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A2Ls in Commercial Refrigeration

Feb 2023

AGENDA

01 Regulatory Landscape

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03 Codes & Standards

04 ASDA Experience

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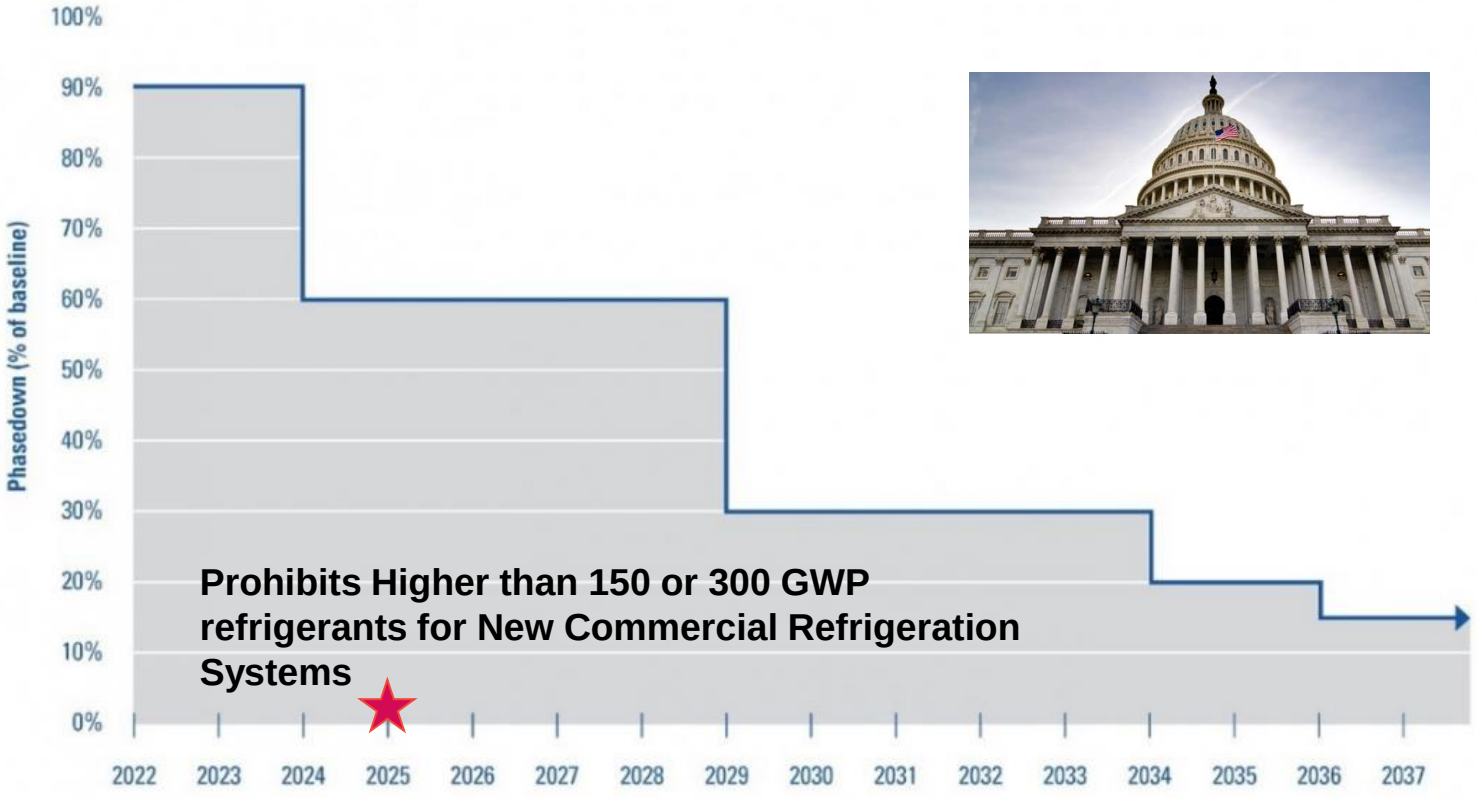
American Innovation and Manufacturing (AIM) Act

AIM Act Phase Down Schedule- CO2 Equivalent Basis

The following illustrates the HFC production and consumption phasedown schedule as outlined in the AIM Act.



