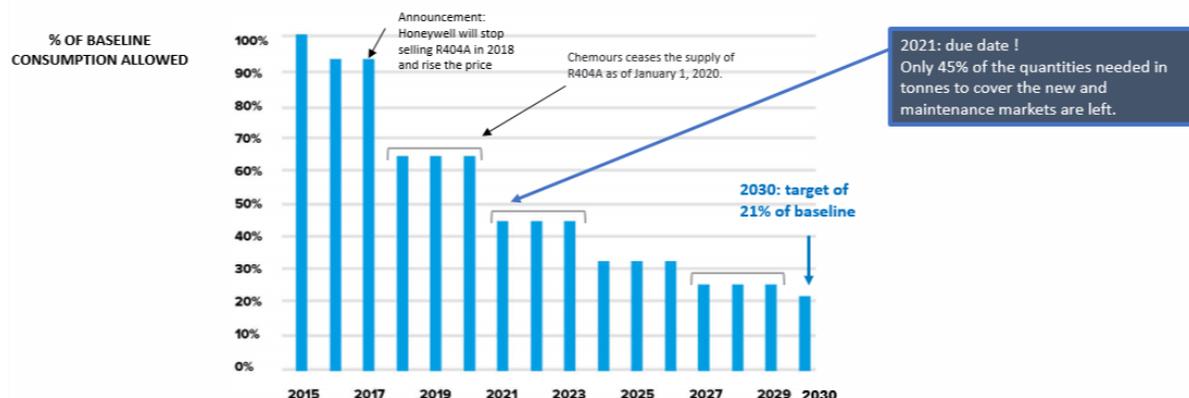
The figure indicates the level of **flammability**:

- 1 - Non-flammable
- 2L - Low flammable
- 2 - Flammable
- 3 - Highly flammable

### 2/ What are the deadlines for using current fluids?

The dates and constraints of use of HFCs are defined by European Regulation 517-2014, also known as F-Gas. The bans are based on the applications and GWP of fluids, for example, it will be mandatory to use GWP fluids below 150 as of January 1, 2022 for new commercial refrigeration facilities over 40 kW, as it is prohibited since January 1, 2020 to use GWP fluids greater than 2500 for refrigeration facilities where the facility load is more than 40T equivalent Co2.

## HFC phase-down which runs from 2015 to 2030



### 3/ When is EN 378 applied and when is IEC applied?

Product safety standards (Series EN 60335-...) must be considered as a priority. These address the level of protection accepted by application category, either by integrating a compressor or as two units for a single-device assembly ("split system"). These safety standards cover:

- Electrical, mechanical and thermal hazards related to the fire and over heating of the appliances when operating in standard use, taking into account the manufacturer's instructions.
- Abnormal situations that can be predicted in practice and take into account electromagnetic phenomena that can affect the safe functioning of the devices.

When the application does not fall within the scope of EN 60335 and/or the application's refrigerant load goes beyond the limits set by 2-89 in commercial refrigeration, for example, then the EN-378 standard applies.



#### 4/ What are the limits of use and our obligations according to EN378?

This standard defines the conditions for a safe commissioning of systems and refrigerants, whether toxic or not, and flammable or not. It allows defining the maximum admissible charge according to the occupancy of the premises and the location of the equipment containing refrigerant. For example R-455A, according to this standard, we can load up to 84 kg per direct expansion circuit in typical establishment Open to Public, like a supermarket. We can also load up to 16.8 kg in a group unit housed according to the volume of the room, which largely meets the needs we know.

ERP: Etablissement Recevant du Public / establishment Open to Public (opposed to private requiring access authorization)

#### 5/ What are the safety rules applicable to each A2L fluid? Design, maintenance, operation rules

As with all fluids, you must be qualified and have the skills required to handle refrigerants.

It is necessary to apply the recommendations of safety standards and implementation, to know the regulations and the safety instructions, and of course to use the appropriate equipment.

For example, depending on whether you are a designer or an installer, the information sits in the different volumes of the standard: see table below.

This standard will assist contractors in designing, manufacturing, installing, commissioning and maintaining refrigeration systems and ensuring best practices.

	EN378-1	EN378-2	EN378-3	EN378-4
Manufacturer				
Installer				
Maintenance				
User				

For system manufacturers, IEC / EN 60335 standards apply when designing equipment. When the application does not fall within the scope of standard EN 60335 and / or when the required refrigerant charge of the application goes beyond the limits set by 2-89, then standard EN-378 is applied.

