Regulations 2018: What’s Set, Pending and Proposed

E360 Webinar • January 16, 2018
Dr. Rajan Rajendran

Vice President, Systems Innovation Center and Sustainability — The Helix Innovation Center
Emerson

Dr. Rajan Rajendran is the vice president, systems innovation center and sustainability at Emerson. He has worked at Emerson since 1990 in various capacities: first as a research engineer; later as manager in the scroll compressor product development group; and as director for 10 years prior to his current role.

Rajan is also the director of The Helix, Emerson’s research and innovation center located on the University of Dayton’s campus. He represents Emerson in its communications with various policy and industry organizations, such as the U.S. Environmental Protection Agency and the U.S. Department of Energy, among others.

Rajan earned a bachelor’s degree in mechanical engineering from the University of Madras. He earned his master’s and doctorate degrees in mechanical engineering from Iowa State University and has an M.B.A. from Wright State University.
Amy Childress has been involved in business development and strategic marketing for high-tech companies for more than 20 years. In her current role, she helps define and promote Emerson Cargo Solutions’ technologies designed to monitor perishable goods in the supply chain. Emerson Cargo Solutions, recently formed via the acquisition of PakSense and LocusTraxx, extends Emerson’s long-time presence and leadership in cold chain management, helping customers improve food quality and safety while reducing global waste.

Previously, she worked in executive-level marketing roles, where she developed marketing materials, oversaw product launches, and generated and negotiated client contracts.

Amy earned a bachelor’s degree from Princeton University.
John Wallace is the director of innovation at Emerson Commercial & Residential Solutions. He has been active in the design and development of electronic control systems for more than 20 years and holds several patents related to the control of HVAC and refrigeration systems.

He is a recognized expert in the field of smart buildings and has testified before the U.S. Senate Energy and Natural Resources committee on the impact of smart building technologies on the nation's infrastructure.

John earned a bachelor's degree in electrical engineering from the University of Kentucky and a master's degree in electrical engineering from the University of Missouri.
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Current Refrigerant and Energy Regulations in Refrigeration Applications

Dr. Rajan Rajendran
Vice President, Systems Innovation Center and Sustainability — The Helix Innovation Center
Emerson
Global agreement on HFC phase-down reached by 197 countries of the world in Kigali, Rwanda “38th Meeting of the Parties to the Montreal Protocol on Substances That Deplete the Ozone Layer”

- United States has not ratified the amendment yet; U.S. State Department issued statement on Nov. 23 in Montreal — “initiated steps to ratify”

Kigali Amendment** Ratified by 20+ Countries, Nov. 22, 2017; Goes Into Effect Jan. 1, 2019

*https://www.state.gov/e/oes/rls/remarks/2017/275874.htm

**http://conf.montreal-protocol.org/meeting/mop/mop-28/final-report/English/Kigali_Amendment-English.pdf
European F-Gas Regulation: Phase-down and Application-specific Bans

Europe Experiencing Impact of 2018 Step-change in Consumption Quota
**Table 2: Description and product-specific controls by end-use**

<table>
<thead>
<tr>
<th>Description</th>
<th>Global Warming Potential Threshold</th>
<th>Coming into Force</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>End-use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand-alone refrigeration systems use HFCs as refrigerants in self-contained systems generally used in supermarkets and convenience stores to store and display perishable foods, beverages and frozen foods.</td>
<td>1 400 (medium temperature) 1 500 (low temperature)</td>
<td>2020</td>
</tr>
<tr>
<td>Centralized refrigeration systems are generally used for storing and displaying food, beverages, and other perishables in convenience stores and supermarkets, using HFCs as refrigerants.</td>
<td>2 200</td>
<td>2020</td>
</tr>
<tr>
<td>Chillers using HFCs as refrigerants are generally used to provide air-conditioning for large commercial buildings or refrigeration in industrial settings.</td>
<td>750</td>
<td>2025</td>
</tr>
<tr>
<td>Mobile refrigeration systems use HFCs as refrigerants to provide refrigeration during the shipping of food and beverage products (e.g., refrigerated trucks).</td>
<td>2 200</td>
<td>2025</td>
</tr>
<tr>
<td>Domestic air conditioning systems use HFCs as refrigerants and are found in residential and small commercial buildings.</td>
<td>Not applicable (affected by phase-down only)</td>
<td></td>
</tr>
<tr>
<td>There are no known domestic manufacturers of domestic refrigeration equipment in Canada.</td>
<td>150</td>
<td>2025</td>
</tr>
<tr>
<td>HFCs with a Global Warming Potential of 1 430 are used as a blowing agent in the manufacture of XPS foam used for wall, roof, and floor insulation.</td>
<td>150</td>
<td>2021</td>
</tr>
<tr>
<td>HFCs are used as blowing agents in rigid PU foam products in the manufacture of insulation products for appliances, pipes, and buildings.</td>
<td>150</td>
<td>2021</td>
</tr>
<tr>
<td>HFCs are used as a blowing agent in high pressure PU spray foam products for the installation of wall, roof, and floor insulation.</td>
<td>150</td>
<td>2021</td>
</tr>
<tr>
<td>HFCs are used as a blowing agent in low pressure PU spray foam products for the installation of wall, roof, and floor insulation.</td>
<td>150</td>
<td>2021</td>
</tr>
<tr>
<td>Motor vehicle air conditioning (MVAC) Motor vehicle air-conditioners typically contain HFCs as refrigerants.</td>
<td>150</td>
<td>2021 (model year vehicles)</td>
</tr>
<tr>
<td>HFCs are used in aerosol products as propellants in a range of personal care, household, and cleaning products.</td>
<td>150</td>
<td>2018</td>
</tr>
</tbody>
</table>

