



trinityconsultants.com

**TURI Spring Continuing Education
Conference
C1-C4 Halogenated Chemicals NOL: A
Focus on Refrigerants**

April 4, 2019

**Kristine Davies
Principal Consultant**



Agenda

- > Acronyms & basic refrigerant types
- > Refrigerant phase out or phase down
- > Next generation refrigerants
- > TUR Options
- > Q&A

Acronyms & Basic Refrigerant Types

- > HVAC/R - heating, ventilation, air conditioning / refrigeration
- > ODP - ozone depletion potential
- > ODS - ozone depleting substance
- > MVAC - motor vehicle air conditioner
- > SNAP - Significant New Alternatives Policy
- > CFCs - chlorofluorocarbons (e.g., R-11, R-12)
 - ❖ 1st generation; Class I ODS with ODP > 0.2
 - ❖ Production phased out since 1996
- > HCFCs - hydrochlorofluorocarbons (e.g., R-22, R-123)
 - ❖ 2nd generation; Class II ODS with ODP < 0.2
 - ❖ Production being phased out by 2020 (R-22 phase out started in 2010)
- > HFCs - hydrofluorocarbons (e.g., R-134a, R-407C, R-410A)
 - ❖ 3rd generation; non-ODS, but several have high global warming potential (GWP)
 - ❖ Production targeted for future phase down
- > Next generation refrigerants - non-ODS and low GWP
 - ❖ Hydrocarbons - e.g., R-290 (propane), R-600a (isobutane)
 - ❖ Hydrofluoroolefins (HFOs) - e.g., R-1234yf
 - ❖ HFC/HFO blends - e.g., R-448A, R-449A

How Do EPA's Refrigerant Rules Impact Facilities and HVAC/R Technicians/Contractors?

1. Phase Out of Specific Refrigerants (Subparts A, C, G, & I)

- > CFCs phased out of production in 1996 (e.g., R-11, R-12)
- > HCFCs being phased out of production (e.g., R-22) by 2020
- > HFCs now targeted for phase down
- > SNAP Program approves/disapproves substitutes
- > Reduces supply and increases cost

2. Required Practices When Working on AC Units (Subparts B & F)*

- > Technician certifications
- > Evacuation & recovery (no venting)
- > Disposal requirements
- > Sales restrictions
- > Leak repair provisions for units with full charge ≥ 50 lbs
- > Promotes recovery, recycling, & reclamation

*Commonly referred to as Clean Air Act Section 609 (mobile) and Section 608 (stationary) provisions

Relevance to Industry

- > Phase out of HCFCs and HFCs will increase refrigerant costs and accelerate equipment retrofits/replacements
- > Non-compliance with the leak repair provisions can lead to steep penalties & forced retrofits/replacements
 - ❖ Earthgrains Baking - \$5.25 million
 - ❖ Bristol Meyer Squibb - \$3.65 million
 - ❖ American Seafoods Group - \$9-\$15 million
- > Revised leak repair provisions represent significant raising of the bar for recordkeeping