(1) Ozone Depleting Potential
(2) Global Warming Potential (100-year, IPCC AR4)

1990s

Freon™

- HFC Based
- No ODP
- High GWP
- ASHRAE: A1

Today

Opteon™ XP

- HFO Blends
- No ODP
- Lower GWP
- ASHRAE: A1

Tomorrow

Opteon™ XL

- HFO & HFO Blends
- No ODP
- Low GWP
- ASHRAE: A2L

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Opteon™ Refrigerant Solutions

Typical End-Use Application	Low & Medium Temperature Refrigeration/Chillers	Air Conditioning/ Chillers	Refrigeration, Air Conditioning/ Chillers	Air Conditioning/ Chillers/Heat Pumps
Installed HCFC or HFC	**R-22** (GWP: 1760) **R-404A/ R-507A** (GWP: 3943/3985) **R-407A** (GWP: 1923) **R-407F** (GWP: 1596) **R-422D** (GWP: 2473)	**R-22** (GWP: 1760) **R-407C** (GWP: 1624) **R-422D** (GWP: 2473) **R-417A** (GWP: 2127)	**R-134a** GWP: 1300	**R-410A** GWP: 1924
Opteon Retrofit & New Equipment Options	**Opteon™ XP40** (R-449A) GWP: 1282	**Opteon™ XP20**[1] (R-449C) GWP: 1146	**Opteon™ XP10** (R-513A) GWP: 573	
Opteon Safety Class A2L, New Equipment Only	**Opteon™ XL40**[1] (R-454A) GWP: 238 **Opteon™ XL20**[1] (R-454C) GWP: 146	**Opteon™ XL20**[1] (R-454C) GWP: 146	**Opteon™ XL10** (R-1234yf) GWP: <1	**Opteon™ XL41**[1] (R-454B) GWP: 467 **Opteon™ XL20**[1] (R-454C) GWP: 146

Notes:

- [1] Opteon™ XP20 and Opteon™ XL blends are not yet fully commercial in all regions.
- GWP values noted are based on IPCC 5th Assessment Report. GWP values for HFC regulatory purposes follow IPCC 4th Assessment Report

Opteon™ XL40 (R-454A)

- Meets regulatory requirements
  - Non-Ozone Depleting
  - GWP: 238 (94% reduction vs. 404a)
- Mildly Flammable – A2L designation
- Close performance to R-22 and R-404A
- Compatibility with POE Oil

ASHRAE #: R-454A
Blend Components: R-1234yf/32
Blend Composition: 65/35

Opteon™ XL20 (R-454C)

- Meets regulatory requirements
  - Non-Ozone Depleting
  - GWP: 148 (96% reduction vs. R-404a)
- Mildly Flammable – A2L designation
- Close performance to R-22 and R-404A
- Compatibility with POE Oil

ASHRAE #: R-454C
Blend Components: R-1234yf/32
Blend Composition: 21.5/78.5

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UL / ASHRAE Charge Sizes By Application Type

- Charge will vary by application as specified by UL and ASHRAE
- Charge size will have to be calculated by product with the below formula:
- Value(Per UL) X LFL (Lower flammability Limit)= Charge
- The LFL of a refrigerant differs based on the

Designation	Application Example	Charge Calculation	Charge Size Example
M1	Closed-door self-contained	8 m^3 x LFL	Opteon™ XL20 (R-454C)= 5.1 lbs. / circuit
M2	Open-front self-contained	13 m^3 x LFL	Opteon™ XL20 (R-454C)= 8.3 lbs. / circuit
M3	Field erected systems	260 m^3 x LFL	Opteon™ XL20 (R-454C)= 166 lbs. / circuit

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*A circuit is defined as separate refrigeration system with no connecting lines or possibility of charges exceeding the limit
*Field erected systems are defined as any system requiring 2 or more braze connections
*Charge limits can be exceeded with the addition of significant safety and ventilation devices
*Charge limits are based on releasable charge

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ASDA – Market Approach

UK's Third-Largest Supermarket

Large-scale UK business

Multi-format omni-channel offering

Every Day Low Price foundations

George.

