JRA

STANDARD OF
THE JAPAN REFRIGERATION AND
AIR CONDITIONING INDUSTRY ASSOCIATION

Requirements of refrigerant leak detector and alarm for air conditioning and refrigeration equipment

JRA 4068T : 2016R

Translated and Published by
The Japan Refrigeration and
Air Conditioning Industry Association

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

Contents

Page

Standard of the Japan Refrigeration and Air Conditioning Industry Association

Requirements of refrigerant leak detector and alarm for air conditioning and refrigeration equipment

JRA 4068T : 2016R

Introduction

This standard has been established for the standardization of the specifications for refrigerant leak detectors and alarms that are compliant with Refrigeration Safety Regulation under High Pressure Gas Safety Act and detectors and alarms that are non-compliant with the said regulations for greater ease in use for air conditioning and refrigeration equipment manufacturers, installation service operators and users and hence the wider promotion of the standards in the marketplace without any confusion.

1 Scope

This standard specifies the requirements for stationary refrigerant leak detectors and refrigerant leak detector-alarms used for implementing adequate safety measures in detecting the concentration of no flame propagation (A1) and lower flammability (A2L) refrigerants leaking from air conditioning and refrigeration equipment. However, this shall not apply to the following.

- Detectors and detector-alarms for air conditioning and refrigeration equipment with capacity of less than 3 legal tons of refrigeration as calculated under High Pressure Gas Safety Act
- Portable detectors
- Oxygen meters for measuring oxygen deficiency

2 Normative references

The following standards contain provisions which, through reference in this text, constitute the provisions of the standard herein. For dated references, only the cited edition applies. For undated references, the most recent edition (including any amendments) applies.

ASHRAE STANDARD 34 Designation and safety classification

ISO 817 Refrigerants -- Designation and safety classification

IEC 60529:2001 Degrees of protection provided by enclosures (IP CODE)

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

LFL: Lower Flammability Limit (lower explosive limit)

Minimum concentration of the refrigerant that is capable of propagation a flame through a homogeneous mixture of

the refrigerant and air as specified in **ISO 817**.

3.2

ODL: Oxygen Deprivation Limit

Concentration of a refrigerant designated to prevent physiological problems resulting from oxygen deficiency as specified in **ISO 817**.

3.3

ATEL: Acute-Toxicity Exposure Limit

The concentration of a refrigerant designated to prevent problems resulting from acute toxicity as specified in **ISO 817**.

3.4

RCL: Refrigerant Concentration Limit

Maximum refrigerant concentration in the air specified in **ISO 817** to reduce the risks of acute toxicity, oxygen deficiency and flammability hazards. The value for A1 refrigerants is determined by ODL and ATEL.

3.5

Detector

Device for detecting refrigerant gas concentration in the air and initiating specified signal output if detected concentration reaches the specified concentration value.

3.6

Detector-alarm

Device consisting of detector and alarm, configured either as integrated whole or in separate units, that detects refrigerant gas concentration in the air and initiates an alarm if detected concentration reaches the specified concentration value.

3.7

Configuration in separate units

System configuration in which the detector and the alarm are separate units, functioning as detector-alarm through interconnection between the units.

3.8

Stational type

Device that is installed on a fixed location, such as on wall in exterior space (inside a room, inside a machinery room, inside a semi-underground space, etc.) or interior space of air conditioning and refrigeration equipment (inside an indoor unit, inside an outdoor unit, etc.).

3.9

Test gas

Gas used for inspection and for testing. Recommended test gas is that with properties approximating the refrigerant gas to be detected.

3.10

Miscellaneous gases

Various gases other than the target refrigerant gas that exist in the atmosphere. The gases that are particularly important here are redox gases such as ethyl alcohol, hydrogen and ethylene that are likely to cause false alarms by the detector and the detector-alarm.

3.11

Specified concentration value

For a leak detector, the concentration (ppm) that initiates specified signal output. For a detector-alarm, the concentration (ppm) that initiates an alarm.

3.12

Maximum specified concentration value

The upper limit in concentration that assures refrigerant safety. The values are a quarter of LFL (ppm) for A2L refrigerants and a half of RCL (ppm) for A1 refrigerants.

3.13

Minimum specified concentration value

The lower limit in concentration that prevents false alarm triggered by miscellaneous gases. For A2L refrigerants, the value is a hundredth of LFL (ppm) or 1 000 ppm, whichever is larger. For A1 refrigerant, the value is a hundredth of RCL (ppm) or 1 000 ppm, whichever is larger. However, the value for CO_2 is 2 000 ppm。

3.14

Specified signal output

Signal, which may be analog signal, digital signal, point of contact, communication, etc., that shows that the gas concentration has reached the specified concentration value.

3.15

Indication

Function for indicating the detected concentration.

3.16

Control room

Location where relevant personnel are stationed on a full-time basis for implementing various measures if alarm is initiated.

3.17

Condensation-resistant type

Devices with performance levels that qualify in the condensation-resistance test specified in **10.9**, with resistance against condensation and freezing in sealed refrigerated display cabinets, such as reach-in-type refrigerated display cabinets, caused by opening/closing of the lid or door.

3.18

Waterproof property

Degree of waterproof protection specified in **IEC 60529** that are appropriate for the environment where used.

3.19

IPX3

Degree of waterproof protection specified in **IEC 60529** that are referenced as rainproof. Protection from spraying water is required.

4 Detector types

4.1 Detection method

Detection of change in the detection element with an electrical mechanism, based on semiconductor, infrared ray or

other methods.

4.2 Operating ambient temperature

The detector and the detector-alarm shall be functional in one of the following temperature ranges. However, the specifications may exceed the temperature ranges specified below.

Temperature range 1: -10 °C[1)] to 40 °C (Example of location: Inside the room or inside the refrigerator)

Temperature range 2: -20 °C to -10 °C (Example of location: Inside the freezer)

Temperature range 3: -30 °C to -10 °C (Example of location: Inside the freezer)

Temperature range 4: -40 °C to -20 °C (Example of location: Inside the freezer)

Temperature range 5[2)]: -30 °C to 50 °C (Example of location: Outdoors, etc.)

Note[1)]: 0 °C is acceptable as the lower limit in temperature for infrared ray type.

Note[2)]: The temperature range that guarantees designated accuracy is -10 °C to 40 °C.

4.3 Refrigerant types

The refrigerants regulated under the standard herein are refrigerants classified as A1 or A2L in **ISO 817** or **ASHRAE STANDARD 34**, those scheduled to be added to the classifications or those not regulated by the standards but whose physical properties are identified clearly and also detectable with either semiconductor or infrared ray type. The safety classifications of refrigerants as specified in **ISO 817** are shown in Table 1.

Table 1 – Safety classifications of refrigerants

Higher Flammability	A3	B3
Flammable	A2	B2
Lower Flammability	A2L	B2L
No flame Propagation	A1	B1
	No toxicity	Toxic

The gas concentration values for refrigerants designated in **ISO 817** and those scheduled to be included in the standard and values based on these values are shown in **Table 2**. It is to be noted that these are reference values. Concentration values may be determined in accordance with **ISO 817** or **ASHRAE STANDARD 34** also for other refrigerants. The specifications designated in these standards may also be applied and used. Refrigerants not designated in the standards may also make use of the specifications in this standard, both in application and in use, provided that they clearly possess physical properties necessary for detection and alarm specified in **Table 2**. It is to be noted that RCL-related values are not shown for A2L refrigerants, because the specified concentration values are determined by LFL-related values.