Developments in Refrigerant Phase Out Schedules

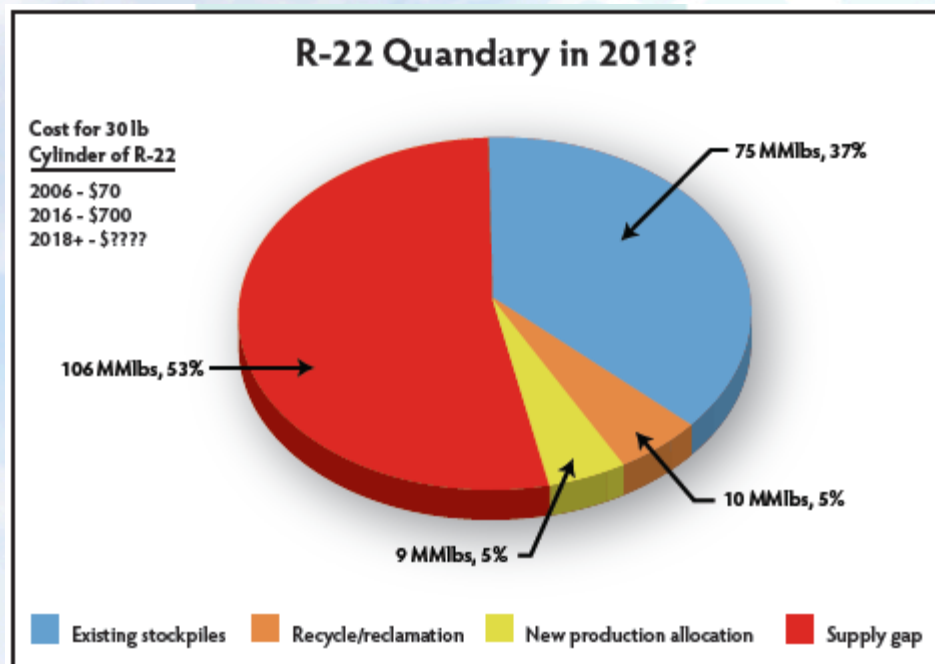
HCFC Phase Out is Here

- > HCFC production phase out schedule
 - ❖ 2015 = 90%
 - ❖ 2020 = 99.5% overall and 100% for R-22 & R-142b
 - ❖ 2030 = 100%

- > R-22 quandary?

- ❖ EPA production allocations = 13 million lbs (2017), 9 million lbs (2018), & 4 million lbs (2019)
- ❖ EPA estimates recycle/reclamation < 10 million lbs/year in 2016
- ❖ Represent only a fraction of the ~200 million lb/year service need in the U.S.

- > Costs for R-22 have already risen 10x since 2006



The Latest on R-22

- > R-22 continues to be most commonly used refrigerant across all industry sectors
 - ❖ Installed capacities at most sites range from several 100 lbs to several 1,000 lbs
- > Most retrofits/retirements are not planned
- > R-22 prices have returned from \$25-\$35/lb levels to \$10-\$17/lb levels
 - ❖ Due largely to success of R-407C as replacement in AC applications

HFCs are the New Target

- > HFCs (e.g., R-134a, R410A), which are the most common replacement for HCFCs, are the new target since they are potent GHGs
- > HFC targeting mechanisms
 - ❖ EPA's SNAP Program
 - ❖ Kigali Amendment to Montreal Protocol
 - ❖ Expansion of 40 CFR 82, Subpart F (i.e., CAA Section 608) provisions to non-ODS substitutes
 - ◆ Will cover in Section 2

HFCs are the New Target - Kigali Amendment

- > HFC phase down within Kigali Amendment to Montreal Protocol, 10/15/2016
 - ❖ 2019 - 10%
 - ❖ 2024 - 40%
 - ❖ 2029 - 70%
 - ❖ 2034 - 80%
 - ❖ 2036 - 85%
 - ❖ Relative to 2011-2013 HFC baseline + 15% of HCFC/CFC baseline
- > Trump Administration expected to ratify since has industry backing?

HFCs are the New Target - Kigali Amendment

- > Expected reduction of 70 billion tons of carbon dioxide equivalent through 2050
- > Goal is to prevent 0.5 degrees C of global warming by the end of the century

Next Generation Refrigerants

What Are “Next Generation” Refrigerants?

- > HFOs and HFO/HFC Blends
 - ❖ R-1234yf, R-1234ze, R-1233zd
 - ❖ R-449A, R-454A, R-513A, R514A
- > “Natural Refrigerants”
 - ❖ Water
 - ❖ Air
 - ❖ Carbon dioxide (R-744)
 - ❖ HCs
 - ◆ Propane (R-290)
 - ◆ Isobutane (R-600a)
 - ◆ Cyclopentane
 - ❖ Anhydrous ammonia (R-717)

Next Gen Refrigerants - Advantages

> HFOs and Blends

- ❖ Low ODP and low GWP
- ❖ Very short life in environment (HFOs)
 - ◆ 10 days for R-1234yf
 - ◆ Due to C-C double bond
- ❖ Good stability in service
- ❖ Less flammable than other next generation refrigerants
- ❖ In service data on millions of MVACs
- ❖ Low conversion cost/time
- ❖ Many already have SNAP approval