The standard EN60335-2-89, is in the form of **international recommendations** :

1/ It processes the accepted or required level of protection against:

-electrical, mechanical, thermal risks linked to fire and radiation from the devices when they operate in normal use, considering following the manufacturer's instructions

2/ It covers abnormal situations that may be expected in practice and takes into account electromagnetic phenomena that can affect the safe operation of the devices.

- With incorporated motor-compressor

- or considering two units for assembly into a single device (split system).

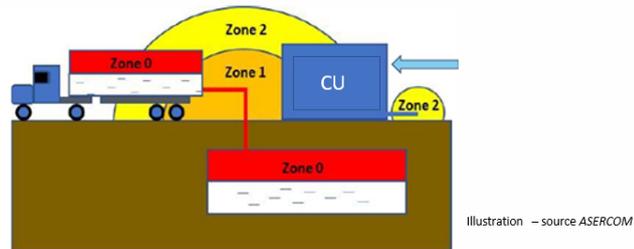


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## 6/ Application of ATEX regulations with A2L fluids and related to the situation, selection of equipment inside or outside.

- The product standards EN-60335 and the generic standard EN-378 define the use of flammable fluids without imposing compliance with the ATEX directive in the case of installation outside the ATEX zone.
- The vapor compression system is not create an ATEX zones (compressor).
- TECUMSEH products are designed in accordance with these product standards.
- The risk of leakage is minimized by design.

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- The vapor compression system is not the cause of ATEX zones (compressor).





## II. A2L refrigerants features

### 1/ What are the risks associated with the use of these new products?

Ensuring a simple solution by respecting good practices:

- Thermodynamics is very similar to that of HFCs.
- The main risk assessment (flammability, load limit, temperature slippage, ATEX, etc.) is managed mainly from the moment of conception.
- The remaining portion of the operator risk analysis is about 20% (see manufacturers' installation guides).
- Components are qualified and declared to meet harmonized standards; they are suitable for the use of flammable fluids.
- No over-equipment required.
- Tecumseh condensation groups are eco-designed (MEPS) and designed for a high ambient temperature.
- The selection of products, installation, start-up are as simple as today with HFCs.
- Some specific safety precautions, over the life of an installation during start-up or maintenance.

The potential learning curve is fast because the A2Ls are ultimately very close to HFCs.

### 2/ Have SILENSYS been improved to win in COP?

SILENSYS condensation groups have complied with Eco Design requirements since 2016.

No manufacturer of condensation groups in Europe can market a product that does not comply with this "mandatory" requirement.

Increased energy efficiency combined with high ambient temperature operation are key design criteria for the next generation SILENSYS Advanced group.

### 3/ What is the additional effectiveness of the new A2L products? What are these origins?

The new HFOs have very high thermodynamic cycles and also high critical temperatures, which means that they will reach high energy efficiencies, especially in very hot external conditions like the heat waves that we can meet more and more in our regions.

### 4/ Are they explosive and when will they be mandatory?

Unlike A3 fluids, such as propane, A2L fluids are not explosive but potentially flammable when in limited conditions.

### 5/ What are the advantages / disadvantages of A2L refrigerants compared to propane?

Propane is a very good refrigerant. R-455A is superior to it because it has a very similar energy efficiency, a capacity 10% higher, and, because of its self-extinguishing characteristics, it is the safest alternative to the dangers of propane.

### 6/ What do you have the proportion of A2L gas can be admitted allowed to leak into a non-ventilated room due to for its flammability or its toxicity rate?

The admissible fluid content in a room is calculated according to the recommendations of standard EN 378 according to its toxicity (ATEL / ODL) \* or according to its flammability (LFL \*).

This information is found in Appendix E of the standard as well as the practical limit (in Kg / m<sup>3</sup>) which is the simplified value of a concentration used to determine by a simplified calculation the maximum acceptable quantity of refrigerant in an occupied space.



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The refrigerant concentration limit (RCL) is the maximum concentration of refrigerant in the air set in order to reduce the risks of acute toxicity, asphyxiation and inflammation, according to Article C.3 of EN 378 .

