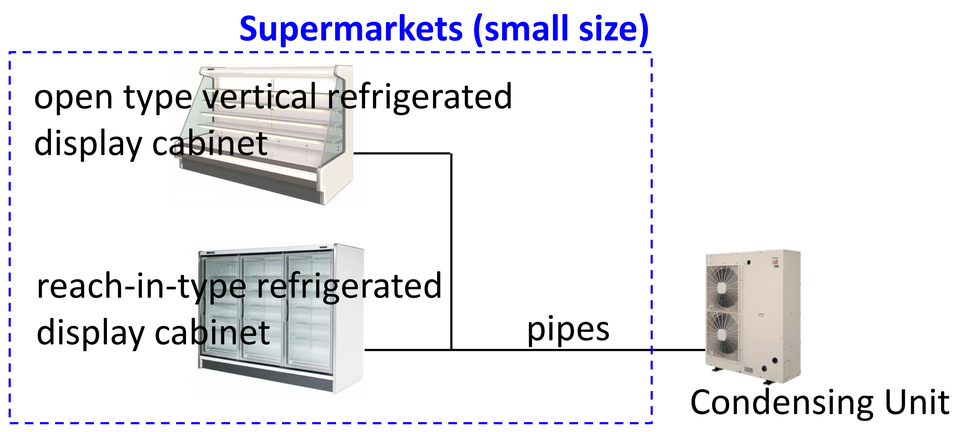
Risk Assessment for Commercial Refrigerating appliance

JRAIA The Japan Refrigeration and Air Conditioning Industry Association

Working Group for Risk Assessment of Lower Flammability Refrigerant

Introduction

[Subject system] Commercial Refrigerating appliance using A2L
[Refrigerants (A2L)] R32, R1234yf, R1234ze(E)
[Model of risk assessment]
Refrigerated display cabinet installed in Supermarkets



Conclusion

Risk cases	< Dominant risk factors >		Usage stage	Installation/ Service stages	Disposal stage
	Cause	Leakage gas retention	Ignition sources	Human error	
	Factor	High concentration	Cooker, Heater	Refrigerant recovery Gas burner	Refrigerant recovery Electrical wiring
Leakage on joint parts of upper pipes	Safety measures		"Outputting an alarm with a leak detector"		
			"Education for store staffs"	"Education for workers" and "Carrying a portable leak detector"	
Leakage on joint parts of pit pipes / Leakage in display area of Open type	Safety measures		"Outputting an alarm with a leak detector" and "Fan operating with a leak detector"		
			"Education for store staffs"	"Education for workers" and "Carrying a portable leak detector"	
Leakage in display area of Reach-in type	Safety measures		"Outputting an alarm with a leak detector" and "Closing a shut-off valve"		
			"Education for store staffs"	"Education for workers" and "Carrying a portable leak detector"	

- In all cases, the amount of refrigerant is limited.（a quarter of LFL or less）.
- It is required to install a leak detector.

System / Installation

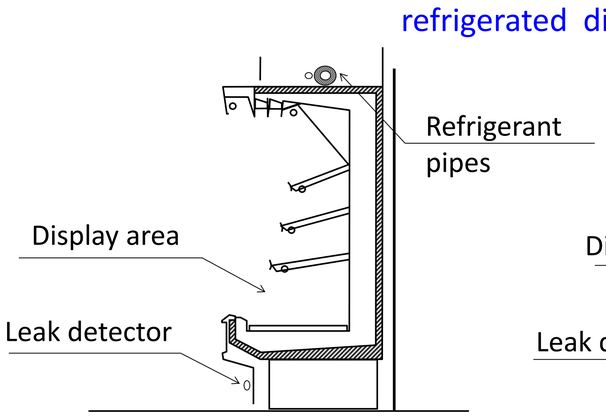
- Cooling capacity: 5.0 ~ 40.0 kW (ET=-10℃)
- Charge amount of refrigerant: 20 kg
  (the maximum charged amount for Model of risk assessment)
- Type : Setting one or more than one Refrigerated display cabinet to one Condensing Unit
- Total number of Refrigerated display cabinet : about 1.3 million in Japan
- User: Supermarket etc.