Table 2 – Values related to refrigerant gas concentration (informative)

Refrigerant	Safety classification	Type/chemical formula/structure	LFL (ppm)	LFL/4 (ppm)	LFL/100 (ppm)	RCL (ppm)	RCL/2 (ppm)	RCL/100 (ppm)
R12	A1	CFC (CCl_2F_2)				18 000	9 000	180
R22	A1	HCFC ($CHClF_2$)				59 000	29 500	590
R124	A1	HCFC ($CHClFCF_3$)				10 000	5 000	100
R125	A1	HFC (CHF_2CF_3)				75 000	37 500	750
R134a	A1	HFC (CH_2FCF_3)				50 000	25 000	500
R401A	A1	R22/152a/124 (53.0/13.0/34.0)				27 000	13 500	270

Table 2 – Values related to refrigerant gas concentration (informative) *(Continued)*

R401B	A1	R22/152a/124 (61.0/11.0/28.0)				30 000	15 000	300
R402A	A1	R125/290/22 (60.0/2.0/38.0)				66 000	33 000	660
R402B	A1	R125/290/22 (38.0/2.0/60.0)				63 000	31 500	630
R404A	A1	R125/143a/134a (44.0/52.0/4.0)				130 000	65 000	1 300
R407A	A1	R32/125/134a (20.0/40.0/40.0)				83 000	41 500	830
R407B	A1	R32/125/134a (10.0/70.0/20.0)				79 000	39 500	790
R407C	A1	R32/125/134a (23.0/25.0/52.0)				81 000	40 500	810
R407D	A1	R32/125/134a (15.0/15.0/70.0)				68 000	34 000	680
R407E	A1	R32/125/134a (25.0/15.0/60.0)				80 000	40 000	800
R410A	A1	R32/125 (50.0/50.0)				140 000	70 000	1 400
R410B	A1	R32/125 (45.0/55.0)				150 000	75 000	1 500
R417A	A1	R125/134a/600 (46.6/50.0/3.4)				13 000	6 500	130
R422A	A1	R125/134a/600a (85.1/11.5/3.4)				63 000	31 500	630
R422D	A1	R125/134a/600a (65.1/31.5/3.4)				58 000	29 000	580
R423A	A1	R134a/227ea (52.5/47.5)				59 000	29 500	590
R448A	A1	R32/125/1234yf/134a/1234ze(E) (26.0/26.0/20.0/21.0/7.0)				110 000	55 000	1 100
R449A	A1	R32/125/1234yf/134a(24.3/24.7/25.3/25.7)				100 000	50 000	1 000
R449B	A1	R32/125/1234yf/134a(25.2/24.3/23.2/27.3)				100 000	50 000	1 000
R450A	A1	R134a/1234ze(E) (42.0/58.0)				72 000	36 000	720
R452A	A1	R32/125/1234yf (11.0/59.0/30.0)				100 000	50 000	1 000
R500	A1	R12/152a (73.8/26.2)				30 000	15 000	300
R502	A1	R22/115 (48.8/51.2)				73 000	36 500	730
R507A	A1	R125/143a (50.0/50.0)				130 000	75 000	1 300
R509A	A1	R22/218 (44.0/56.0)				75 000	37 500	750
R744 (CO_2)	A1	CO_2				40 000	20 000	400
R513A	A1	R1234yf/134a (56.0/44.0)				72 000	36 000	720
R1233zd(E)	A1	HFO（$CF_3CH=CHCl$）				16 000	8 000	160
R32	A2L	HFC（CH_2F_2）	144 000	36 000	1 440			
R1234yf	A2L	HFO（$CF_3CF=CH_2$）	62 000	15 500	620			
R1234ze(E)	A2L	HFO（$CF_3CH=CHF$）	65 000	16 250	650			
R444A	A2L	R32/152a/1234ze(E) (12.0/5.0/83.0)	82 000	20 500	820			
R444B	A2L	R32/152a/1234ze(E) (41.5/10.0/48.5)	92 500	28 125	925			
R447A	A2L	R32/125/1234ze(E) (68.0/3.5/28.5)	65 000	16 250	650			
R447B	A2L	R32/125/1234ze(E) (68.0/8.0/24.0)	121 000	30 250	1 210			
R451A	A2L	R1234yf/134a (89.8/10.2)	70 000	17 500	700			
R452B	A2L	R32/R125/R1234yf (67.0/7.0/26.0)	119 000	29 750	1 190			
R454A	A2L	R32/1234yf (35.0/65.0)	63 000	15 750	630			
R454B	A2L	R32/1234yf (68.9/31.1)	77 000	19 250	770			

5 Performance

Detectors and detector-alarms for detecting refrigerant gas concentrations shall meet the requirements for Performance Criteria 1 or Performance Criteria 2 specified in **5.2** or Performance Criteria 3 in **5.3**. Additionally, if the installation of detector-alarms is required under regulations or the equivalent to those, a device that satisfies the criteria is required. The comparison of Performance Criteria 1 through Performance Criteria 3 are shown in **Table 3**. Only Performance Criteria 1 applies to infrared ray type detector and detector-alarm. Detectors and detector-alarms that cover CO_2 listed in **Table 2** are commonly infrared ray types.

Table 3 – Comparison of the Characteristics of the Performance Categories

Type	Accuracy	Detection delay	Alarm delay	Inspection	Replacement	Specified concentration value	Characteristics, suitable environment, etc.
Performance Criteria 1	Specified concentration value ±25 %	30 seconds	30 seconds	At least once per year	When criteria is not satisfied	Setting & alarm at high concentration level possible	High accuracy guaranteed at values close to specified concentration value; regular inspection of at least once per year required. Performance Criteria 1 only for infrared ray types.
Performance Criteria 2	Specified concentration value ±25 %	30 seconds	30 seconds	— (Not regulated)	5 years later (Continued use possible if calibration satisfies accuracy level 5 years later)	Setting & alarm at high concentration level possible	High accuracy guaranteed at values close to specified concentration value; inspection may be omitted for 5 years after installation. Suited to load side of refrigeration equipment and environments affected by miscellaneous gases.
Performance Criteria 3	1/100 of LFL – 1/4 of LFL (1/100 of RCL – 1/4 of RCL)	60 seconds	60 seconds	— (Not regulated)	5 years later	—	Alarm initiation within regulated range (a hundredth of LFL to a quarter of LFL) guaranteed for 5 years; replacement after 5 years. Suited to indoor environment of normal air conditioner because miscellaneous gas level is relatively low.

It is to be noted that the performance criteria specified here is for factory settings by the manufacturer. Additionally, if not specified, the factory settings for a detector and a detector-alarm are to be at the highest level in accuracy between the upper limit and lower limit of each temperature range.

5.1 General

The detector detects refrigerant gas concentration in the air and initiates specified signal output if detected concentration reaches the specified concentration value. The detector-alarm consists of a detector and an alarm, configured either as integrated whole or in separate units, that detects refrigerant gas concentration in the air and initiates specified signal output if detected concentration reaches the specified concentration value. The detector-alarm should preferably initiate specified signal output if detected concentration reaches the specified concentration value. The output of a detector and a detector-alarm is connected to the shut-off valve that shuts off the refrigerant flow, ventilation device for ventilation inside the room, alarm device for initiating alarm or external input to the air conditioning and refrigeration equipment, etc. Furthermore, the following provisions related to detection apply to detectors only and shall not apply to detector-alarms. However, the provisions related to detection shall apply also to detector-alarms if it is configured for direct output from the detection component of the detector-alarm. Additionally, condensation resistance specified in **5.2.8** and **5.3.7** shall be satisfied only when required of a condensation-resistant type.

5.2 Performance Criteria 1 and Performance Criteria 2

The detector and the detector-alarm of Performance Criteria 1 shall meet the provision in **5.2.1** - **5.2.5** and **5.2.6**. Those of Performance Criteria 2 shall meet the provision in **5.2.1** - **5.2.5** and **5.2.7**. The interval between inspections and replacement time specified in **8** vary on whether Performance Criteria 1 or Performance Criteria 2 applies. Also, Performance Criteria 1 only applies to infrared ray types.