Next Gen Refrigerants - Disadvantages

> HFOs and Blends

- ❖ Mildly flammable (as opposed to most current refrigerants that are not flammable)
- ❖ Manufacturing is in its infancy
- ❖ May pay high market rates until multiple companies are at full scale production
 - ◆ \$50-\$80/lb based on recent survey of manufacturers
 - ◆ May have issues with availability if there are production issues
- ❖ Will be reportable under new TURA category

Next Gen Refrigerants - Advantages

> Natural Refrigerants

❖ Water/Air

- ◆ Non-toxic
- ◆ Inexpensive
- ◆ Environmentally friendly
- ◆ Not reportable under TURA

❖ Carbon Dioxide

- ◆ Used in commercial and institutional applications in Europe
- ◆ Non-toxic and non-flammable
- ◆ Lower volume of refrigerant needed = smaller system and less power consumption
- ◆ Inexpensive
- ◆ High heat output (heat pump)
- ◆ Not reportable under TURA

Next Gen Refrigerants - Disadvantages

> Natural Refrigerants

❖ Water/Air

- ◆ Too inefficient to be practical in most applications

❖ Carbon Dioxide

- ◆ Likely cannot retrofit existing system
 - Requires high pressure and compressor temperatures
 - Inefficient if no need for excess heat
- ◆ Is considered a greenhouse gas (GWP=1), may be reportable and/or regulated under MA and EPA rules

Next Gen Refrigerants - Advantages

> Natural Refrigerants

❖ HCs

- ◆ Long history with many applications in other parts of the world
- ◆ Inexpensive
- ◆ Not reportable under TURA (generally)

❖ Anhydrous Ammonia

- ◆ Widely used in many industries in Europe and large installations in the U.S.
- ◆ Non-flammable
- ◆ Inexpensive
- ◆ Very efficient

Next Gen Refrigerants - Disadvantages

> Natural Refrigerants

❖ HCs

- ◆ Highly flammable
- ◆ Considered VOCs, so promote formation of ground-level ozone
- ◆ Typically need new system, not retrofit due to increased need for flammability protection

❖ Anhydrous Ammonia

- ◆ Toxic
- ◆ Reportable under both TRI and TURA

So.....What Should We Do?

> Review Options

❖ Input Substitution

- ◆ Replace use of materials in C1-C4 chemical category
- ◆ May not be able to do with only input substitution

❖ Production Unit Redesign/Modification

- ◆ Replace refrigeration system with non-TURA reportable chemicals
- ◆ For HCs, need to really consider flammability issues to determine if replacement is a good option

❖ Production Unit Modernization

- ◆ Add automatic leak detection system

So.....What Should We Do?

> Review Options

❖ Improved Operation and Maintenance

- ◆ Easiest option to implement
- ◆ Existing framework for good O&M practices within 40 CFR Part 82 Subpart F
- ◆ Implement leak repair provisions for all sizes and refrigerant types, regardless whether required by EPA
- ◆ Fewer leaks = fewer refrigerant additions = less likely to trigger reporting
 - Since threshold determination is based on refrigerant additions in calendar year

Production Unit Modernization: A Look at the Revised Rule

Revisions to Leak Repair Provisions - Automatic Leak Detection

- > Can avoid follow-up leak inspection requirements if employ automatic leak detection system
- > Must directly detect refrigerant in air, monitor its surrounding in another manner, or monitor appliance conditions
- > Must be audited or calibrated annually
- > If detect refrigerant in air:
 - ❖ Appliance must be located indoors
 - ❖ Have 10 ppm accuracy
 - ❖ Have 100 ppm alert level
- > Other systems must alert when lose 50 lbs or 10% of full charge, whichever is less
- > If only used to monitor portion of appliance, then inspections apply to remainder

Improved O&M: Another Look at the Revised Rule

Leak Rate Calculation – It's a Projection of Amount Lost if Not Repaired for a Year

EPA Leak Rate Calculation for Appliances with Full Charge ≥ 50 lbs – Annualizing Method

Step 1. Take the pounds of refrigerant added to bring the unit to a full charge, and divide that by the number of pounds the unit holds at full charge.