Risk case / Safety measures

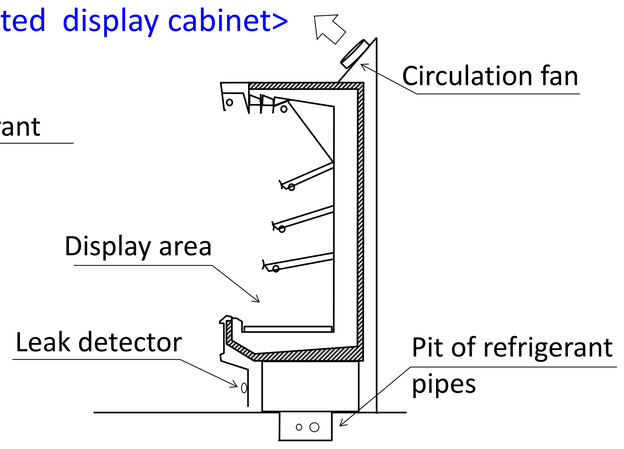
[Refrigerated display cabinet]

- Refrigerant pipes joint : Top of refrigerated display cabinet / Pit of refrigerant pipes
- Leakage location : Joint parts of upper pipes / Joint parts of pit pipes / Display area
- Safety measures : Leakage from joint parts of pit pipes・・・Leak detector + Circulation fan
  Leakage in display area of Open type・・・ Leak detector + Circulation fan
  Leakage in display area of Reach-in type・・・ Leak detector + Shut-off valve, Check valve

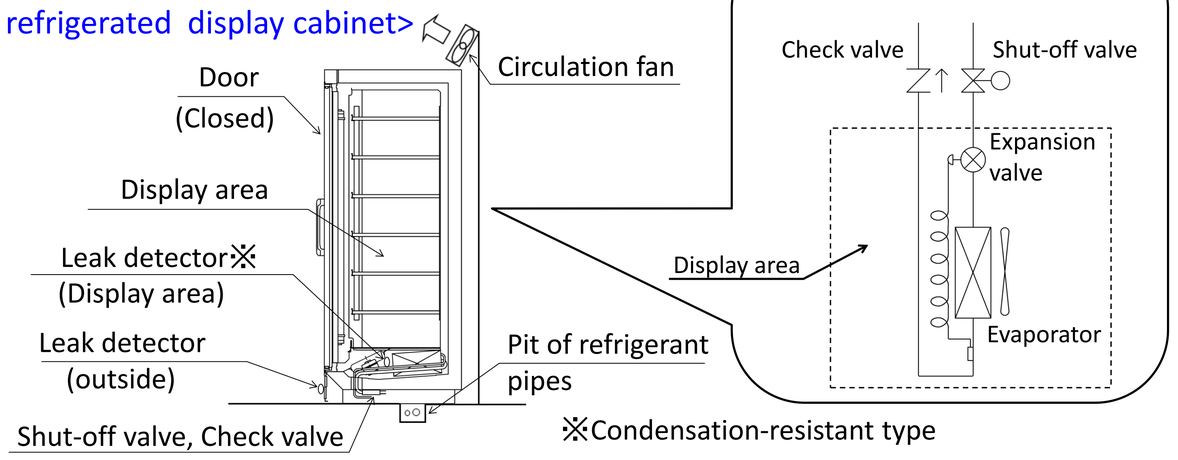
<Construction of upper pipes>



<Construction of pit pipes of open type refrigerated display cabinet>



<Construction of pit pips of reach-in-type refrigerated display cabinet>



Concerning showcases,
the brazing for the pit pipes is often performed. To conduct RA strictly, the joint parts of pipes which are brazed are set as the leakage point.

Ignition source

[Spark]
- Match, Oil lighter

[Open flame]
- Match, lighter
- Combustion equipment (Cooker, Heater, etc.)
- Gas burner (for brazing)

※ The places where ignition sources such as cookers and etc. are installed cannot be controlled. The measures shall be taken under all conditions, then ensures safety.

Flammable volume-time integration

- **Refrigerated display cabinet**

Leak location		Floor area	Amount of the refrigerant	Leak rate	Flammable volume-time integration
		m^2	kg	kg/h	$m^3 \cdot min$
Open type	Joint parts of upper pipes	84.7	20	10	4.23
	Joint parts of pit pipes	84.7	20	75	610.2
	Display area	84.7	20	75	2103.0
Reach-in type	Display area (with safety measures)	84.7	20	75	0.0016