ATEL: maximum recommended concentration of refrigerant intended to reduce the risks of acute toxicity for humans in the event of discharge of a refrigerant

ODL / concentration of a refrigerant or other gas resulting in the presence of insufficient oxygen for normal breathing

Lower flammability Limit: LFL: minimum concentration of refrigerant capable of propagating a flame in a homogeneous mixture of refrigerant and air.



### III. A2L refrigerants available on the market

#### 1/ What are the real HFOs (no components with R-32, or other HFC)?

The pure HFO proposed for commercial and industrial refrigeration are the R1234yf and the R1234ze. These pure molecules have better energy performance than previous HFCs and have a lower GWP. Tecumseh has validated refrigerant R1234yf as it presented better results with our ranges of Compressors and the transition with this refrigerant is simple.

#### 2/ What is the 5-year vision of these fluids?

These very low GWP fluids will achieve the F-Gas targets before 2030, with no current vision of a usage limit. They are all F-Gas compliant and bring energy gains, which is the key to the future and the only true definition of the long term. Making a new installation from 2020/2021, with an A2L fluid and compliant equipment, ensures the quantities of fluids needed in Europe for sustainable refrigeration.

#### 3/ What to replace the R-407F in order to limit the high discharge Temperature?

Honeywell long-term solution to replace R-404A is R-455A which, in terms of discharge temperature, is much lower than R-407F since according to compressor technologies we can reach temperatures similar to that of R-404A and up to 7 to 8 degrees higher maximum in low temperature application for hermetic piston compressors.

#### 4/ What are the fluids that can be classified A2L? What fluids are they replacing? Are they more efficient? What authorizations?

The A2L classification takes into account the slight flammability of these fluids. The dilemma faced is that as we lower Global Warming Potential (GWP), the result is to increase the flammability of fluids. Synthetic Fluids manufacturers have chosen to select the most efficient, least risky and most accessible fluids of all the options that have been tested for the last 20 years.

As part of all webinars held, the three long-term fluids proposed are a replacement for R-134a (GWP=1430) and R-404A (GWP=3922) in commercial and industrial refrigeration (R455A / R454C, R1234yf).

#### 5/ Can we replace R-134a, R-404A and R-410A with A2L fluid?

Yes, there are options at low GWP to replace all of these fluids. Please note that an A1 system cannot be converted to an A2L fluid, otherwise the PED compliance and CE marking of the installation may be lost. This is to be avoided!

#### 6/ Why is there not only one fluid for all devices?

To date, there is no universal fluid to cover all applications. In addition, one of the requirements of F-Gas is to select the solution with the best energy efficiency (Objective of reduction of energy consumption).

The choice of fluid depends on the operating regime, the technology of the compressors and exchangers, and the temperature set points for defined powers. The selected fluid must have the appropriate volumetric capacity. To date, there is no fluid which can cover all applications

For example, an electronic component test cell, helicopter AC or overhead crane AC, freezer room and living room AC systems will have different capacities.



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**7/ A2L fluids will replace high GWP fluids. We always advocate not to mix between two fluids of different nature (A1 and A2L), how can R-455A actually replace R-404A?**

Mixing two fluids in a system is illegal in France: the resulting mixture could not be recycled or evaluated in terms of GWP. Furthermore, the system could not be adjusted knowing that the relationship between pressure and temperature would be completely unknown. The labeling of the installation could not be carried out, nor be in accordance with French regulations. It is important to clarify once again that A2Ls should be used in new systems and should not be mixed with other fluids.

The R-455A is the best replacement for the R-404A on the market with a long-term solution with low GWP and superior efficiency for long-term refrigeration.

Before any replacement of any kind, contact the component manufacturer.



## IV. The implementation of A2L refrigerants

### 1/ What is the most suitable HFO between R1234ze and R1234yf for commercial cold refrigeration for less than 4 kW?

For this type of application and in these capabilities, the R1234yf will be the most suitable. This is the one that Tecumseh has chosen to develop its condensation groups in this power range for applications in positive operating temperatures.

### 2/ What are the conditions for using A2L fluids in a central kitchen cold room to replace R-404A?

Once the load is determined according to EN 378 and the selection made properly (if there is slippage), the placement of these fluids is extremely similar to that of HFCs. The specificity of central kitchens or cold rooms will therefore be taken into account when determining the load and not elsewhere.

### 3/ Availability of fluid and equipment, price and implementation mainly for R-455A?

This fluid has been commercially available for several years, all the components are available and many OEMs have therefore been able to develop new product ranges. We advise you to contact your distribution network to obtain the price of fluids.