**Phase-down schedule of HFC consumption:**
- 2019 — 90%; 2024 — 60%; 2030 — 30%; 2034 — 20%; 2036 — 15%; baseline 2011–2013

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**Canada Has Also Ratified the Kigali Amendment to the Montreal Protocol.**

Summary* of EPA’s Refrigerant SNAP Approval and De-listings by Application

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>GWP</th>
<th>Supermarket (New***)</th>
<th>Supermarket (Retrofit****)</th>
<th>Remote condensing unit (New)</th>
<th>Remote condensing unit (Retrofit****)</th>
<th>MT &lt; 2,200 BTU/hr. and not contain flooded evap. (New)</th>
<th>MT ≥ 2,200 BTU/hr. with or without flooded evap. (New)</th>
<th>LT (New)</th>
<th>LT and MT (Retrofit****)</th>
<th>Refrigerated food processing and dispensing equipment (New)</th>
<th>Cold storage warehouses (New)</th>
<th>Ice machines (New)</th>
<th>Very low-temp refrigeration (New)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-452A</td>
<td>2,140</td>
<td>-</td>
<td>-</td>
<td>OK</td>
<td>OK</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Jan. 1, 2021</td>
<td>Jan. 1, 2023</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>HFC-134a</td>
<td>1,300</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>Jan. 1, 2019</td>
<td>Jan. 1, 2020</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>-</td>
</tr>
<tr>
<td>R-448A</td>
<td>1,282</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>Neither SNAP-approved, nor banned</td>
<td>Neither SNAP-approved, nor banned</td>
<td>OK</td>
<td>OK for LT only</td>
<td>-</td>
<td>-</td>
<td>OK</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>R-449A</td>
<td>1,296</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>Neither SNAP-approved, nor banned</td>
<td>Neither SNAP-approved, nor banned</td>
<td>OK</td>
<td>OK for LT only</td>
<td>-</td>
<td>-</td>
<td>OK</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>R-513A</td>
<td>573</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>-</td>
</tr>
<tr>
<td>R-450A</td>
<td>547</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>-</td>
</tr>
<tr>
<td>R-290</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>R-744</td>
<td>1</td>
<td>OK</td>
<td>-</td>
<td>OK</td>
<td>-</td>
<td>OK</td>
<td>OK</td>
<td>OK</td>
<td>-</td>
<td>OK</td>
<td>OK</td>
<td>-</td>
<td>OK</td>
</tr>
<tr>
<td>R-717</td>
<td>0</td>
<td>OK (in primary loop of secondary system)</td>
<td>-</td>
<td>OK (in primary loop of secondary system)</td>
<td>-</td>
<td>OK (in primary loop of secondary system)</td>
<td>OK (in primary loop of secondary system)</td>
<td>OK (in primary loop of secondary system)</td>
<td>OK (in primary loop of secondary system)</td>
<td>OK (in primary loop of secondary system)</td>
<td>OK (in primary loop of secondary system)</td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

*Abbreviated – For complete listing, see EPA website. The court ruled the EPA did not have the authority to enforce an HFC ban for companies using HFCs based on HFCs historically being on the approved alternative list.