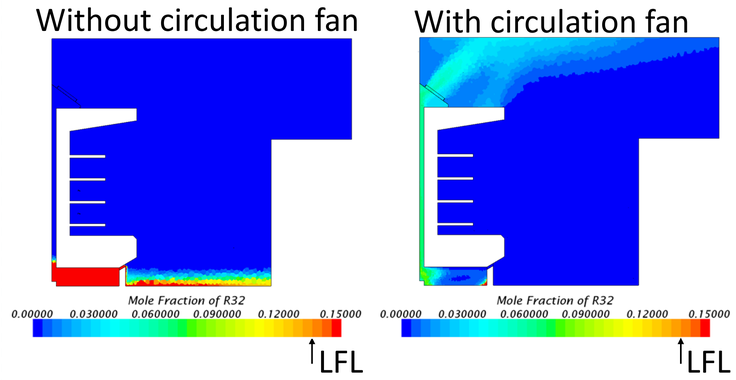
⇒From the result of RA, in the case of the leakage on the joint part of the pit pipe and in the display area of open type, it is necessary to circulate with a circulation fan.
Reach-in type is sealed, therefore, safety measures are required, then RA is conducted.

Risk assessment

- **Effect of safety measures**

[Open type]

Without circulation fan / With circulation fan



⇒Circulating the refrigerant with a circulation fan, then ensuring safety

- **Result (Refrigerant: R32)**

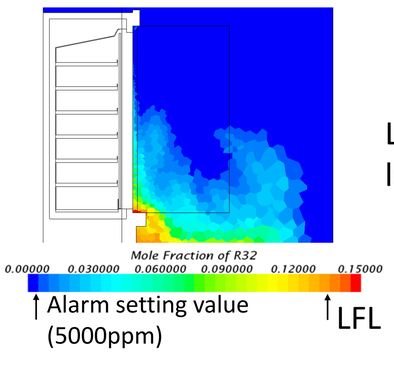
Life stage [allowable level]	Installation (modification) [≦ 2.0×10^{-7}]		Usage [≦ 2.0×10^{-8}]		Service [≦ 2.0×10^{-7}]		Disposal [≦ 2.0×10^{-7}]	
Safety measures	without	with	without	with	without	with	without	with
Open type	7.56×10^{-6}	8.21×10^{-8}	2.80×10^{-8}	5.51×10^{-11}	8.89×10^{-4}	4.43×10^{-8}	3.38×10^{-6}	1.80×10^{-8}
Reach-in type	7.68×10^{-7}	8.89×10^{-9}	4.11×10^{-10}	8.45×10^{-11}	2.23×10^{-5}	5.12×10^{-9}	4.70×10^{-8}	2.53×10^{-10}

※As for Reach-in type, we have conducted a risk assessment of when the door is opened, as it becomes risk higher when the door is opened in the event of leakage in display area.

RA of the Commercial Refrigerators and Freezers which is another main use of the Commercial Refrigerating appliance is proceeded in the future (August, 2016 – June, 2017）.

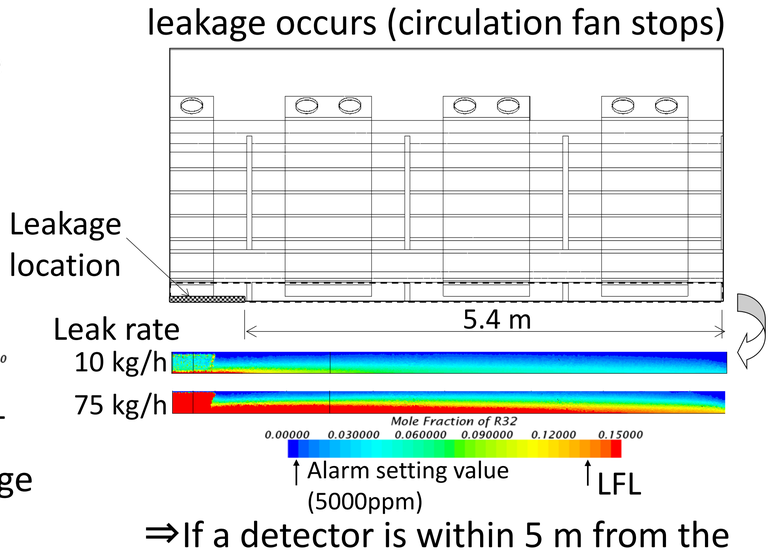
[Reach-in type]

With safety shut-off valve



⇒Shutting off the leakage by the shut-off valve, then ensuring safety

Concentration distribution when leakage occurs (circulation fan stops)



⇒If a detector is within 5 m from the leakage point, it is possible to detect.

Documentation

1. Guideline of design construction for ensuring safety against refrigerant leakage from commercial refrigerating appliance lower flammability (A2L) refrigerants JRA GL-18 : 2016
2. Requirements for ensuring safety against refrigerant leakage from commercial r refrigerating appliance using lower flammability (A2L) refrigerants JRA 4072 : 2016