### 4/ What are the differences with HFCs compared to basic handling? (recovery, ...)

In the principle of handling, no significant difference.

Avoid or eliminate any risk of ignition and formation of flammable areas (ventilate, do not smoke, do not braze in the presence of fluid, ...)

For the material and packaging, there are some special features to consider Vacuum pump and recovery machine approved for the use of A2L fluids

Bottle (fluid and recovery) with red shoulder and tap with specific thread connection

### 5/ Is it imperative to drain the entire installation in the event of a leak?

Certainly not ! In the event of a leak, recharge with fresh fluid (in the liquid phase).

### 6/ Are A2L fluids authorized in electrical rooms (Main Low Tension Electrical Cabinet)?

Normally yes, and only the risk analysis will determine it for each situation.

### 7/ In which specific cases are A2L fluids authorized or prohibited? And conditions of realization ?

There are no specific bans in common applications

The regulations and standards in force must be applied and will define the possible constraints as for all fluids of all categories (A1 / A2L / A2 / A3)

The connection by dudgeon is authorized, like assembly by crimping, with A2L fluids (the dudgeon is strictly prohibited with A3 fluids)

### 8/ Considering air conditioning, is the A2L fluid authorized for Establishment Open to Public / High-Rise Buildings museums in a technical room underground in large quantities?

The constraints in the basement are more important and the restrictions too. But the technical room is not normally considered as an Establishment Open to public.

### 9/ Operation of a refrigeration installation at an orchard with R-1234ze. Are there any oil return problems?

The solubility of R-1234ze with oil is a parameter to be considered depending on the operating conditions and compressor technologies, in particular on screws or at extreme speed. However, this



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does not create a specific problem, because the R-1234ze is used with POE oil, and the new compressor approved for this fluid, with the appropriate oil.

**10/ In what types of establishment, Condensing Units operating with these fluids classified as flammable, could be prohibited from fitting?**

The EN 378 standard regulates the use of A2L fluids from design to maintenance and includes the assessment of acceptable load limits to avoid any risk in a situation.

As an example, in France the "Direction Générale de la sécurité civile » (Office ruled by the government to drive security measures in public areas) published in 2017 a "Practical guide to fire safety in retail stores and shopping centers"

This guide deals, among other things, with the risk management linked to the use of A2L type refrigerants in refrigeration cabinets placed in these establishments.

**11/ Is crimping allowed?**

Yes with A1 and A2L fluids

**12/ In the case of the replacement of a component (MAINTENANCE, After Sales Service), requiring a brazing operation; Is there a minimum distance between two pieces of equipment loaded with A2L fluid, before using a torch?**

Confined environment, or in the open air.

Safety instructions must be observed and any risk of a flammable zone must be avoided. Do not intervene in a room saturated with refrigerant and as it is the case with all fluids, you must ventilate the intervention area and prevent the formation or presence of any source of ignition

**13/ For a study CF + 3 ° C 640 m3 8.5 kW and CF + 3 ° C 6.1 kW of 440 m3, suggestions 2 independent groups R-455A or only one common?**

The technical choice completely depends on the configuration of the building and the location of the refrigeration equipment.

The benefit of a single system or several independent systems remains the choice of the prime contractor and the refrigeration engineer.

In terms of product safety in the event of a breakdown, but also in terms of energy efficiency, independent groups would rather be the best compromise.



## V. A2L refrigerants glide

### 1 / Is the glide problem similar to R-407C?

R-407C has been used in air conditioning and heat pumps for around twenty years without any major problems.

The most important thing with glide is to make the right selection of components with use of the middle point and not Dew. Next, to adjust the system, consider the midpoint again for the condensation and evaporation temperatures. Bubble and dew temperatures must be taken into account when it comes to controlling superheat or subcooling.

The calculations and the selections of materials are always made at the constant pressure of the average temperature, that is to say at the temperature resulting from this formula,  $(T_{\text{bubble}} - T_{\text{dew}}) / 2$

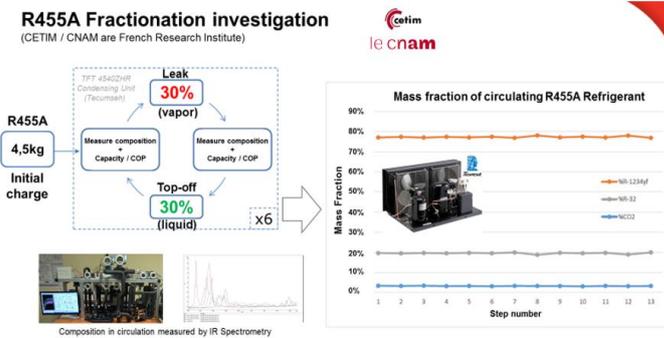
### 2 / How to manage glide with a capillary expansion?

