Current status of Japan’s legislation on F-gases and RACHP using Low-GWP Refrigerants

Hideaki Kasahara
JRAIA
13 July 2018
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1. Timeline of Regulations and Protocols
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3. Actions to shift low-GWP refrigerants
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0. Who is JRAIA?

The Japan Refrigeration and Air conditioning Industry Association

- Established in 1949. (2019 is the 70th anniversary)
- 168 member companies including the associate members. (as of 1st of April 2018)
- The business fields of the member companies are:
  - Air conditioning (residential, commercial, automotive)
  - Refrigeration (commercial, industrial, transport)
  - Ventilation
  - Heat pump system (HP water heaters)
  - Refrigerants
  - Parts
0. Who is JRAIA?

1) Previous side-events at OEWG

- **OEWG39** in Bangkok, 12 July 2017
  “Latest findings of A2L risk assessment conducted in Japan and current status of A3 risk assessment”

- **OEWG38** in Vienna, 10 July 2016
  “Implementation of alternative refrigerant management in Japan; Latest activities including risk assessment for A2L refrigerants”
  [https://www.jraia.or.jp/english/side/index.html](https://www.jraia.or.jp/english/side/index.html)
1. Timeline of Regulations and Protocols

1) Relation between Global and Japanese Acts

- Vienna Convention
- Montreal Protocol
- UNFCCC
- Kyoto Protocol (COP3)
- Paris Agreement (COP21)
- Dubai Pathway
- Kigali Amendment
- Ozone Layer Protection Act
- HCFC production regulation starts
- HFC introduction
- Home Appliance Recycle Act
- EoL Automotive Recycle Act
- Fluorocarbon Recovery & Destruction Act
- Revised “OLP” Act (2018)
- Revised Fgas Act (2015)

Global Warming Countermeasure Plan

Global

Japan
2. Regulations relate to F-gases in Japan

1) Overview

"Ozone Layer Protection Act" (revised in 2018)
- Regulation on production and consumption of CFC/HCFC/HFCs (abbr. OLP Act)
- National law to be ratified the Kigali amendment to the Montreal Protocol

"Act on Rational Use and Proper Management of Fluorocarbons" (revised in 2015)
- Regulation on emission of CFC/HCFC/HFCs (abbr. Fgas Act)
- Target GWP and year for each product group

"High Pressure Gas Safety Act" (revised in 2016)
- Regulation on safety of flammable (toxic) gas
- Method of safe use of products and refrigerants
- A2L refrigerants are included as "particular inert gas"

"Global Warming Countermeasure Plan" (Cabinet Decision in 2016)
- Regulation on emission of energy origin CO₂
### 2. Regulations relate to F-gases in Japan

2) Regulation of refrigerant by “designated products”

Regulated by “Act on Rational Use and Proper Management of Fluorocarbons”

<table>
<thead>
<tr>
<th>Designated Products</th>
<th>Target GWP (Weighted Average GWP)</th>
<th>Target year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential A/Cs (Mini-Split)</td>
<td>750</td>
<td>2018</td>
</tr>
<tr>
<td>Commercial A/Cs (Split / smaller than 6HP*)</td>
<td>750</td>
<td>2020</td>
</tr>
<tr>
<td>Mobile A/Cs</td>
<td>150</td>
<td>2023</td>
</tr>
<tr>
<td>Condensing unit &amp; refrigerating unit</td>
<td>1500</td>
<td>2025</td>
</tr>
<tr>
<td>Cold storage warehouses</td>
<td>100</td>
<td>2019</td>
</tr>
<tr>
<td>Urethane foam</td>
<td>100</td>
<td>2020</td>
</tr>
<tr>
<td>Dust blowers</td>
<td>10</td>
<td>2019</td>
</tr>
</tbody>
</table>

* Capacity range of the category is defined as “smaller than 3 tons of refrigeration capacity per day” specified in “Refrigeration safety Regulation”. The value corresponds to approximately 6 HP models which has a rated cooling capacity of 15kW. The calculation formula of the tonnage can be found in the regulation.
2. Regulations relate to F-gases in Japan
2) Regulation of refrigerant by “designated products”

Regulated by “Act on Rational Use and Proper Management of Fluorocarbons”

