JRAIA
The Japan Refrigeration and Air Conditioning Industry Association

Risk assessment for A3 Chiller

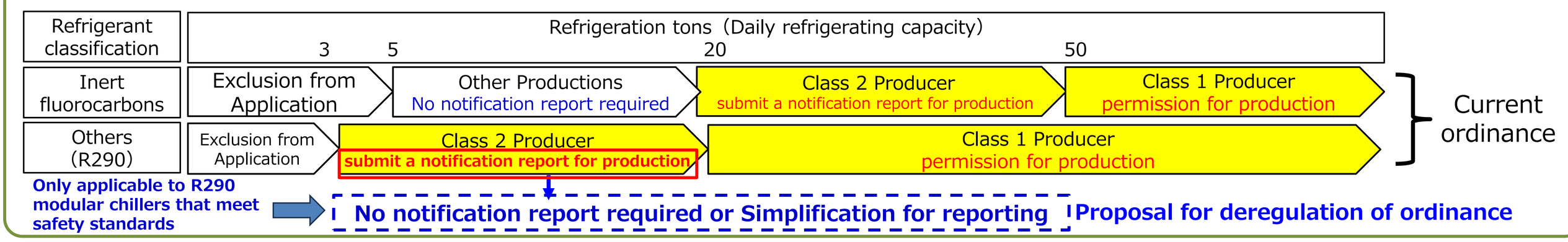
Chiller risk assessment WG3

Purpose of activities

◇In preparation for carbon neutral by 2050, R290（Propane）chillers are beginning to launch on the European market.

◇However, Japan has a High-Pressure Gas Safety Act（Refrigeration Safety Ordinance）, which requires safety considerations and compliance for the launch of R290 chillers. Under the High-Pressure Gas Safety Act, flammable gas refrigeration equipment requires a notification report for production 3 tons or more and less than 20 tons and a permission for production for 20 tons or more. In order to replace current inert gas chillers, deregulation of these requirements must be considered.

◇Therefore, Chiller risk assessment WG3 is working to limit the scope of application to R290 air-cooled modular chillers less than 20 tons that are equipped with leak detectors and fan agitation functions in the event of a refrigerant leak and meet safety standards, aiming to eliminate or simplify the notification report for production required for class 2 producer.



Examination of the R290 chiller risk assessment model

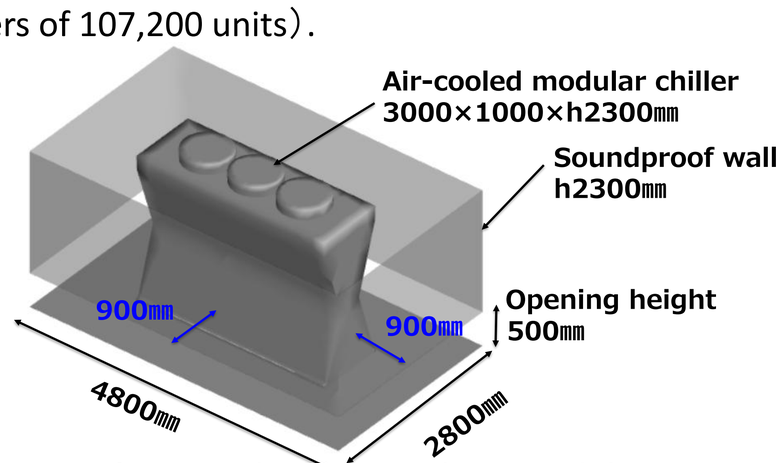
We are currently investigating the number of chillers in use, their installation environment, structure, refrigerant charge, etc., and are considering outdoor R290 air-cooled chillers surrounded by soundproof walls and their life stages.

The tolerance value is 1.0×10^{-8}, the level of an accident occurring less than once in 100 years during usage, and taking into account that work is carried out by specially trained workers, it can be adjusted at 9.33×10^{-7}, one order of magnitude higher than the once-in-100-year accident level of 9.33×10^{-8}（1/107,200/100）。（based on an estimated domestic market stock of air-cooled chillers of 107,200 units）.

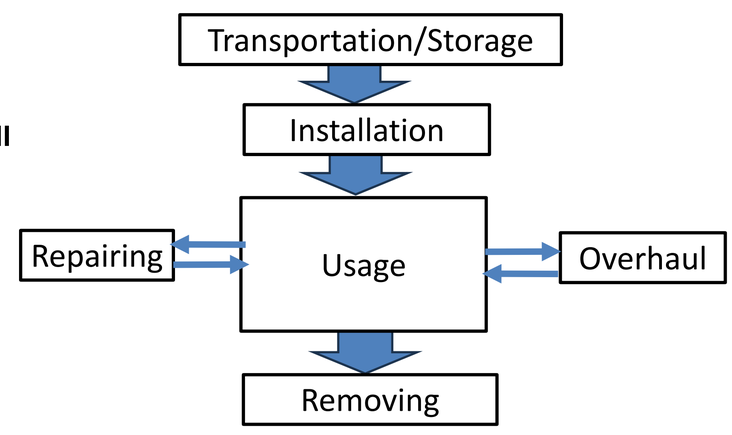
R290 modular chiller specifications

Refrigerant	R290（A3）	R32（A2L）
Cooling capacity	**180 kW**	180 kW
Refrigeration tons	**less than 20**	less than 20
Refrigerant circuits	**4 circuits**	4 circuits
Refrigerant charge*	**5 kg**	10 kg
Installation location	**Outdoors**	Outdoors
Refrigerant Leak Rate	**40.71kg/h**	75kg/h

*Per refrigerant circuit



Refrigerant leakage analysis model



Life stages of chillers

R290 chiller ignition scenario and refrigerant leak analysis results

①Ignition scenarios and safety measures

The ignition scenarios for the usage and removing life stages under consideration are shown. Based on the scenarios, FTA（Fault Tree Analysis）and safety measures to reach the tolerance value are being considered.