5.2.1 Accuracy

5.2.1.1 Detection accuracy

For the detector, the difference between the specified concentration value and the concentration at specified signal output in the detection accuracy test 1 specified in **10.2.1** shall be within ±25 % of the specified concentration value specified in **7.1**.

5.2.1.2 Alarm accuracy

For the detector-alarm, the difference between the specified concentration value and the concentration at specified signal output and at alarm initiation in the alarm accuracy test 1 specified in **10.2.3** shall be within ±25 % of the specified concentration value specified in **7.1**.

5.2.2 Resistance to miscellaneous gas

The detector and the detector-alarm shall initiate specified signal output and alarm in the miscellaneous gas resistance test specified in **10.3**.

5.2.3 Influence of temperature

The detector and the detector-alarm shall meet the criteria in detection accuracy specified in **5.2.1.1** or in alarm accuracy specified in **5.2.1.2** in the temperature test specified in **10.4**.

5.2.4 Delay

5.2.4.1 Detection delay

The detection delay of the detector shall be within 30 seconds in the detection delay test 1 specified in **10.5.1**.

5.2.4.2 Alarm delay

The alarm delay of the detector-alarm shall be within 30 seconds in the alarm delay test 1 specified in **10.5.3**. However, the delay shall be within 60 seconds if the delay is longer due to structural and theoretical characteristics of the detector-alarm (such as existence of a long aspirating pipe in a detector).

5.2.5 Influence of fluctuation in power source voltage

The detector and the detector-alarm shall meet the criteria for detection accuracy specified in **5.2.1.1** or for alarm accuracy specified in **5.2.1.2**, and meet the criteria for detection delay specified in **5.2.4.1** or for alarm delay specified in **5.2.4.2** in power source voltage fluctuation test specified in **10.6**.

5.2.6 Stability

For the detector and the detector-alarm in Performance Criteria 1, the difference between the specified concentration value and the concentration at specified signal output and the value at alarm initiation in the stability test 1 specified in **10.7** shall be within ±50 % of the specified concentration value specified in **7.1**.

5.2.7 Durability

5.2.7.1 Gas resistance

For the detector and the detector-alarm in Performance Criteria 2 that is not the infrared ray type, the difference between the specified concentration value and the concentration at specified signal output and at alarm initiation in the gas resistance test 1 specified in **10.8.1** shall be within ±50 % of the specified concentration value specified in **7.1**,

and the detector and the detector-alarm shall meet the criteria for resistance to miscellaneous gas specified in **5.2.2**.

5.2.7.2 Sensor durability

For the detector and the detector-alarm in Performance Criteria 2 that is not the infrared ray type, the difference between the specified concentration value and the concentration at specified signal output and at alarm initiation in the sensor durability test 1 specified in **10.8.2** shall be within ±50 % of the specified concentration value specified in **7.1**, and the detector and the detector-alarm shall meet the criteria for resistance to miscellaneous gas specified in **5.2.2**.

5.2.8 Condensation resistance

The detector and the detector-alarm that is the condensation-resistant type shall meet the criteria in detection accuracy specified in **5.2.1.1** and in alarm accuracy specified in **5.2.1.2** in the condensation resistance test specified in **10.9**.

5.3 Performance Criteria 3

The detector and the detector-alarm of Performance Criteria 3 shall meet the provision in **5.3.1 - 5.3.6**. However, Performance Criteria 3 does not apply to infrared ray type detectors and detector-alarms.

5.3.1 Accuracy

5.3.1.1 Detection accuracy

For the detector, the concentration at specified signal output in the detection accuracy test 2 specified in **10.2.2** shall be higher than the minimum specified concentration value and less than or equal to the maximum specified concentration value and shall not initiate specified signal output when less than or equal to the minimum specified concentration value.

5.3.1.2 Alarm accuracy

For the detector-alarm, the concentration at specified signal output and the concentration at alarm initiation in the alarm accuracy test 2 specified in **10.2.4** shall be higher than the minimum specified concentration value and less than or equal to the maximum specified concentration value and shall not initiate specified signal output and alarm when less than or equal to the minimum specified concentration value.

5.3.2 Resistance to miscellaneous gases

The detector and the detector-alarm shall not initiate specified signal output and alarm in the miscellaneous gas resistance test specified in **10.3**.

5.3.3 Influence of temperature

The detector and the detector-alarm shall meet the criteria in detection accuracy specified in **5.3.1.1** or in alarm accuracy specified in **5.3.1.2** in the temperature test specified in **10.4**.

5.3.4 Delay

5.3.4.1 Detection delay

The detection delay of the detector shall be within 60 seconds in the detection delay test 2 specified in **10.5.2**.

5.3.4.2 Alarm delay

The alarm delay of the detector-alarm shall be within 60 seconds in the alarm delay test specified in **10.5.4**.

5.3.5 Influence of fluctuation in power source voltage

The detector and the detector-alarm shall meet the criteria for detection accuracy specified in **5.3.1.1** or for alarm accuracy specified in **5.3.1.2**, and meet the criteria for detection delay specified in **5.3.4.1** or for alarm delay specified in **5.3.4.2** in a power source voltage fluctuation test specified in **10.6**.

5.3.6 Durability

5.3.6.1 Gas resistance

The detector and the detector-alarm that is not the infrared ray type shall meet the criteria in detection accuracy specified in **5.3.1.1** or in alarm accuracy specified in **5.3.1.2** in the gas resistance test 2 specified in **10.8.3**, and shall meet the criteria for resistance to miscellaneous gases specified in **5.3.2**.

5.3.6.2 Sensor durability

The detector and the detector-alarm that is not the infrared ray type shall meet the criteria in detection accuracy specified in **5.3.1.1** or in alarm accuracy specified in **5.3.1.2** in the sensor durability test 2 specified in **10.8.4**, and shall meet the criteria for resistance to miscellaneous gases specified in **5.3.2**.

5.3.7 Condensation resistance

The detector and the detector-alarm that is the condensation-resistant type shall meet the criteria in detection accuracy specified in **5.3.1.1** or in alarm accuracy specified in **5.3.1.2** in the condensation resistance test specified in **10.9**.

6 Construction

6.1 Strength

The structure shall have adequate strength, and handling and maintenance shall be easy.

6.2 Corrosion resistance

In the parts of using the metal, the portion in contact with gas shall be corrosion-resistant material or material subjected to anti-corrosion treatment, and other parts shall be favorable painting and plating.

6.3 Waterproof property

Adequate resistance against moisture or water is necessary, depending on the environment where used.

6.4 Explosion proof

The device shall be the explosion proof construction, if it is used in an environment that requires explosion proof. However, due to the fact that A1 refrigerant is no flame propagation and A2L refrigerant is lower flammability, explosion proof construction is not necessary in an environment where only refrigerant equipment charged with A1 refrigerant or A2L refrigerant is used.

6.5 Operational status check

The device shall be able to easily identify whether it is in operation or otherwise. If installed within the equipment, the operational status may be easily distinguishable with the detector and the detector-alarm inside clearly visible or the operational status displayed on the equipment, etc.

6.6 Protection

The detector and the detector-alarm shall be protected to prevent unauthorized personnel to easily misaligned the zero point or sensitivity of it.

7 Functions

7.1 Specified concentration value

The specified concentration value shall be within the range that is higher than the minimum specified concentration value and lower than or equal to the maximum specified concentration value. For the detector and the detector-alarm with indication, the value shall be within the indicated range. For a semiconductor type detector and detector-alarm,

the recommended specified concentration value, based on general detection principle, is less than 10 000 ppm.