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<tr>
<td>Residential A/Cs (Mini-Split)</td>
<td>750</td>
<td>2018</td>
</tr>
<tr>
<td>Commercial A/Cs (Split / smaller than 6HP*)</td>
<td>750</td>
<td>2020</td>
</tr>
<tr>
<td><strong>Larger Commercial A/Cs</strong> (Split / exclude VRF)</td>
<td>750</td>
<td>2023</td>
</tr>
<tr>
<td><strong>Centrifugal (Turbo) Chillers</strong></td>
<td>100</td>
<td>2025</td>
</tr>
<tr>
<td>Mobile A/Cs</td>
<td>150</td>
<td>2023</td>
</tr>
<tr>
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<td>2020</td>
</tr>
<tr>
<td>Dust blowers</td>
<td>10</td>
<td>2019</td>
</tr>
</tbody>
</table>

Two product categories will be added in April 2019.
2. Regulations relate to F-gases in Japan
3) HFC phase down latest status in Japan under Kigali Amendment

We are here!

Prospect amount of HFC use in Japan. The line can be kept in case the target GWP and year for designated products are met.
3. Actions to shift low-GWP refrigerants

1) JRAIA’s Vision and Activities on Environmental Conservation

**EQUIPMENT**

Energy Saving
- Energy Efficiency
- Emission control on CO₂ basis

**REFRIGERANTS**

Direct Emission Control
- Promotion of recovery
- Measures against leakage (proper management of refrigerants)
- Reduction of amount charged into equipment

**ALTERNATE REFRIGERANTS**

Acceleration to shift to new refrigerants
- Research of low GWP refrigerants
- Risk Assessment

1) JRAIA’s Vision and Activities on Environmental Conservation

- Act on Rational Use & Proper Management of Fluorocarbons
- Home Appliances Recycling Act
- EoL Automotive Recycling Act
- High Pressure Gas Safety Act
3. Actions to shift low-GWP refrigerants

2) Key Concept for Refrigerants Conversion

S: Safety
- Low Toxicity
- Low Flammability

E: Environment Performance
- Zero Ozone Depletion Potential (ODP)
- Low Global Warming Potential (GWP)

E: Energy Efficiency
- High Seasonal Efficiency
- Similar performance at high load cooling

E: Economic Feasibility
- Low Capital Cost
- Low Operating Cost
### 3. Actions to shift low-GWP refrigerants

#### 3) 6 Steps to introduce products using alternative (flammable) refrigerant

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
</table>
| Step 1 | Selection of candidate refrigerants  
  - Efficiency, Reliability, Compatibility with lubricating oil, etc. |
| Step 2 | Study on product safety  
  - Risk assessment by product, Development of new standards and guidelines, etc. |
| Step 3 | Compliance with safety standards  
  - Ensuring safety to be complied with national and international standards. |
| Step 4 | Consistency with safety regulations  
  - New standards and guidelines, Relaxation of Building Codes. |
| Step 5 | Study on market acceptability  
  - Risk mitigation by safety devices (ventilator, gas sensor, shutoff valve, etc.)  
  - Education/promotion on additional safety measures to the market. |
| Step 6 | Product launch  
  - Sales strategy against price hike, Subsidy, Service training, Spare parts supply, etc. |
3. Actions to shift low-GWP refrigerants

4) Timeline of Step 2 : Risk assessment by product

### A2L refrigerant risk assessment has difficulty and long period

<table>
<thead>
<tr>
<th>Product Type</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential A/Cs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial A/Cs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>R32 residential models launched.</td>
</tr>
<tr>
<td>VRF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chiller</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>HFO centrifugal chillers launched.</td>
</tr>
<tr>
<td>Built-in Ref. Display Cabinets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (Refrigeration equipment)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **R32 residential models launched.**
- **R32 light commercial models launched.**
- **HFO centrifugal chillers launched.**

New Risk assessment for **A3 Refrigerant**.
3. Actions to shift low-GWP refrigerants

5) Risk Assessment of Residential A/Cs using A3 Refrigerants - Outline (1/2)

Project Outline

- Along with the global trend to tackle with the safe use of A3 refrigerants, JRAIA will propose safety ensured air-conditioners using A3 for domestic application through this study.
- Based on the results of risk assessment of Residential A/Cs using A2L refrigerants, JRAIA also conducts risk assessment for A3 refrigerants and recommends measures to ensure safety of the products sold in Japanese market.
- JRAIA collaborates with universities and research institutes to compare hazards of A2L refrigerants with A3.

