



## UL Standards – Update on Natural Refrigerants

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# A Little History

Pre-1990, most refrigerants were non-flammable

In the 1990s, environmental concerns caused the refrigeration industry to look at different refrigerants.

It was originally not easy for UL to accept refrigerants that are flammable

We were active participants in developing the requirements SC61C, UL 250, SC61D,

And we continue to be active In addition to household refrigerators, UL has developed requirements for the use of flammable refrigerants in commercial refrigerators, vending machines, and room air conditioners.



# Developmental History

## UL 250 – Household Refrigerators

Initial proposal March 17, 1993, Supplement SA published 8-25-00.

Similar to requirements in IEC 60335-2-24 (pub. 88?)

## UL 471 – Commercial Refrigerators

Initial proposal August 31, 2000 (testing the waters)

Unilever/Ben and Jerry's interest; Resurrected requirements late 2007

Supplement SB published October 24, 2008

Similar to requirements in IEC 60335-2-89

## UL 541 – Refrigerated Vending Machines

Published requirements December 30, 2011

## UL 484 – Room Air Conditioners

Published requirements October 21, 2011

Similar to requirements in IEC 60335-2-40



# ASHRAE 34 Background

- ASHRAE 34 – Designation and Safety Classification of Refrigerants
- Refrigerants are categorized for toxicity
  - “A” – Lower toxicity
  - “B” – Higher toxicity
- Refrigerants are classified with respect to flammability
  - “1” – No flammability                      “2” – Lower Flammability
  - “3” – Higher Flammability              “2L” – Subset of “2”
- Commonly used natural refrigerants
  - Propane (R290), **A3**                      Isobutane (R600a), **A3**
  - Ammonia (R717), **B2L**                      Carbon Dioxide (R744), **A1**



# Requirement Highlights

The refrigerant used shall be non-toxic, Group A

## Refrigerant Charge Limits (A3 Refrigerants):

- *Household Refrigerators*                      2.01 oz (57 grams)
- *Commercial Refrigerators*                5.3 oz (150 grams)
- *Room Air Conditioners*                    2.2 lb (1 kg) of propane (+)
- + - *Amount is based on size of room*

- The refrigerant shall be evaluated to determine the flammable limits
  - Verification of flammability, lower flammable limits, etc.
- Refrigerant containing parts and tubing to be protected
  - Different than IEC standards



# Requirement Highlights - Tests

- Appliances to be constructed so that leaked refrigerant will not accumulate near ignition sources
- Ignition Sources: Electrical switching components (they potentially arc during normal operation). Also, hot parts that exceed the ignition temperature of the flammable refrigerant.
- Leakage Tests (refrigerators):
  - SB5.1.2 Protected Cooling System
  - SB5.1.3 Unprotected Cooling System
  - SB5.1.4 Leakage outside the food storage area
  - The measured concentration of refrigerant close to ignition sources shall not exceed 75% of LFL, or 50% of LFL for over 5 minutes.



# Requirement Highlights

- What happens if the LFL is exceeded?
  - Move the component
  - Determine if component is really an ignition source
- Ignition test: May be conducted on switching components that can be exposed to flammable refrigerant
- Temperature test: Surface temperatures shall not exceed the ignition temperature of the flammable refrigerant reduced by 100 C
  - Propane: 470 C
  - Isobutane: 460 C
- Markings/Installation Instructions



# What is UL Doing?

1. February 2011, UL facilitated the initial Flammable Refrigerants JTG meeting in Las Vegas, NV.
2. The JTG established three (3) working groups (WG's).
  - a. WG1 developing requirements for flammable refrigerants applicable to air conditioning equipment.
  - b. WG2 developing similar requirements for refrigeration equipment.
  - c. WG3 to address requirements for the testing and evaluation of flammable refrigerants (including the new 2L types) and take into consideration the recommended requirements of the equipment WG's.