** Includes ice machines connected to a supermarket rack refrigeration system.

*** EPA uses term "retrofit" to indicate the use of a refrigerant in an appliance that was designed or originally operated using a different refrigerant. Term does not apply to upgrades to existing equipment where the refrigerant is not changed.
Court Ruling

- Mexichem & Arkema challenged the EPA’s SNAP refrigerant delisting (Rule 20) in the D.C. Circuit Court of Appeals, arguing:
  - The EPA had no authority under the Clean Air Act Section 612 to require the replacement of HFCs.
- Court ruled 2:1 in favor of Mexichem & Arkema and found that the EPA under Section 612 only had authority to phase out ozone-depleting substances and not HFCs, which are non-ozone depleting substances.
  - 45-day appeals window closed 9/22/17

Response and Next Steps

- Petitions for a rehearing were filed by Honeywell and Chemours as well as by Natural Resources Defense Council (NRDC) with the U.S. Court of Appeals for the DC Circuit on Friday, September 22, 2017.
- The Court has issued a hold/stay of the Court Order until after the petitions for rehearing are reviewed.
  - The impact is that the delisting (Rule 20) is still the law of the land.
  - No established timeline for the petition review process
- States like California may act to fill the void and potentially create regulations on HFCs.
CARB Rulemaking #1 Proposal (Effective Fall 2018)

- Adopt provisions from U.S. EPA SNAP Rules 20 and 21 by reference
- Initial focus on stationary refrigeration and AC
  - Supermarket Systems (new and retrofit)
  - Remote Condensing Units (new and retrofit)
  - Stand-alone (self-contained) Refrigeration
  - Refrigerated Vending Machines
  - Retail Food (refrigerated food processing and dispensing equipment)
  - Cold Storage
  - Chillers

AHRI Sent Comments Requesting CA Follow the Canadian Proposal for Adoption of SNAP Rules 20 and 21.
CARB Rulemaking #2 Proposal: SLCP Strategy to Reduce HFC Use

- **Stationary refrigeration measures**
  - In 2021: Refrigerants with a GWP of 150 or greater prohibited in new refrigeration systems containing 50 or more pounds of refrigerant
  - In 2021: Refrigerants with a GWP of 1,500 or greater prohibited in new refrigeration systems containing 20 to 50 pounds of refrigerant

- **Stationary air-conditioning measures**
  - In 2021: Refrigerants with a GWP of 750 or greater prohibited in new air-conditioning systems containing two or more pounds of refrigerant

- **Chiller measures**
  - In 2021: Refrigerants with a GWP of 150 or greater prohibited in new chillers (refrigeration or air-conditioning)

- **Sales restrictions on refrigerants**
  - In 2020: No production, import, sales, distribution or entry into commerce of refrigerants with a GWP of 2,500 or greater
  - In 2024: No production, import, sales, distribution or entry into commerce of refrigerants with a GWP of 1,500 or greater

*Effective Mid-2019 and No Deadline Set for Comments; Industry Needs to Provide Input*
Alternatives and Development Approach to New Refrigerants

1. R-410A
   - Like R-404A & R-407/22
   - Arm-42
   - 400–675

2. R-32/HFO Blends
   - ~300
   - HFC/HFO Blends
   - 0–500
   - 500–1,000
   - 1,000–1,500
   - >1,500

3. CO2
   - R-446A, R-447A, ARM-71a
   - R-32/HFO Blends
   - 400–675
   - >1,500

Legacy

- R-410A
- R-404A
- R-507A
- R-407C
- R-452A = XP44
- R-448A = N40
- R-449A = DR33
- R-449B = ARM-32
- R-450A = N13
- R-513A = XP10
- R-444B = L20
- L40, DR7
- ARM-20b
- R-22
- R-32
- R-32/HFO Blends
- R-448A

A1 – Non-Flammable
A2L – Mildly Flammable
A3 – Flammable
B2L – Toxic, Mildly Flam.