#2 clothing(1) brand by volume(2) in the UK through George

Strong own-brands

Food sourcing competitive advantage via IPL

~140k flexible and engaged colleagues

ASDA
Walmart

Supported by Walmart

Overview:

- 145,000 employees
- 581 grocery locations
- Store sizes: 3,000 sq.ft. - 100,000 sq.ft.
- 20 cold storage facilities
- 2 e-commerce fulfillment centers

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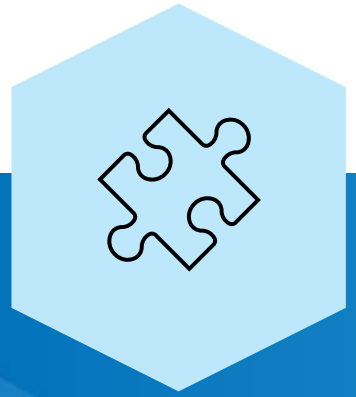
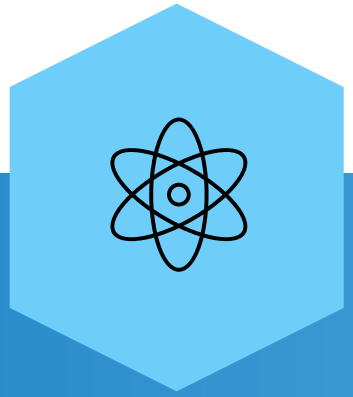
Evaluation



The Challenge

HFC phasedown in-process (F-gas)
Identify new store technologies
Build a retro/remodel strategy for 500+ locations
Focus on sustainability
Key considerations included:

- On-par or reduced energy consumption.
- Comparable CAPEX to maintain store count growth.
- Reduced OPEX where possible
- Simplicity/serviceable
- Limit consumption of other resources



The Process

Technology evaluation of multiple systems and architectures

Array of next generation HFO blends including R-454C, R-455A, R-454A, CO2 transcrtical systems, & hydrocarbon micro-distributed systems

Limited Store trial (January 2018)

- Opteon™ XL40 (R-454A), Emerson Scroll Compressors, Hubbard Pack System

Full Store installation (October 2019)

The Output

Multiple trials installed with Opteon™ XL40 (R-454A) due to the favorable capacity and performance

Hybrid Strategy Deployment:

- Remodel with A2L compliant cases
- Gas retrofit to lower GWP solutions (R-449A)
- Cost spread approach
- Simple solution that works, ensured compliance, and met all expectations

Adopted the use of low-GWP A2L refrigerant technology as their standard for all new and refurbishment store projects

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ASDA Case Study

Overview:

Replaced Centralized R-744 CO2 packs – running 135 m Chilled and 48.75 m frozen display cases with:

Modular A2L packs utilizing Opteon™ XL40 (R-454A) – running 137.5 m Chilled and 55.625 m Frozen display cases.

Energy Savings

34%

Total Cost of Ownership (20yrs)

25%

Total Equivalent Warming Impact

29%

Reduced Leak Rate

Have reduced refrigerant leakage in new and refurbished installations to below 3% per annum of the total system charge.

CAPEX & OPEX

Energy costs are currently the largest contributor to OPEX and the recent stresses on global energy supply and the associated increase in electricity prices have brought this into stark focus. The cost of equipment, installation and maintenance is also very significant when comparing CO2 R-744 to an A2L gas.

TEWI

Using a more pragmatic and holistic calculation. This emphasizes the importance of taking a wider, real-world view and performing full analysis when seeking solutions with the lowest environmental impact, rather than looking at systems in isolation.