# UL JTG Flammable Refrigerants WG1

## Working Group #1 (Air conditioning, heat pump and similar equipment):

Discussing possible additions/changes to:

- UL 474, Dehumidifiers
- UL 484, Room Air Conditioners (initial requirements published)
- UL 1995; Heating and Cooling Equipment
- UL 60335-2-40; Requirements for Heat pumps, ACs, and Dehumidifiers

Anticipating using as a guide the flammable refrigerant requirements for Class A2 and A3 presently in IEC 60335-2-40

Looking at flammable natural refrigerants for smaller, self-contained equipment

Working with ASHRAE 15 for larger equipment



# UL JTG Flammable Refrigerants WG2

## Working Group #2 (Refrigeration equipment):

- Potentially adding IEC 60335-2-40 requirements for larger equipment and charges
- Discussing many possible revisions to UL 471/541 including:
  - Adding non-ventilated requirements and larger charge sizes from IEC 60335-2-40 to UL 471/541, Supplement SB
  - Adding other refrigerants
- Discussing possible changes to other refrigeration equipment standards
  - UL 563; Ice Makers
  - UL 621; Ice Cream Makers
- **UL 250, 471 and 541 already contain flammable refrigerant requirements (for smaller equipment / charges)**



# UL JTG Flammable Refrigerants WG3

## Working Group #3 (Refrigerants):

- Discussing recommended updates to UL 2182, “Safety Standard for Refrigerants” including:
- Eliminating 100°C flammability testing to harmonize with ASHRAE 34 and pending ISO 817 revision
- Incorporating optional burning velocity testing
- Retaining Auto Ignition Temperature test to support hot surface requirements in end-use standards
- Considering hydrocarbon purity requirements (but not odorization/stenching which would require new technology)
- Not incorporating Minimum Ignition Energy (MIE) testing pending input from the other two WG’s
- Discussing additional test apparatus for testing of refrigerants
- Expecting to finish work around same time as WG#1 & #2 after risk assessments to ensure consistency



# Acknowledgement of EPA SNAP Ruling

Need to be aware of both UL and EPA SNAP requirements

Recent Ruling; some SNAP Use Conditions different than UL reqs.

- Specific Refrigerants

- Warning marking letter height

- UL taking steps to “harmonize”

UL can List products before SNAP Rules finalized

- But please work with the EPA; they allow “test cases”

- (Ben and Jerry’s)



# Carbon Dioxide

## As a Secondary Coolant

CO2 pressure typically 34.5 bar (500 psig) or less

Pressure relief device required, set at design pressure

Pressure Regulating Relief device required, set at 90% design pressure

Ultimate Strength = 3X Design Pressure

Cascade systems similar, but pressures may be higher.

Note Machinery Room requirements in ASHRAE 15

Loss of power is a particular concern – that's why regulating relief devices are used (lose less CO2)



# Carbon Dioxide Transcritical Systems

Critical pressures 1058 psig high side, 955 psig low side

Extremely high pressures in transcritical systems

- Up to 2000 psig High Side

- Approximately 1000 psig Low Side

“Traditional” UL requirements

- Ultimate strength

  - High side = 5X design pressure or 3X fan failure pressure

  - Low side = 3X design pressure

Pressure relief not required for smaller self-contained systems, but larger systems may need pressure limiting device and relief device



# Carbon Dioxide

## Fatigue Pressure Requirements

The following test pressures are reflective of a 135 Bar (1958 psig)  
Design Pressure

2 Samples – Ultimate strength of 3X design pressure (or max. abnormal press. for self-contained)  
3 x 135 bar = 405 bar (5874 psig)

3 Samples - Cycling

First cycle – Design Pressure – 135 Bar (1958 psig)

249,999 cycles

High – 95% Design Pressure – 128 Bar (1859 psig)

Low – Sat. Pressure at 4.4 C – 38 Bar (553 psig)

Last “cycle” – 2X upper cycle pressure – 257 Bar (3702 psig)

(Self-contained equipment may need a pressure limiting device to lower pressures during fan failure.)



# Future Challenges

- Recovery/Recycling equipment?
  - UL 1963 revisions underway
- 57 gram limit for household refrigerators
- Larger refrigeration systems (ASHRAE 15)
- Other types of equipment (Ice makers, Ice Cream Makers, etc.)
- Ammonia Requirements
- Potentially revising Carbon Dioxide Pressure Requirements





# Thank You

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- Questions