Step 2. Take the shorter of:
A) the number of days that have passed since the last day refrigerant was added OR
B) 365 days
and divide that number into 365 days/year

$$\text{Leak Rate (\% per year)} = \frac{\text{Refrigerant Added (lbs)}}{\text{Full Charge (lbs)}} \times \frac{365 \left(\frac{\text{days}}{\text{year}}\right)}{\text{A or B (days)}} \times 100$$

Step 3. Multiply the result from Step 1 by the result from Step 2.

Step 4. Multiply the number calculated in Step 3 by 100 to calculate a percentage.

Rule also allows for use of the rolling average method, but the annualizing method is, by far, the most commonly used method. Note also that only one leak rate calculation method can be used per facility.

Leak Rate Calculation Example

- > Determines the amount of refrigerant that would leak out in a year if nothing done
- > Example (using “Annualizing Method”):
 - Day 1 - Unit fully charged with 250 lbs of R-22
 - Day 8 - Unit found to have lost 2 lbs of R-22

Leak Rate = 41.7% =

$$\left(\frac{2 \text{ lbs refrigerant added}}{250 \text{ lbs refrigerant in full charge}} \right) \times \left(\frac{365 \text{ day/yr}}{7 \text{ days since refrigerant last added}} \right) \times 100$$

Revisions to Leak Repair Provisions - Extension and Reduced Thresholds

- > Extends applicability to appliances that contain non-exempt substitutes (e.g., HFCs)
 - ❖ Good management practice to extend to all refrigerants
- > Lowers allowable leak (or repair “trigger”) rates
 - ❖ Comfort cooling & other units - 15% to 10%
 - ❖ Commercial refrigeration - 35% to 20%
 - ❖ Industrial process refrigeration - 35% to 30%
 - ❖ In reality...many facilities repair all leaks regardless of whether trigger threshold is exceeded

Revisions to Leak Repair Provisions - Testing/Mothballing

- > Initial and follow-up verification testing
 - ❖ Now required for **all appliance types**, including comfort cooling and commercial refrigeration (was only req'd for industrial units previously)
 - ❖ **Shortens window** for performing follow-up verification test from 30 days to 10 days of initial verification test or of the appliance achieving normal operating characteristics and conditions
- > If cannot be repaired within 30 days, must
 - ❖ Mothball appliance, OR
 - ❖ Prepare retrofit or retirement plan (must be implemented within 1 year)

Revisions to Leak Repair Provisions - Leak Inspections

- > Establishes leak inspection requirements if exceed allowable leak rates
 - ❖ Commercial/industrial process refrigeration ≥ 500 lbs - quarterly, until 4 consecutive quarters w/ no leaks above allowable leak rate
 - ❖ All other units ≥ 50 lbs - once per calendar year, until 1 year w/ no leaks above allowable leak rate
 - ❖ Must be performed by certified technicians
 - ❖ Not required if equipped with automatic leak detection system

References

- > https://www.tranenynj.com/wp-content/uploads/2017/09/HVAC_Industry_Refrigerant_Update_March2017.pdf
- > https://www.chemours.com/Refrigerants/en_US/products/Opteon/Stationary_Refrigeration/assets/downloads/news/new-generation-hfo-refrigerants.pdf
- > <https://www.globenewswire.com/news-release/2018/12/11/1665406/0/en/Next-Generation-Refrigerant-Markets-Global-Outlook-to-2023-The-Development-of-Green-Buildings-Smart-Cities-Create-Lucrative-Opportunities.html>

Questions?

Contact Information:

Kristine Davies (508) 273-8600 x2701

kdavies@trinityconsultants.com



Additional Regulatory Information on New Refrigerant Rules

EQ article provided at:

<https://www.trinityconsultants.com/news/federal/refrigerant-rule-revisions--is-your-facility-prepared>

Complete summary table in PDF format provided at:

<http://www.trinityconsultants.com/Documents/Summary-of-Key-Revisions-to-Refrigerant-Management->