Life stages	Main ignition source (height, duration)	Refrigerant leak scenarios	Ideas of safety measure
Usage	Control power panel breaker（0.3m,5msec.） ・Electromagnetic switch（0.3m, 5msec.） ・Terminal block（0.3m, 5msec.）	Refrigerant leakage due to equipment aging ・Leakage from the air heat exchanger ・Leakage from the unit floor panel	**●Safety Measures for R290 Modular Chillers** ・Installation of an in-unit refrigerant leak detector ・Operation of the unit fan in the event of a refrigerant leak ***If a refrigerant leak is detected, the unit fan ventilates to prevent the creation of a flammable area.**
Removing	・Smoking（1.55m,45sec.） ・Static electricity（0.58m,1 μ sec.） ・Brush motor electric screwdriver（0.29m,3sec.） ・Sparks from grinding（0.2m,15sec.）	・Refrigerant leakage due to work error（Forgetting to tighten the hose, etc.） ・Release of refrigerant from unit into the atmosphere when removing（Release that create flammable area） ・Leakage from refrigerant dissolved in refrigeration oil	**●Safety measures during working** ・No open flames near the unit ・Carry a portable leak detector ・Use ventilation fans in the working area ・Wear anti-static gloves ・Release refrigerant without creating a flammable area ・Use a vacuum pump to recover refrigerant dissolved in refrigerant oil

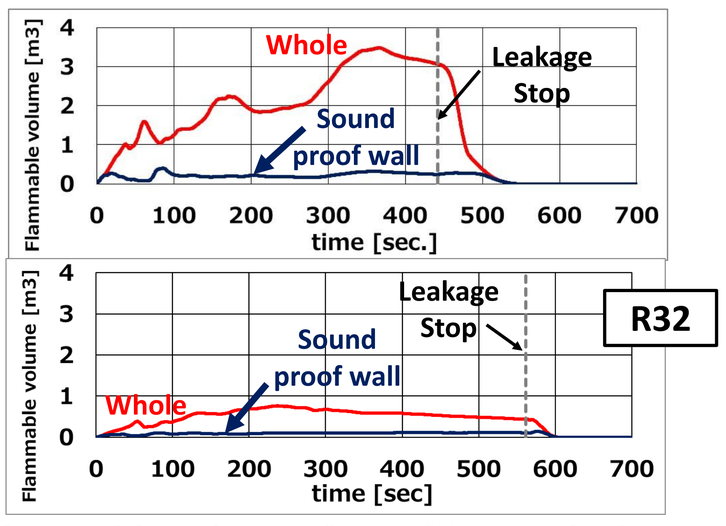
Technical standard for R290 modular chillers (requirement for deregulation of the ordinance)

Create guidelines for the safe operation of R290 modular chillers

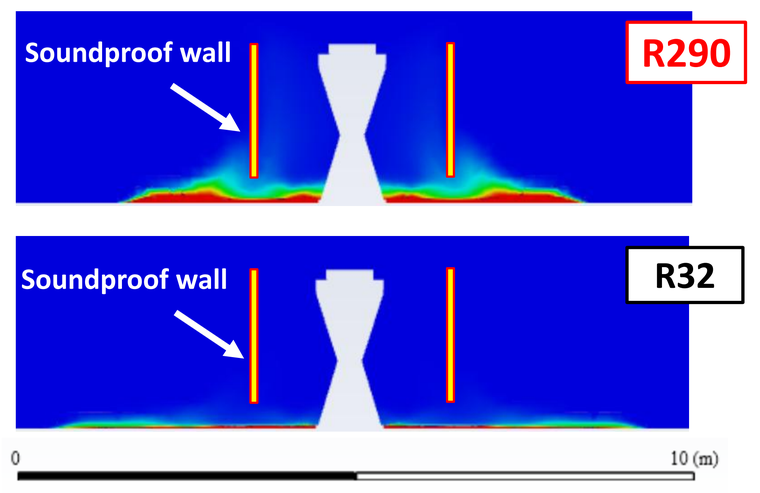
②Refrigerant leak analysis results

This shows the results of a refrigerant leak analysis when a refrigerant leaks from the unit floor panel (natural wind is present). When R290 leaks, the average flammable space volume is significantly larger than that of R32, but the flammable space is only generated at a height of 0.33 m or less. In the future, we plan to consider cases where the leak height is higher.

Space	item	unit	R290	R32
Sound proof wall	Volume-time integration	m³・min	**1.9**	0.9
	Duration of flammable region	min	**8.7**	9.4
	Average flammable volume	m³	**0.22**	0.10
Whole	Volume-time integration	m³・min	**17.4**	5.1
	Duration of flammable region	min	**8.7**	10.0
	Average flammable volume	m³	**2.0**	0.5
	Maximum flammable height	m	**0.33**	0.05
	Flammable distance	m	**9.8**	6.4



Flammable volume after refrigerant leakage



Flammable space after refrigerant leakage

Plans

Based on the risk assessment, technical standards and safety guidelines for safety measures for R290 modular chillers will be created by fiscal year 2028. Specific negotiations regarding deregulation of R290 modular chillers are scheduled to begin in early fiscal year 2026.