GWP Level

Qualitative — Not to Scale

Pressure or Capacity

R-134a Like
- Like (V. Low Pr.)
- 0–500
- >1,500

R-123 Like
- DR2, N12, ARC 1
- DR3, ARM-20b
- HDR110
- DR8, ARM-20a
- R-32/HFO Blends
- 400–675

HFO 1234yf
- R-407A
- R-407C
- R-452A = XP44
- ARM-35

HFO 1234ze
- R-407A
- R-407C
- R-452A = XP44
- ARM-35

CO2
- 0–500
- >1,500

R-290
- NH3

A1 – Non-Flammable
A2L – Mildly Flammable
A3 – Flammable
B2L – Toxic, Mildly Flam.
U.S. Dept. of Energy Regulations Summary
Energy Mandates Have Evolved to Become Extremely Significant

Commercial Refrigeration Equipment¹
- Effective March 2017 on New Equipment
- CRE Measured in kWh/24-Hour Day
  - Each Equipment Class Assigned Equation Accounting for Total Display Area (TDA) or Volume
- 20–86% Energy Reduction Required, Depending on Class

Automatic Commercial Ice Makers²
- Effective January 2018 on New Equipment
- ACIM Measured in kWh/100 lbs Ice
  - Each Equipment Class Assigned Equation
- 5–25% Energy Reduction Required

Walk-In Coolers and Freezers (WICF)³
- Effective January 2020 on New Equipment
  - MT June 2017: Report AWEF/Label
  - MT Jan. 2020: AWEF Enforcement
  - LT Jan. 2020: Report/Label/Enforcement
- Measured in Three Major Components Using AHRI-1250
- 30–37% Energy Reduction Required

Refrigerants and Regulations:
10 Significant Targets Over the Next Four Years

Supermarket (Rack)
- Cooler: <2,500 GWP, 1/1/17
- Freezer: <2,500 GWP, 1/1/18

Walk-In (Remote CDU)
- Cooler: <2,200 BTU
- Freezer: >2,200 BTU

Reach-In (Stand-Alone)
- Cooler: <2,200 BTU, 3/27/17
- Freezer: 20–50%, 1/1/19

Ice Machines
- Soft Serve/Frozen Bev.: 5–15%, 1/1/20

EPA approved (listed) R-452A: 7/21/17

DOE published Final Rule: 7/10/17
Current Temperature Monitoring and Food Safety Regulations

Amy Childress
Vice President of Marketing & Planning,
Cargo Solutions
Emerson
According to the CDC, about 48 million people (1 in 6 Americans) get sick, 128,000 are hospitalized, and 3,000 die each year from food-borne diseases. This is a significant public health burden that is largely preventable.

https://www.cdc.gov/foodborneburden/index.html
Global Food Distribution Is Complex

Complicated Supply Chain
What Is FSMA (Food Safety Modernization Act)?

- Signed into law on January 4, 2011
- Result of numerous food safety incidents in the early 2000s
- 2006 spinach incident
- Overarching goal is to ensure U.S. food supply is safe by shifting focus from simply responding to prevention

https://www.fda.gov/Food/GuidanceRegulation/FSMA/

Prevention the KEY Tenet of FSMA;
Goal Is to Create a Modern, Risk-based Framework for Food Safety
Some Core FSMA Rules

• Preventative Controls for Human Food and Animal Feed
• Produce Safety Rule
• Foreign Supplier Verification Program (FSVP)
• Sanitary Transport of Human and Animal Food
• Intentional Adulteration

https://www.fda.gov/Food/GuidanceRegulation/FSMA/ucm247546.htm
Where Does Temperature Play in the FSMA Rules?

• There are many variables involved in ensuring food arrives in a safe manner to consumers.

• We know bacteria and other pathogens cause food poisoning.

• Cross-contamination, inappropriate processing methods, and temperature abuse can all contribute.

• Maintaining correct temperatures can help prevent and mitigate food-borne illness.


Remember, the Key Word Is “Prevention”.
Temperature Elements of FSMA

Sanitary Transport

If requested, proof of:

- Proper sanitation
- Proper storage and transport temperatures
- Documented, written and communicated procedures for safe transport
- Verification of adequate employee training on pre-cooling and transport procedures

Preventative Controls for Human Food

- Food must be processed and stored at correct temperatures
- Records must be available upon inspection

Foreign Supplier Verification Program

- Requires food imported into the U.S. be produced in a manner that meets U.S. safety standards
- As if they were grown and processed in the U.S.
- Audits of foreign suppliers may occur

The Benefits of Automated Temperature Monitoring in Transit

• Data loggers and real-time tracking devices can be placed on perishable loads in transit.

• They automatically transmit their temperature to the cloud, using cellular-based systems.

• Simple to use/require minimal human interaction

• Historical records are kept in the cloud. Proactive alerts can also be sent, potentially preventing an event from actually occurring.