<table>
<thead>
<tr>
<th>Project Milestones</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Risk assessment</strong></td>
<td>Preparatory study</td>
<td>Risk Assessment</td>
<td>Risk reduction</td>
</tr>
<tr>
<td><strong>Hazard estimation</strong></td>
<td>Preparatory study</td>
<td>Hazard estimation</td>
<td>Reduction effectiveness</td>
</tr>
</tbody>
</table>

Kobe Symposium 2018

NEDO Project
Abstract of presentations at Kobe Symposium 2018

- Perform risk assessment based on the life cycle stage of Residential A/Cs.
  - Study ignition sources exist in surroundings of indoor and outdoor units.
  - Extract ignition sources used for transportation, installation, service, and recyle stages.
  - Simulate the flammable space-time volume by CFD for each stage.
  - Derive ignition probability from encounter rate of ignition source and flammable space-time volume.

- In order to use A3 refrigerants for Residential A/Cs, WG will present safe working procedures for safety-ensured equipment, installation and service, and will also provides concept of guideline of appropriate installation methods.

To find out results of the project, please come to Kobe Symposium held in 6th - 7th December 2018!
4. Low-GWP Alternatives and Products

1) World market trend of Residential & Commercial A/Cs

Global sales in 2017: 110.56M-units

- XX%: Share of Residential A/Cs with A2L
- YY%: Share of Commercial A/Cs with A2L
4. Low-GWP Alternatives and Products

2) Market shift to A2L refrigerant in Japan

**Residential A/Cs**

<table>
<thead>
<tr>
<th>Year</th>
<th>R410A (GWP=2088)</th>
<th>R32 (GWP=675)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>2013</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>2014</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>2015</td>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td>2016</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>2017</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Commercial A/Cs**

<table>
<thead>
<tr>
<th>Year</th>
<th>R410A</th>
<th>R32</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>2013</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>2014</td>
<td>60%</td>
<td>40%</td>
</tr>
<tr>
<td>2015</td>
<td>40%</td>
<td>60%</td>
</tr>
<tr>
<td>2016</td>
<td>20%</td>
<td>80%</td>
</tr>
<tr>
<td>2017</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

**Requirement of Fgas Act**

- **Target GWP**: 750
- **Target year**: 2018

- **Requirement of Fgas Act for under 6HP models**
- **Target GWP**: 750
- **Target year**: 2020
### 4. Low-GWP Alternatives and Products

3) Refrigerant conversion status in each product sector

<table>
<thead>
<tr>
<th>Product Category</th>
<th>Number of Units in 2017FY (x 1,000)</th>
<th>Conventional Refrigerants ⇒ Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential A/Cs</td>
<td>9,054.6</td>
<td>R410A ⇒ R32 ⇒ ?</td>
</tr>
<tr>
<td>Commercial A/Cs</td>
<td>827.1</td>
<td>R410A ⇒ R32 (for small single split models) ⇒ ?</td>
</tr>
<tr>
<td>Gas engine-driven A/Cs</td>
<td>28.7</td>
<td>R410A</td>
</tr>
<tr>
<td>Residential H/P Water Heaters</td>
<td>446.7</td>
<td>CO₂ (R744) / R32</td>
</tr>
<tr>
<td>Commercial H/P Water Heaters</td>
<td></td>
<td>R410A ⇒ CO₂ (R744) / R454C</td>
</tr>
<tr>
<td>Water Chilling Units</td>
<td>12.2</td>
<td>R410A / R407C / R404A / R134a ⇒ ?</td>
</tr>
</tbody>
</table>
| Centrifugal (Turbo) Chillers            | 0.266                               | LP : R245fa ⇒ R1233zd(E) / R1224yd(Z) / R514A  
                                         |                                      | HP : R134a ⇒ R1234ze(E) / R1234yf        |
| Commercial Built-in Ref. Cabinets       | 184.8                               | R404A / R410A / R134a ⇒ ?                |
|                                         |                                     | R600a / CO₂ (R744)                       |
| Commercial Ref. Cabinets / split        | 128.0                               | R404A ⇒ R410A ⇒ R448A / R449A / R407H / R463A ⇒ ? |
|                                         |                                     | CO₂ (R744)                               |
| Condensing Units                        | 93.4                                | R404A / R410A / R134a ⇒ ?                |
| Refrigeration Units                     | 28.3                                | R404A / R410A / R134a ⇒ ?                |
| Automobile A/Cs                         | (4,700)                             | R134a ⇒ R1234yf (CO₂ (R744))             |
| Vending Machines                        | (320)                               | R404A / R134a ⇒ R600a / CO₂ (R744) / R1234yf |
| Domestic Refrigerators                  | (4,400)                             | R600a                                    |
4. Low-GWP Alternatives and Products
4) RACHP products using lower GWP refrigerants sold in Japan