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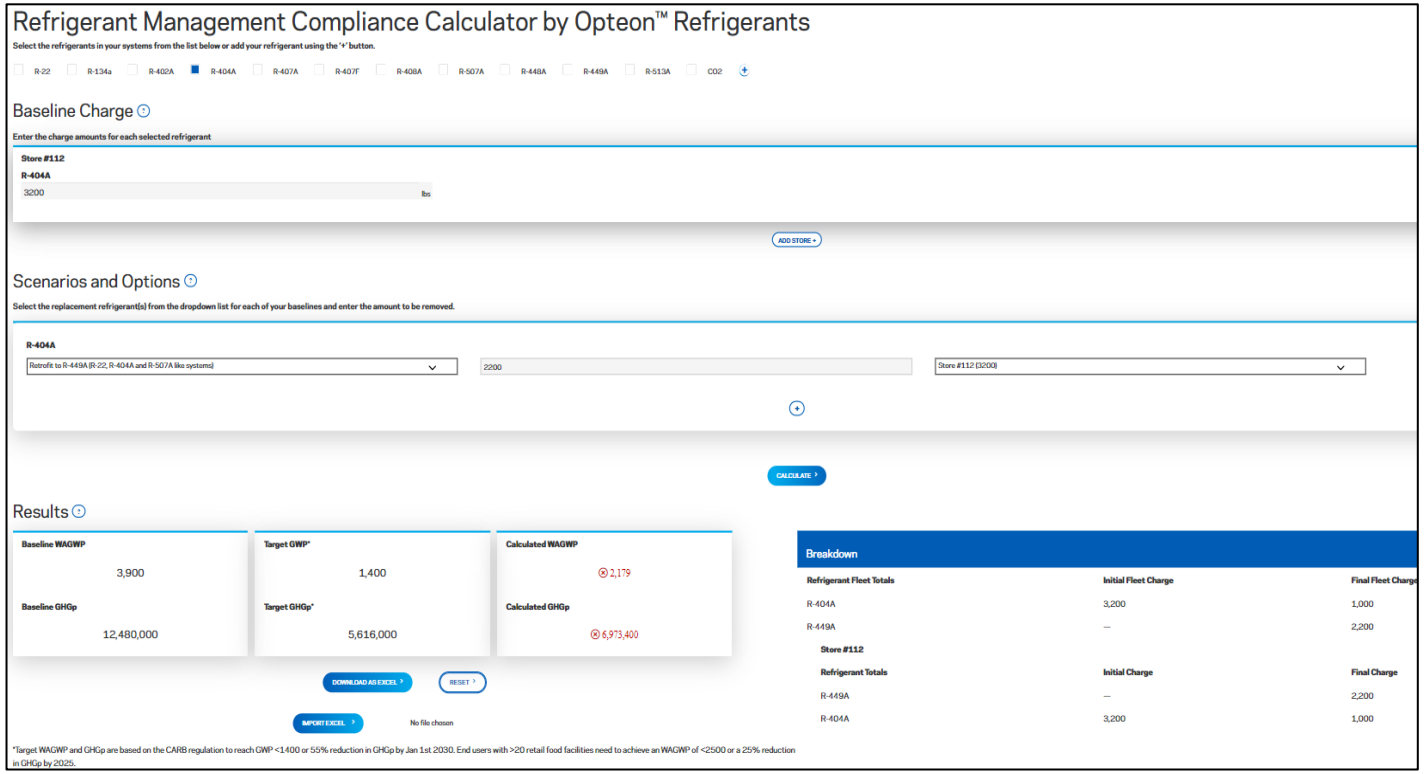
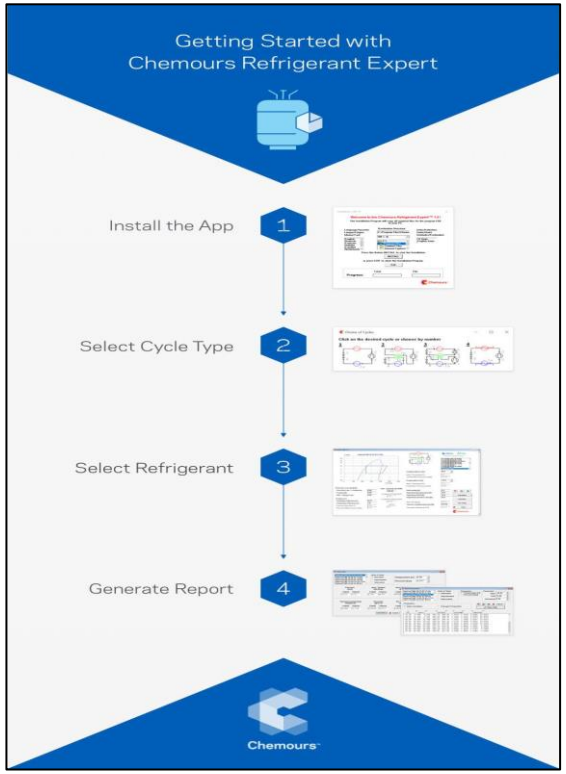
Chemours Tools

Opteon™ Compliance Calculator



Chemours Refrigerant Expert Software



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We Are Here To Help!

The AIM Act is still in progress; Stay up to date and ask for help!

- Product Quality
- Global Availability
- Technical Support
- Engineering Support
- Training
- Regulatory & Technology Insights

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Thank you!

For more information, go to
Low GWP Refrigerants for Commercial Refrigeration | Opteon™