7.2 Indication

For the detector and the detector-alarm with indication, the device shall clearly show the range from 0 to LFL (when setting the specified concentration value at a low level, the value may be set at an appropriate value below LFL, with attention to the said specified concentration value) for A2L refrigerant and the range from 0 to RCL (when setting the specified concentration value at a low level, the value may be set at an appropriate value below RCL, with attention to the set specified concentration value) for A1 refrigerant. Additionally, the detector and the detector-alarm with indication shall also possess output accuracy corresponding to the relevant performance category and indication accuracy corresponding to the alarm accuracy. For devices to be installed with the equipment specified to possess indication defined by regulations or the equivalent to those, indication is essential. If indication is not essential, indication is optional.

7.3 Alarm initiation and termination

The detector-alarm shall initiate alarm both with sound and light (such as buzzer, lamp turning on or flashing, etc.) when the gas concentration exceeds the specified concentration value. Also, alarm initiation shall take place in the location where the detector-alarm is installed or in the control room staffed by relevant personnel capable of implementing various measures. Also, the device shall be configured to continue issuing alarm, once initiated and regardless of gas concentration, unless disabling operation is executed. This shall be enabled if the device possesses signal output. If not equipped with indication, it is recommended that the device is able to change the initiated light and sound alarm system once the gas concentration level falls below the specified concentration value, to show that the gas concentration has fallen (such as with the change in sound quality, change in the power-on or flashing lamp scheme, etc.). Also, the alarm system shall return to that at initiation, if the concentration rises once again.

7.4 Alarm volume

The detector-alarm shall be set at a volume at which the alarm can be heard clearly in the environment where used. For example, the volume of city gas alarms is prescribed as 70 dBA or higher at a point 1 m away from the alarm.

7.5 Signal output

Signal output is the ability to send specified signals outside, such as to the shut-off valve that shuts off the refrigerant flow, ventilation device for ventilation inside the room, alarm device or external input component of the air conditioning and refrigeration equipment, when the detected concentration level reaches the specified concentration value. The detector shall possess signal output, and the detector-alarm should preferably possess signal output. Also, the output of specified signals may be in signals that can be determined detection or alarm of no-voltage contact, etc. If signal output is for no-voltage contact, the device may have open contact in surveillance and power failure and close contact in case of alarm or device failure. If the signal output is required by regulations or the equivalent to those, signal output is essential.

7.6 Identifying the location

The alarm that receive the signal from multiple locations shall be configured to initiate alarm not only for one detected location but other detected locations as well. Also, the location that initiated alarm shall be identified.

7.7 Integration with interlock function

If the provision is exist in a guideline, etc., related to the installed air conditioning and refrigeration equipment, the detector and the detector-alarm shall be equipped with start interlock function that prevents activation of the air conditioning and refrigeration equipment unless connected to the detector and the detector-alarm. For the start

interlock function, there is the method to connect to contact points that are enabled by short-circuiting, etc.

7.8 Failure monitoring

The detector and the detector-alarm shall be equipped with the function to monitor sensor output failure. It shall be a structure that allows identify the failure from the exterior (such as lamp indication) or from the output (such as buzzer sounding off, external output, etc.).

8 Inspection

For the detector and the detector-alarm in Performance Criteria 1, inspection pertaining to detection and alarm shall be conducted at least once per year to check that the detector is functioning normally. Calibration shall also be conducted if the detection accuracy or alarm accuracy is found not to be within the specified range at the time of regular inspection. Only Performance Criteria 1 applies to infrared ray type detector and detector-alarm.

The detector and the detector-alarm other than the infrared ray type in the Performance Criteria 2 or Performance Criteria 3 shall be replaced after 5 years of use. However, devices in Performance Criteria 2 that have been calibrated after five years of use to satisfy detection accuracy as specified in **5.2.1.1** and alarm accuracy as specified in **5.2.1.2** may be used without replacement. However, regular inspection shall be conducted at least once per year after that.

For the detector and the detector-alarm in Performance Criteria 1 or Performance Criteria 2, calibration shall executed if the device does not satisfy the specifications of this standard at regular inspection. If the specifications are not satisfied even after calibration, the device shall be replaced. For the detector and the detector-alarm with replaceable sensors, the device may be used with replacement of sensors, until the next regular inspection date or replacement date defined in this standard.

For the detector and the detector-alarm in Performance Criteria 1 or Performance Criteria 2, inspection shall be conducted after detection or alarm on refrigerant leakage, calibration shall be conducted if the specifications of the device do not satisfy the criteria in this standard. If the specifications are not satisfied even after calibration, the device shall be replaced. In such a case, replacement of sensors may be satisfactory. The detector and the detector-alarm in Performance Criteria 3 shall be replaced after detection or alarm on refrigerant leakage.

As for the alarm, it shall be confirmed to inspect the alarm-related circuit and initiate the alarm at least once per year.

Additionally, the detector and the detector-alarm as a whole should preferably be replaced after 10 years, considering the product life of the functional parts, etc. If there are provisions under regulations or the equivalent to those that differ from the above, compliance with the said provisions is required.

9 Installation location

The device shall be installed outside the equipment (in a room, in a machinery room, in semi-underground space, etc.) or within the equipment (within indoor unit, within outdoor unit, etc.) at a location where refrigerant leakage can be detected without fail, at any location and in any use. If used in outdoor space, the device may be equipped with appropriate waterproof functionality as needed. If the installation location is specified in the guidelines related to the system to be installed or under regulations or the equivalent to those, compliance with such provisions is required.

Additionally, if the device is to be installed in an environment where there is gas, etc., that will cause erroneous detection or product degradation for the specific detection type, attention shall be paid to the location of installation. For a semiconductor type detector, attention shall be paid to environment where there is high concentration of miscellaneous gases, silicone, water vapor and other gases. For an infrared ray type, attention is required in

environments where there is high concentration of water vapor or large presence of dust particles, etc. When using an infrared ray type to measure CO_2 concentration, attention shall be paid to the environment where there is dry ice and others that generate CO_2.

10 Test methods

10.1 Test requirements and content

Testing conditions are as follows.

a) Infrared ray type: Temperature of 20±5 °C or 25±5 °C, relative humidity of 65±10 %, and atmospheric pressure of 101.3±5 kPa

b) Devices other than infrared ray type: Temperature of 20±5 °C or 25±5 °C and relative humidity of 65±10 %

Table 4 shows the tests to be conducted to satisfy accordingly Performance Criteria 1 and Performance Criteria 2 specified in **5.2** or Performance Criteria 3 specified in **5.3**.

Also, durability assurance is executed by conducting the stability test specified in **10.7** for Performance Criteria 1, gas resistance test 1 specified in **10.8.1** and sensor durability test 1 specified in **10.8.2** for Performance Criteria 2 and gas resistance test 2 specified in **10.8.3** and sensor durability test 2 specified in **10.8.4** for Performance Criteria 3. The interval between inspections and replacement time specified in **8** vary on whether Performance Criteria 1, Performance Criteria 2 or Performance Criteria 3 applies. Also, condensation resistance test specified in **10.9** is a test for condensation-resistant type devices.

Table 4 – Performance criteria and corresponding tests

Test / Performance	Detection accuracy	Alarm accuracy	Resistance to miscellaneous gases	Temperature	Detection delay	Alarm delay	Power source voltage fluctuation	Stability	Durability		Condensation resistance
									Gas resistance	Sensor durability	
Performance Criteria 1	**10.2.1**	**10.2.3**	**10.3**	**10.4**	**10.5.1**	**10.5.3**	**10.6**	**10.7**	**–**	**–**	**10.9**
Performance Criteria 2	**10.2.1**	**10.2.3**	**10.3**	**10.4**	**10.5.1**	**10.5.3**	**10.6**	**–**	**10.8.1**	**10.8.2**	**10.9**
Performance Criteria 3	**10.2.2**	**10.2.4**	**10.3**	**10.4**	**10.5.2**	**10.5.4**	**10.6**	**–**	**10.8.3**	**10.8.4**	**10.9**

10.2 Accuracy test

10.2.1 Detection accuracy test 1

The detection component of the detector is exposed to test gas in concentration close to the specified concentration value specified in **7.1**, calculating the concentration at specified signal output, based on the detector output in the test, and examine the difference with the specified concentration value. Also, the detection component of the detector is exposed to test gas concentration that is increased gradually, to examine the difference between the specified concentration value and the concentration at specified signal output.