- **Residential mini-split Air Conditioners (Heat Pumps)**
  - 10 manufacturers
  - Capacity: 2.2 - 9.0 kW
  - POM: since 2012

- **Light Commercial mini-split Air Conditioners (Heat Pumps)**
  - 6 manufacturers
  - Capacity: 3.5 - 14.0 kW
  - POM: since 2013

**Refrigerant:** R32 [A2L / GWP675]
* Conventional ref.: R410A (GWP2088)

GWP 68% down!
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- **Residential Water Heater - Air Source Heat Pumps (Eco Cute)**
  - 8 manufacturers
  - Capacity (@65°C): 4.5 - 7.5 kW
  - POM: since 2001

- **Commercial Water Heater - Air Source Heat Pumps (Eco Cute)**
  - 8 manufacturers
  - Capacity (@65°C): 4.4 - 74.0 kW
  - POM: since 2006

**Refrigerant: CO₂ (R744) [A1 / GWP1]**

* Conventional ref.: R410A (GWP2088)

Natural refrigerant!
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- **Panasonic Refrigeration (Condensing Unit)**
  - Model: OCU-CR series
  - Capacity (@Te= -10°C): 4 – 30 kW
  - POM: September 2010
  - Refrigerant: CO₂ (R744) [A1 / GWP1]

  ![Image of Panasonic Refrigeration Units]

  **Natural refrigerant!**

  Also available in Europe
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- Toshiba Carrier Refrigeration (Condensing Unit)

  Model: TAM_AT-SV series
  Capacity (@Te= -10°C): 0.8 - 6.3 kW
  POM: November 2016
  Refrigerant: R448A [A1 / GWP1387]

* Conventional ref.: R404A (GWP3922)

GWP 65% down!
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- **Hitachi Appliance Refrigeration (Condensing Unit)**
  
  **Model**: KX-T_AMV series  
  **Capacity (@Te= -10°C)**: 14 – 18 kW  
  **POM**: September 2017  
  **Refrigerant**: R448A [A1 / GWP1387]
  
  * Conventional ref.: R404A (GWP3922)

- **GWP 65% down!**
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- **Mitsubishi Electric Refrigeration (Condensing Unit)**

  Model: EcoV DUAL series  
  Capacity (@Te= -10°C): (17 kW)  
  POM: Q3-Q4 2018


  * Conventional ref.: R404A (GWP3922)

  GWP 62% down!
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- Mitsubishi Heavy Industries Thermal Systems Refrigeration (Condensing Unit)
  - Model: HCCV1001,2001M
  - Capacity (@Te= -10°C): 16 - 32.5 kW
  - POM: April 2017
  - Refrigerant: CO₂ (R744) [A1 / GWP1]

* Natural refrigerant!
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- **Daikin Industries**
  Module Chiller
  
  Model: HEXAGON Force 32 series
  Capacity: 85 – 180 kW
  POM: November 2018
  
  Refrigerant: R32 [A2L / GWP675]
  
  * Conventional ref.: R410A (GWP2088)

GWP 68% down!
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

Mitsubishi Heavy Industries Thermal Systems
Industrial and Commercial Water Heater Heat Pump

Model: EQA401
Capacity: 40 kW (max 50 kW)
POM: December 2018

Refrigerant: R454C [A2L / GWP148]
* Conventional ref.: R410A (GWP2088)

GWP 93% down!
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- **Trane (Ingersoll Rand)**
  - Centrifugal Chiller
  - Model: CVHH / CDHH series
  - Capacity: 800 - 4000 USRt
  - POM: November 2014
  - Refrigerant: R1233zd(E) [A1 / GWP1] (IPCC-AR5)
    - * Conventional ref.: R123 (GWP77)
  - Model: CVHE / CVHG / CVHF series
  - Capacity: 200 - 1200 USRt
  - POM: March 2017
    - * Conventional ref.: R123 (GWP77)