• FSVP ensures imported food is monitored as well.
The Benefit of Automated Monitoring Systems in Storage

• Be prepared to share temperature records, on demand.

• Sensors in coolers, freezers and display cases at the retail grocery level. Via IoT technologies, data is transmitted.

• Automated record keeping occurs, and historical data is available.

• Proactive, real-time alerts can also be sent, potentially preventing a food safety incident.

Implement Automated Recording for All Segments of the Cold Chain

Be Proactive and Preventive.
Address the Entire Supply Chain.
Summary

- Automated temperature monitoring ensures data and historical data are transmitted to the cloud for on-demand analysis.
- Proactive alerts help prevent situations from occurring.
- Systems are easy to implement and require little human interaction.
- Prevention is key and is a core principle of FSMA.
- Proper temperature management is critical to food quality and safety.

By Working in Concert, Grower/Shippers, Carriers and Retailers Can All Work Together to Reduce Food-borne Illness.
How Innovation in IoT, Building Management and Control Systems in Smart Buildings Create the Smart Grid

John Wallace
Director of Innovation
Emerson
Renewable Energy Represents Fastest-growing Type of Electrical Generation

- Renewable (wind/solar) represent more than 50% new generation capability and 15% of total capability

However, Growth in Renewable Energy Requires New Techniques to Manage the Grid.

- Renewable energy typically non-deterministic (i.e., varies depending on conditions), which can create challenges for electrical grid management
- NREL study identified several methods to mitigate, including new types of demand side management
Example Opportunity:
• Value of transactive controls on aggregated rooftop air-conditioning units on a peak summer day

ISO communicates that price is about to increase from $0.1/kWh to $1.0/kWh, unless 100 MW is removed from the system.

I’m a hotel with a big conference underway. I need maximum cooling for my building. I’m looking to buy your additional load reduction to avoid price increases.

I’m a big box store, with variable-speed fans on my RTUs. I can run those fans at somewhat lower speeds for 10 minutes and “sell” you the load reduction. It will make no noticeable difference to my customers, and I can make some money (part of the price increase the other customer is avoiding).

Example illustrates concept of “across the meter” coordination

“Real-time” utility pricing would be a driver

Essentially, demand response on steroids

DOE supporting the vision with demonstration projects and research
Smart Building Ecosystem
Comprehensive, interoperable integration of devices, buildings and grid with transactive controls utilizes software applications to monitor, control and aggregate building resources.

Transactive Control and Smart Buildings Ecosystem
- Enables smart buildings to be aggregated dynamically and ‘transact’ with the electric utility (i.e., buildings provide benefit to the consumer, the utility, and the environment);
- Leverages applications on a cyber-secure transactional platform (VOLTTRON) that enhances seamless interoperability (i.e., doesn’t require new hardware or devices);
- Provides value from all aspects of the utility to the consumer domains (i.e., has capability to capture values from regulated and non-regulated markets).

Controls for Building Efficiency
- Are defined by their inner building communication mechanisms (i.e., hardware and sensors for one building or system);
- Utilize demand side management controls that optimize energy use for consumers (i.e., measured by annual net consumption);
- Engage in direct load control or demand response for limited value to both the grid and building owner; and,
- Provide value to the owner or operator, so they can recoup the investment.
Congressional **Interest** in Potential Benefits of “Smart Buildings”

- **S.1046 Smart Buildings Acceleration Act (2015)** defined “smart building” as:
  - Flexible and automated
  - Extensive operation monitoring, including remote access
  - Integrated with overall building operations
  - Communicates with utilities and other third parties

- **S.1904 Smart Cities and Communities Act of 2017**: a bill to promote the use of smart technologies and systems in communications and for other purposes

- Senate Energy and Natural Resources Committee Hearing on Smart Buildings (2017)

**Wallace testimony before Senate Committee on Energy and Natural Resources**

“Providing the ability for smart buildings to be ‘connected’ with outside services offers new, potentially more effective ways to optimize buildings and respond not just to the conditions within the building but other conditions (such as real-time utility pricing) as well. As we as an industry look to incorporate these new technologies, we need to ensure that we maintain the appropriate balance between local control of the building equipment and the external services that can optimize operations — not only of an individual building, but of a portfolio of buildings.”

**Note:** None of these bills have passed the Senate as of Dec. 2017.
Thank You!

Questions?

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