10.2.2 Detection accuracy test 2

The detection component of the detector is exposed to test gas in concentration that is higher than the minimum specified concentration value and lower than or equal to the maximum specified concentration value, to confirm the concentration at specified signal output, based on calculation of detector output during the test. The detection

component of the detector is exposed to test gas in concentration close to the minimum specified concentration value, to confirm the concentration at specified signal output, based on detector output during the test. The device shall show that it does not initiates specified signal output when less than or equal to the minimum specified concentration value.

10.2.3 Alarm accuracy test 1

The detection component of the detector-alarm is exposed to test gas in concentration close to the specified concentration value specified in **7.1**, calculating the concentration at alarm initiation and at specified signal output, based on the detector output in the test, and analyzing the difference with the specified concentration value. Also, the detection component of the detector-alarm is exposed to test gas concentration that is increased gradually, to examine the difference between the specified concentration value and the concentrations at alarm initiation and at specified signal output.

10.2.4 Alarm accuracy test 2

The detection component of the detector-alarm is exposed to test gas in concentration that is higher than the minimum specified concentration value and lower than or equal to the maximum specified concentration value, to confirm alarm is initiated. The detection component of the detector-alarm is exposed to test gas in concentration close to the minimum specified concentration value, to confirm that alarm is not initiated when lower than or equal to the minimum specified concentration value.

10.3 Miscellaneous gas resistance test

After turning on power and kept in an environment under test conditions specified in **10.1** for one hour, the detector and the detector-alarm is exposed to the type and concentration of gas specified in test 1 shown in **Table 5** for one minute, to confirm that there is no specified signal output and no alarm initiation. Next, after removing the gas in test 1 and again turning on power and kept in an environment under test conditions specified in **10.1** for one hour, the device is exposed to the type and concentration of gas specified in test 2 shown in **Table 5** for one minute, to confirm that there is no specified signal output and no alarm initiation.

Table 5 – Miscellaneous gas resistance test

Test No.	Type of gas	Concentration (ppm)
test 1	Ethyl alcohol	1 000
test 2	Hydrogen	500

10.4 Temperature test

The detection component of the detector and the detector-alarm is exposed to test gas at concentration close to the specified concentration value specified in **7.1** and at temperature suited to its characteristics. After making output adjustments, it is placed in an isothermal chamber at the lower limit temperature of each temperature range (-10 °C for temperature range 5) ± 3 °C and at the upper limit temperature of each temperature range (40 °C for temperature range 5) ± 3 °C. After the temperature inside the detector and the detector-alarm stabilizes, detection accuracy test 1 specified in **10.2.1**, detection accuracy test 2 specified in **10.2.2**, alarm accuracy test 1 specified in **10.2.3** or alarm accuracy test 2 specified in **10.2.4** are conducted. In temperature range 5, assurance of specified accuracy at -10 °C and at 40 °C is acceptable.

10.5 Delay test

10.5.1 Detection delay test 1

The detection component of the detector is exposed to test gas in concentration close to the specified concentration value specified in **7.1**, to examine the time consumed for the concentration calculated from detector output to reach 60 % of the test gas concentration.

10.5.2 Detection delay test 2

The detection component of the detector is exposed to test gas in concentration close to the maximum specified concentration value, to examine the time consumed for the concentration calculated from detector output to reach the concentration at the time of specified signal output.

10.5.3 Alarm delay test 1

The detection component of the detector-alarm is exposed to test gas in concentration 1.6 times that of the specified concentration value specified in **7.1**, to examine the time until the alarm is initiated.

10.5.4 Alarm delay test 2

The detection component of the detector-alarm is exposed to test gas in concentration close to the maximum specified concentration value, to examine the time until the alarm is initiated.

10.6 Power source voltage fluctuation test

The detector and the detector-alarm, excluding battery-operated type, is tested by fluctuating power at ±10 % of the rated voltage, to conduct the detection accuracy test 1 specified in **10.2.1**, detection accuracy test 2 specified in **10.2.2**, alarm accuracy test 1 specified in **10.2.3** or alarm accuracy test 2 specified in **10.2.4**, along with detection delay test 1 specified in **10.5.1**, detection delay test 2 specified in **10.5.2**, alarm delay test 1 specified in **10.5.3** or alarm delay test 2 specified in **10.5.4**.

10.7 Stability test

The test is conducted for Performance Criteria 1. The detection component of the detector and the detector-alarm is exposed to test gas in concentration close to the specified concentration value specified in **7.1**. After keeping leaving the power on for 2 hours or more, the component is exposed once again to the test gas in concentration close to the specified concentration value. The difference between the specified concentration value and the concentrations at output of specified signal based on the output of the detector and the detector-alarm at exposure and at alarm initiation is examined. Also, the detection component of the detector and the detector-alarm is exposed to test gas concentration that is increased gradually, to examine the difference between the specified concentration value and the concentrations at alarm initiation and at specified signal output.

10.8 Durability test

10.8.1 Gas resistance test 1

The test is conducted for Performance Criteria 2. The detection component of the detector and the detector-alarm is sprayed with the type and concentration of gas specified in **Table 6** at the rate of 100 mL/min for 30 seconds while power is on, followed by pause for one minute. This is repeated 1 000 times, and the device is left stand for one hour with the power on. It is next exposed to test gas in concentration close to the specified concentration value. The difference between the specified concentration value and concentrations at output of specified signal, based on the output from the detector and the detector-alarm at exposure to the test gas, and at alarm initiation is examined. Also, the detection component of the detector and the detector-alarm is exposed to test gas concentration that is increased gradually, to examine the difference between the specified concentration value and the concentrations at alarm

initiation and at specified signal output. The miscellaneous gas resistance test specified in **10.3** is conducted as well.

Table 6 – Gas resistance test

Type of gas	Concentration (ppm)
Methane	10 000 - 12 500

10.8.2 Sensor durability test 1

The test is conducted for Performance Criteria 2. With the power on and in an environment of temperature at 35 °C and relative humidity of 60 %, the detection component of the detector and the detector-alarm is exposed for 30 minutes to atmosphere with 500 ppm concentration of hydrogen gas twice a day. This is repeated for 10 days. Later, the device is left stand for 24 hours or longer with the power on in atmosphere and then exposed to test gas in concentration close to the specified concentration value. The difference between the specified concentration value and concentrations at output of specified signal, based on the output from the detector and the detector-alarm at exposure to the test gas, and at alarm initiation is examined. Also, the detection component of the detector and the detector-alarm is exposed to test gas concentration that is increased gradually, to examine the difference between the specified concentration value and the concentrations at alarm initiation and at specified signal output. The miscellaneous gas resistance test specified in **10.3** is conducted as well.

10.8.3 Gas resistance test 2

The test is conducted for Performance Criteria 3. The detection component of the detector and the detector-alarm is sprayed with the type and concentration of gas specified in **Table 6** at the rate of 100 mL/min for 30 seconds while power is on, followed by pause for one minute. This is repeated 1 000 times, and the device is left stand for one hour with the power on. It is next exposed to test gas in concentration close to the specified concentration value. Next, the detection accuracy test 2 specified in **10.2.2** or alarm accuracy test 2 specified in **10.2.4** and the miscellaneous gas resistance test specified in **10.3** are conducted.