It is managed by controlling the liquid charge which is reduced by 25% in weight compared to a fluid without glide and then it is adjusted by controlling the BP to arrive at the pressure corresponding to the desired average temperature on the evaporator. In no case should the evaporator freeze until it leaves, this would also signal an excessive charge of fluid.

### 3 / If the leak is on the exchanger, therefore in two-phase, is it more problematic?

Indeed. The only sensitive areas are the exchangers and the liquid bottle. This is why all the study that was done by CETIM and CNAM proposed in the Webinar was based on this hypothesis of two-phase condenser leakage. As you can see, there is no variation in the circulating composition even after six times the generation of 30% leakage and the refill of new R-455A.

### Is it imperative to empty the entire system in case of a leak?





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## VI. A2L low flammability refrigerants

### 1 / Is it explosive like R-32?

Neither the R-32 nor any of the A2Ls are explosive. Only so-called A3 fluids comprising hydrocarbons such as propane or isobutane are.



## VII. Replacement by A2L refrigerants....

### 1 / Can we retrofit an existing installation to R-404A in direct expansion with R-455A?

No, clearly, it is strongly advised not to do so, even if technically it would remain feasible.

The R-455A and R454C are not in the same category of fluid as the R-404A compared to the PED, which would require requalifying the existing installation which was compliant for an A1 fluid and which would lose its conformity when switching to a fluid A2L.

Today, the equipment and components are available for the R-455A/R454C and allow you to easily work on new installations that comply with regulatory requirements.

### 2 / Are The R-455A or R-454C recommended to replace the R-404A?

For any negative cooling installation in direct expansion with condensing group from 1 to 20kW, R-455A and R-454C are an A2L low GWP fluid recommended for any new installation.

For a positive cold installation, both are also suitable to replace the R-404A.

Many positive cold systems now also work with R-134a (or equivalent), in this case the R-1234yf is a long-term replacement very similar to R-134a.

### 3 / Does the nature of A2L fluids have an impact on the selection of oil and the choice of viscosity grade? (ex: Retrofit)

First, A2L fluids should only be used in new systems with the materials and components intended for these fluids. These are not so-called reversion fluids. If an existing machine were reconverted with these fluids, this could only be done at the cost of a complete study and a requalification to comply with the PED (as explained because we would move from a fluid group 2 PED to group 1 )

In addition, during the design and development phase of the A2L compressors, the oils and their characteristics were re-evaluated in order to ensure lubrication conditions in accordance with the requirements of each manufacturer. In general, compatibility and thermochemical resistance over time are essential for reliability.

For hermetic compressors, the oils are generally identical to the previous families. However, conversion of an HFC installation with an A2L fluid is not possible since the original components are not designed to stop the risk of flammability.

### 4 / Do you have any experience with other A2Ls for retrofits?

A2L fluids are not fluids for re-converting an existing installation designed for A1 fluids (change of PED category).

Today, they must be put in new installations only, with the material and components widely available for these fluids.

### 5 / With the exception of NH3, can R-455A, R-1234ze and R-1234yf fluids be used in conversion? If yes, what about the seals and the oil to be used?

In fact, ammonia cannot generally be considered in the conversion of an installation, because of its incompatibility with copper and its alloys and because of its toxicity.

The very low GWP A2L fluids presented are not fluids intended for the conversion of existing installations, for reasons of compliance with European regulations which require CE marking and compliance with PED.

To comply with these obligations, all the materials and all the components of an installation concerned by PED or other regulations must be compliant for use with the fluid.

The fluids are classified into 2 groups according to the PED:

- Group 1 which includes fluids: explosive, extremely flammable, easily flammable, flammable, very toxic, toxic, oxidizing.

- Group 2 which includes all the other fluids which are not referred to in group 1

For oils and seals, the manufacturers will have selected them. The oils remain POE and the seals remain known products today.