Available Worldwide except Europe & China
4. Low-GWP Alternatives and Products

4) RACHP products using lower GWP refrigerants sold in Japan

- Mitsubishi Heavy Industries Thermal Systems
  - Centrifugal Chiller
    - Model: ETI-Z series
    - Capacity: 150 - 7000 USRt
    - POM: September 2015
    - Refrigerant: R1233zd(E) [A1 / GWP1] (IPCC-AR5)
      * Conventional ref.: R134a (GWP1300)

- Model: GART-ZE / ZEI series
  - Capacity: 300 - 5000 USRt
  - POM: April 2017
  - Refrigerant: R1234ze(E) [A2L / <GWP1] (IPCC-AR5)
    * Conventional ref.: R134a (GWP1300)
4. Low-GWP Alternatives and Products
4) RACHP products using lower GWP refrigerants sold in Japan

- **Ebara Refrigeration Equipment & Systems**
  - **Centrifugal Chiller**
  - Model: RTBA / RTBA-V series
  - Capacity: 220 - 1250 USRt
  - POM: April 2018

**Refrigerant: R1224yd(Z) [A1 / <GWP1] (IPCC-AR5)**

* Conventional ref.: R245fa (GWP1030)
#13 International Symposium for New Refrigerants and Environmental Technology 2018

**THE INTERNATIONAL SYMPOSIUM**

NEW REFRIGERANTS and ENVIRONMENTAL TECHNOLOGY 2018

**Contents**
- Environment Issue
- New Refrigerants and Their System
- Safety of Refrigerants / Risk Assessment
- Energy Conservation
- Compressors and Lubricants

**December 6 (Thu) – 7 (Fri). 2018**

International Conference Center Kobe, Main Hall, Kobe, Japan

**Save the date!**

Organizer
The Japan Refrigeration and Air Conditioning Industry Association (JRAIA)
Kikai Shinko Bldg. 201, 5-8, Shibakoen 3-chome, Minato-ku, Tokyo 105-0011, JAPAN
Tel: +81-3-3432-1671 Fax: +81-3-3438-0308
thttp://www.jraia.or.jp/english/index.html

To find out the latest information, please visit the Web site!
JRAIA hosts the Symposium, so-called “Kobe symposium”, which has been held every two years since 1994.

Photos below are from #12 Symposium held in December 2016.

Luminarie Festival starts 7th Dec at city center!
## Appendix.

### 1) JRA Standards and Guidelines (1)

<table>
<thead>
<tr>
<th>products</th>
<th>No. of Std. or GL.</th>
<th>Title</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>refrigerant leak detector and alarm</td>
<td>JRA 4068</td>
<td>“Requirements of refrigerant leak detector and alarm for air conditioning and refrigeration equipment”</td>
<td>ISO 5149-1, -3:2014</td>
</tr>
<tr>
<td>refrigerant leakage from refrigerating and air conditioning equipment</td>
<td>JRA GL14</td>
<td>“Guideline for prevention of refrigerant leakage from refrigerating and air conditioning equipment and systems using fluolocarbon”</td>
<td>ISO 14903</td>
</tr>
<tr>
<td>chiller</td>
<td>JRA GL15</td>
<td>“Guideline of design construction for ensuring safety against refrigerant leakage from chiller using lower flammability(A2L) refrigerants”</td>
<td>ISO 5149-2, -3, -4, IEC 60335-2-40, IEC 60079-10-1</td>
</tr>
<tr>
<td>commercial air conditioners</td>
<td>JRA 4070</td>
<td>“Requirements for ensuring safety against refrigerant leakage from commercial air conditioners using lower flammability(A2L) refrigerants”</td>
<td>ISO 5149-1, -2, -3, -4, ISO 5149-1/Amd1</td>
</tr>
<tr>
<td></td>
<td>JRA GL16</td>
<td>“Guideline of design construction for ensuring safety against refrigerant leakage from commercial air conditioners using lower flammability(A2L) refrigerants”</td>
<td>ISO 5149-1, -2, -3, -4, ISO 5149-1/Amd1</td>
</tr>
</tbody>
</table>
## 1) JRA Standards and Guidelines (2)

<table>
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<th>Title</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>commercial refrigeration equipment</td>
<td>JRA 4072</td>
<td>“Requirements for ensuring safety against refrigerant leakage from commercial refrigeration equipment using lower flammability(A2L) refrigerants”</td>
<td>ISO 14903, IEC 60079-10-1:2015, IEC 60335-2-40:2013</td>
</tr>
</tbody>
</table>
Thank you for your attention!!