10.8.4 Sensor durability test 2

The test is conducted for Performance Criteria 3. With the power on and in an environment with temperature at 35 °C and relative humidity of 60 %, the detection component of the detector and the detector-alarm is exposed for 30 minutes to atmosphere with 500 ppm concentration of hydrogen gas twice a day. This is repeated for 10 days. Later, the device is turned on for 24 hours or more in atmosphere and then exposed to test gas close to the concentration of the specified concentration value. Next, the detection accuracy test 2 specified in **10.2.2** or the alarm accuracy test 2 specified in **10.2.4** and miscellaneous gas resistance test specified in **10.3** are conducted.

10.9 Condensation resistance test

With the power on, the detection component of the condensation-resistant type detector and the detector-alarm is placed in an isothermal chamber at the lower limit temperature of each temperature range. When the surface temperature of the detection component reaches the specified temperature, the device is placed in an environment with temperature of 25 °C or higher and relative humidity of 60 % or higher (the dew point for 25 °C and 60 % humidity is 16.7 °C) for 3 minutes or until condensation occurs on the surface. This is repeated 36 times if degree of water resistance is IPX3 or higher. For others, this is repeated 1 000 times. Later, the moisture on the surface is removed to conduct either the detection accuracy test 1 specified in **10.2.1** or the detection accuracy test 2 specified in **10.2.2** or the alarm accuracy test 1 specified in **10.2.3** or the alarm accuracy test 2 specified in **10.2.4**.

11 Product information and cautionary notes on handling

The following information shall be shown on the device or in the user manual.

a) Name, product name and model

b) Name of typical gas targeted for detection

c) Date of manufacture or code

d) Name of manufacturer or code

e) Detection type

f) Operating temperature range (temperature range 1-5)

g) Operating humidity range

h) Specified concentration value at factory setting (for Performance Criteria 1 and Performance Criteria 2 only)

i) Performance Criteria (Performance Criteria 1, Performance Criteria 2 or Performance Criteria 3)

j) Operation method

k) Maintenance & inspection method

l) Notes on miscellaneous gases, etc., in operating environment

m) Inspection interval or replacement interval

n) Power source voltage

o) Detector type, such as condensation-resistant, moisture-resistant or water-resistant, if applicable

p) Output specifications

q) Handling method after detection or alarm of refrigerant leakage (inspection or replacement)

Annex A
(Informative)
Bibliography

JIS M 7626:1994 Stational type combustible gas alarm

JIS M 7653:1996 Portable type combustible gas detector

ISO 23953-2:2015 Refrigerated display cabinets - Part 2:Classification, construction, characteristics and test conditions

JIS T 8201:2010 Oxygen deficiency indicator

JIA E 001-15:2015 The criteria of gas alarm inspection for city gas

ISO 5149-1:2014 Refrigerating Systems and heat pumps－Safety and environmental requirements－Part 1：Definitions, classification and selection criteria.

ISO 5149-3:2014 Refrigerating systems and heat pumps－Safety and environmental requirements－Part 3：Installation site

JRA GL-13:2012 Guideline of design construction for ensuring safety against refrigerant leakage from multi-split system air conditioners

KHKS 0302 Facility criteria of air conditioning and refrigeration equipment

Exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation under High Pressure Gas Safety Act

Exemplified standard (23. Gas leakage detector-alarm equipment and the installation location) related to General High-Pressure Gas Safety Regulation under High Pressure Gas Safety Act

JRA 4068T：2016

Requirements of refrigerant leak detector and alarm for air conditioning and refrigeration equipment Commentary

This commentary provides further explanation of the specifications and descriptions given in the standard and its Annex and does not constitute part of the standard.

1 Purpose of this requirement

Risk assessment on air conditioning and refrigeration equipment using R32, R1234yf or R1234ze(E) classified as lower flammability (A2L) under **ISO 817** had been conducted since 2011. The results showed that the detection of refrigerant leakage with detector and safety measures, such as ventilation, alarm or shut-off valve, implemented before increase in flammable volume in refrigerant leakage space will assure safe management of equipment using A2L refrigerants. Based on these findings, **JRAIA** has developed its own standard and guideline for each equipment type, in order to ensure safe management of air conditioning and refrigeration equipment using A2L refrigerants.

On March 12, 2015, the Subcommittee on High Pressure Gas Safety under the Industrial Safety Committee of the Industrial Structure Council received recommendations from the Minister of Economy, Trade and Industry to review into the classification of R32, R1234yf and R1234ze(E) (lower flammability gas) as inert gases under Refrigeration Safety Regulation of High-Pressure Gas Safety Act. When the Subcommittee convened on March 9, 2016, this policy was approved. The reclassification of these gases as inert gases will result in producers of high-pressure gases of 3 to less than 5 legal tons of refrigeration to be exempted from the application of the High Pressure Gas Safety Act and producers of high-pressure gases of 5 to less than 20 legal tons of refrigeration reclassified from Class 2 producers that require submission of reports to the category of other producers that do not require reports. At the Subcommittee on High Pressure Gas Safety that convened on March 9, 2016, a proposal was presented to have equipment for lower flammability gas require installation of detector-alarm for Class 2 producers and Class 1 producers and to have other producers to install detector-alarm when necessary.

Additionally, the Subcommittee meeting on March 12, 2015 received recommendations from METI to review into making the installation of detector-alarm even for inert gas equipment, in view of the accidents that occurred in 2014, caused by oxygen deficiency triggered by leakage of the inert R22 refrigerant and resulting in 17 being injured in Fukuoka and 2 injured in Nagasaki. On March 9, 2016, the Subcommittee issued its policy to strengthen inspection and therefore not to make installation of detector-alarm for inert gas (excluding lower flammability gases) equipment compulsory. Notwithstanding this, **JRAIA** has decided to develop guidelines that apply to A1 refrigerants that are widely used in the market today and to A2L refrigerants that are expected to be in use in the future, due to the importance of developing criteria for refrigerant leakage detectors and detector-alarms that can be used to cover a wider range of refrigerants.

2 Background of establishment

Because refrigerant leakage detector and detector-alarm cover various product groups, such as commercial air conditioner, chiller, commercial refrigerator, refrigerated display cabinets and unit coolers, standardization of the common specifications became necessary. Therefore, in order to considering the specification of detector and alarm, “Refrigerant leak detector and alarm WG”, that was composed of the representatives of the technical committee of each product and the representatives of the leak detector manufacturers, was established on May 2015 in Environmental Planning Committee.

For flammable gases, the general specifications are defined in the technical criteria presented by exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation. The details on test method, etc., are specified in **JIS M 7626**. On the other hand, the requirements for nonflammable gas detectors and detector-alarms are available only in summary form in **KHKS0302** and **JRA GL-13**. Detailed specifications have not been established as independent standards under **JIS** or **JRA**.

In view of the current situation, it had been decided that the specifications for refrigerant leakage detectors and detector-alarms used with air conditioning and refrigeration equipment shall be compiled as standard, for the main purpose of preventing the distribution of inferior-quality products in the marketplace and to assure satisfactory detection of refrigerant leakage and safe equipment management.

3 Purpose of this revision

In **JIA E 001-15** which is a reference for this standard, it is defined that the periodic inspection can be omitted for five years, and gas resistance test and the sensor durability test are defined as the durability test in order to ensure it. As a result of the discussion, it was judged to be able to secure the omission of the inspection for five years by performing the gas resistance test, and only the gas resistance test was defined in this standard as a durability test. But, afterwards, it was found that there is the following description in "Technological History of Gas Alarm" (September 2011) of Gas Alarm Industries Association of Japan.

"Expiration date of domestic city gas alarm was extended to five years from three years in 1985, the provision was revised to add the contents of sensor durability test and the new approval has started. 5 000 units of alarm in the market had been recovered, research and analysis is carried out, it was found that the crystal growth and the aggregation of catalyst of the tin oxide occurred in the semiconductor sensor by the surrounding vapor and miscellaneous gases. As a result, the sensor resistance and the effect of the filter removing the miscellaneous gases are reduced permanently and false alarm occurs. As a result of the development of the sensor to solve this problem, the durability of the sensor was improved dramatically, and the five-year life was verified. Also, in order to verify that the durability of the sensor is maintained, the test maintaining the temperature and humidity of the atmosphere in high temperature and high humidity (35 °C and 60% RH) and exposing to a certain amount of hydrogen gas (30 minutes twice a day with 500 ppm) for 10 days was added."

The described test in this document is the sensor durability test specified in **JIA E 001-15**. Therefore, it is determined that it is necessary for the durability test to provide a sensor durability test, it has decided to provide it in addition to this standard. In addition, the points of revision of Refrigeration Safety Regulation and related exemplified standard under High Pressure Gas Safety Act are becoming clear, the representation of the places to refer it in this standard was modified in accordance with its contents.

4 The main points of revision

At this time of revision, because the standard to refer to this standard has not been established, it is treated as a new establishment and the description of the points of revision are omitted.

5 Commentary matters on provision items

a) Applicable refrigerants and scope of application

1) Applicable refrigerants and standard title The refrigerants regulated under the standard herein are refrigerants classified as A1 or A2L in **ISO 817** or **ASHRAE STANDARD 34**, namely, those scheduled to be added to the classifications or those not regulated by the standards but whose physical properties are identified clearly and also detectable with either semiconductor or infrared ray type. **Commentary Table 1** shows the correlations between the refrigerants designated as inert gas in the current Refrigeration Safety Regulations and those classified under **ISO817**. In **Commentary Table 1**, gases that cannot be detected with the semiconductor type is marked with "×" and those that can be detected with "○".

Commentary Table 1 – The correlations between refrigerant gases and their principal detection types

ISO817 classification	Name of refrigerant designated as inert gas in Refrigeration Safety Regulation		Detection with semiconductor type
A1	HFC	R125, R134a	○
	HCFC	R22, R124	○
	CFC	R12	○
		R13	×
		R114	×
	PFC	R116	(×)
	BFC	R13B1	○
	Mixed refrigerants	R401A, R401B, R402A, R402B, R404A, R407A, R407B, R407C, R407D, R407E, R410A, R410B, R417A, R422A, R422D, R423A, R500, R502, R507A, R509A	○
	Others	R744 (CO_2)	×(measured with IR type)
		R704 (helium))	×
A1/A2	R413A		○

Of the refrigerants that have been specified as inert gas, R13, R114 and R704 cannot be detected with a semiconductor type device. Although not confirmed, R116 may not be detectable with the semiconductor type. For this reason, the description "… detectable with either semiconductor or infrared ray type" had been added to the description of types of refrigerants. Refrigerants that can be easily detected with the semiconductor type are those with many hydrogen molecules, etc., in the molecular structure. CO_2 can be detected with the infrared ray type.

This standard has been titled as "Requirements of Refrigerant Leak Detector and Alarm for Air Conditioning and Refrigeration Equipment" In addition to A1 and A2L refrigerants, R290 and other HC refrigerants that are classified as A3 refrigerants are being used. In addition to specifications for flammable gas detector-alarms, the provisions of **JIS M 7626** are equivalent to that of Performance Criteria 1 of this standard and do not regulate Performance Criteria 3 covering low-priced devices that do not need yearly inspection and Performance Criteria 2 for high-performance devices that do not need yearly inspection. In view of the proposals at **IEC** and other international standardization bodies to increase the amount of HC refrigerants, it is likely that HC

refrigerants will be used for air conditioning and refrigeration equipment. Provisions comparable to Performance Criteria 2 and Performance Criteria 3 in this standard herein may be applied to HC refrigerants. However, the detection type widely used for HC refrigerant detectors and detector-alarms is the contact burning type, in addition to the semiconductor and infrared ray types. (See **Commentary Table 2**)

Commentary Table 2 – The correlations between refrigerant gases and their principal detection types

Detection type	Contact burning type	Diaphragm electrode type (Electrochemical type)	Semiconductor type	Infrared ray type
Principal gas types	Flammable gas (HC, etc.)	Oxygen	Fluorocarbon gas (HFC, HCFC, HFO, etc.) Flammable gas (HC, etc.)	Fluorocarbon gas (HFC, HCFC, HFO, etc.) CO_2 Flammable gas (HC, etc.)

The types of detection system for refrigerants specified in this standard herein are assumed to be the semiconductor type and the infrared ray type. Because the scope of knowledge is not sufficient enough to cover the contact burning type in this standard, HC refrigerants are not included in the scope of application. The scope of this standard may be extended into HC refrigerants once more knowledge and expertise in the contact burning type are gained in the future.

Furthermore, insufficient knowledge on toxic refrigerants at the time of development has led to restriction in the application of this standard to non-toxic A1 and A2L refrigerants. However, in cases where detection with a semiconductor type or infrared ray type detector and detector-alarm is possible for toxic refrigerants such as B1 refrigerant, the provisions of this standard may be applied with adjustment of the maximum specified concentration value at a half of the upper limit concentration based on toxicity.

2) Portable detectors Portable detectors have been excluded from the scope of this Standard. Considering that there is **JIS** standards for portable detectors used for flammable gases, the inclusion of portable detectors is basically acceptable. However, the large majority of portable directors in the marketplace today is capable of detecting the existence of refrigerant gas in the aim be an environment but fails to have the precision of regulating detection accuracy. If portable detectors are included in the scope, establishing standard similar to **JIS** for flammable gas portable detectors, it is highly likely that the large majority of portable detectors will fail to meet the requirements. For this reason they have been excluded from the scope of this standard.

3) Air conditioning and refrigeration equipment with less than 3 legal tons of refrigeration** Air conditioning and refrigeration equipment with less than 3 legal tons of refrigeration have been excluded from the scope of this standard. Because the specifications for detectors and detector-alarms are founded on the types of gas detected and from requirements, the size of legal tons of refrigeration is unrelated, except when there are separate requirements under law, etc. This means that air conditioning and refrigeration equipment with less than 3 legal tons of refrigeration can be included. However, this standard calls for regular inspection or replacement, which are believed to be difficult for household air conditioning and refrigeration equipment. For this reason, air conditioning and refrigeration equipment with less than 3 legal tons of refrigeration have been excluded from the scope of this standard.

This, however, does not necessarily mean that application of this standard on such equipment is prohibited. Rather, this standard may be applied to such smaller systems, such as explicitly stating in the product standard, guidelines, user manual, manufacturer catalog, etc., that the product complies with this standard herein.

4) Oxygen deficiency Of the refrigerants covered by this standard, A1 refrigerants are very often involved in accidents caused by oxygen deficiency. To prevent this, it is important to prevent refrigerant concentration to reach ODL or to control oxygen concentration to be below the oxygen deficiency limit. However, **JIS T 8201** sets forth detailed provisions regarding oxygen concentration detectors for preventing oxygen deficiency, resulting in duplication of provisions if they are introduced in this standard herein.

Additionally, A2L refrigerants included in the refrigerants listed as reference in **Table 2** has as its maximum specified concentration at a quarter of LFL related to the flammability. Because this value is smaller than a half of ODL (oxygen deprivation limit) and a half of ATEL (acute-toxicity exposure limit), it becomes necessary to detect oxygen concentration lower than or equal to a quarter of LFL in case of detection with an oxygen monitor. Also, A1 refrigerant requires detection at less than or equal to a half of RCL. However, ATEL is lower than ODL for nearly all refrigerants. When using an oxygen monitor, oxygen concentration shall be detected at a level comparable to less than or equal to a half of ATEL. The concentration values, namely, a quarter of LFL or a half of ATEL, are very low and very often makes detection of these values by an oxygen monitor difficult.

In view of these facts, this standard has been restricted to cases of refrigerant detection and has excluded oxygen concentration detectors from its scope. If detection of oxygen concentration secures safety similar to that of refrigerant concentration in view of the physical values of refrigerants used in applicable air conditioning and refrigeration equipment, however, use of oxygen detectors and monitors in compliance with **JIS T 8201** is acceptable.

5) Safety classifications of refrigerants The label "lower toxicity" in **ISO 817** was not used for refrigerants classified in A, and "no toxicity" is used instead. This is due to the fact that those classified as inert gas in the Refrigeration Safety Regulation are all in classification A under the ISO provisions and are described as having "no toxicity" as the common rule.

6) RCL **ISO 817** defines RCL, which is the upper limit for refrigerant concentration in the air to prevent risks of acute toxicity, oxygen deficiency and flammability. RCL for A2L refrigerants is set at a fifth of LFL. The standard, on the other hand, sets the maximum specified concentration value at q quarter of LFL for A2L refrigerants and a half of RCL for A1 refrigerants. This results in the limit of a half of RCL (which translates to a tenth of LFL) to be lower than a quarter of LFL for A2L refrigerants. In view of possible misunderstanding if this is entered in **Table 2**, the values for RCL, a half of RCL and a hundredth of RCL were not entered for A2L refrigerants.

b) Control room This refers to the location where alarm is initiated and where relevant personnel are stationed on full-time basis. A room commonly referred to as control room does not qualify as a control room as specified herein, if it is not staffed by full-time personnel. If the room is controlled by personnel via remote control, the room qualifies as control room herein.

c) Minimum specified concentration value In an environment with high concentration of miscellaneous gases (redox gases), large quantity of water vapor, etc., false alarm is highly likely with inferior-quality products, etc., for which preventive measures have not been implemented. In order to prevent false alarms, the lower limit in concentration has been established and is called minimum specified concentration value. Although **JIA E 001-15**

establishes the minimum specified concentration value at two-hundredth of the lower explosive limit, very low value could not be established in view of the fact that the LFL varies by the type of refrigerant used and that false alarms shall be prevented. For this reason, the value was set at a hndredth of LFL (ppm) or 1 000 ppm, whichever is larger.

Furthermore, the CO_2 level is stipulated to be 1 000 ppm or lower under the Act on Maintenance of Sanitation in Buildings. However, there is likelihood that air accumulation causes higher concentration of CO_2 if ventilation is insufficient. Therefore, although the CO_2 level is set at a hundredth of RCL, which is 400 ppm, the minimum specified concentration value has been set at 2 000 ppm.

d) Detection method Regarding detection method, the technical criteria presented by exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation under High Pressure Gas Safety Act stipulates that the system should "detect changes in the detection element with an electrical mechanism employing the diaphragm electrode type, semiconductor type, contact burning type or other types. "For air conditioning and refrigeration equipment owned by a manufacturer requiring installation of detection-alarm as specified in Refrigeration Safety Regulation under High Pressure Gas Safety Act, this standard herein cannot contradict with the provisions of the technical criteria presented by exemplified standard related to Refrigeration Safety Regulation. Because the semiconductor type and the infrared ray type are chiefly used for as detector and detector-alarm for A1 and A2L refrigerants today, this standard was established with these types in mind. Additionally, since the technical criteria presented by exemplified standard related to Refrigeration Safety Regulation provides for "other types" as well, this standard does not require the use of these two only. For this reason, the expression in the said technical criteria had been adopted for this standard herein, describing the detection to be "detection of change in the detection element with an electrical mechanism, based on semiconductor, infrared ray or other methods."

e) Operating ambient temperature Definition of the operating ambient temperature is a requirement for the equipment. For the installation environment for the air conditioning and refrigeration equipment to correspond to the specifications of the detector, the operating ambient temperature shall be established and depends on the location of detector installation. Additionally, virtually none of the infrared ray type detectors available for use do not cover temperatures below -20 °C. Similarly, there is hardly any semiconductor type detector capable of detection under -40 °C. Because detectors and detector-alarms suffer decline in accuracy with deviation from the adjusted temperature range, a wide gap between the upper limit and lower limit in temperature in the environment is not recommended. Therefore, the temperature range 1 has been set to -10 to -40 °C (example of location: Inside the room or inside the refrigerator); temperature range 2 set at -20 to -10 °C (example of location: inside the freezer); temperature range 3 at -30 to -10 °C (example of location: Inside the freezer); temperature range 4 at -40 to -20 °C (example of location: inside the freezer); temperature range 5 at -30 to 50 °C (example of location: Outdoors, with the temperature range guaranteeing stipulated accuracy to be from -10 °C to 40 °C). It is to be noted that infrared ray types have temperature range that differs in temperature range 1, because many used for building maintenance, etc., have the lower limit in temperature set at 0 °C. The locations of installation shown for each temperature range are strictly examples. This does not suggest that use of the detectors and detector-alarms for each temperature range is restricted to the specified locations. Products should be chosen to correspond to the temperature range required for the environment where used.

f) Performance Criteria Performance Criteria 1 is based on **JIS M 7626** and the technical criteria presented by

exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation. Performance Criteria 3 is based on **JIA E 001-15**. Detectors and detector-alarms to be used for air conditioning and refrigeration equipment owned by a manufacturer requiring installation of detection-alarm as specified in Refrigeration Safety Regulation under High Pressure Gas Safety Act shall comply with the technical criteria presented by exemplified standard related to Refrigeration Safety Regulation. For flammable gases, **JIS M 7626** that is mutually complementary to the technical criteria establishes provisions for such gases. Accuracy of ±25 % specified therein can be assured with Performance Criteria 1 and Performance Criteria 2. There are no provisions on detection accuracy in the technical criteria. However, detection accuracy is set identical to alarm accuracy in Performance Criteria 1 and Performance Criteria 2 because of the application of the technical criteria when connected with a detector.

Also, affordably priced products will become necessary for wider use of detectors and detector-alarms. For this reason, Performance Criteria 3 was created based on **JIA E 001-15**, the standard for gas detectors, for performance capability that can maintain the specified accuracy level for 5 years without regular inspection. Furthermore, Performance Criteria 2 was established for capability to maintain the specified accuracy level for 5 years with guarantee of accuracy level identical to Performance Criteria 1. Because of the guarantee of a high accuracy level close to the specified concentration value, Performance Criteria 2 is suited to environments likely to be affected by miscellaneous gases, such as on the load side of refrigeration or freezing equipment or chillers for which the possibility of false alarms shall be minimized to the greatest possible extent to prevent interruption in unit operation. In Performance Criteria 3, the specified concentration value can be set high. However, it only guarantees alarm initiation within the specified range (a hundredth of LFL to a half of LFL or a hundredth of RCL to a half of RCL) and is suited for general air conditioning and other common indoor environment where miscellaneous gas presence is relatively small. The provisions of Performance Criteria 3 improves the yield for semiconductor type detectors and detector-alarms and leads to lower pricing.

g) Precision and accuracy The term "accuracy" describes the degree of deviation from the true value. "Precision" represents measurement of dispersion in calculation or in multiple measurements and is also referred to as reproducibility. In the past, deviation from the true value was called "precision" but it has been replaced by "accuracy" with precision associated with measurement of reproducibility. While **JIS M 7626** employed the term "precision" to express the level of discrepancy from the true value. This has been replaced by "accuracy" in this standard herein.

h) Alarm accuracy test 1 **JIS M 7626** sets forth that the alarm precision (i.e., accuracy) test is conducted to "gradually increase gas concentration and examine the level of concentration at the point of alarm initiation." In an actual inspection and test by a detector manufacturer, however, it has been ruled that such a test is difficult to conduct. For this reason, this provision has been combined with "The detection component of the detector is exposed to test gas in concentration close to the specified concentration value calculating the concentration at specified signal output, based on the detector output in the test, and analyzing the difference with the specified concentration value"

i) Stability and stability test **JIS M 7626** sets forth that detection stability be within ±10 % and alarm stability at within ±25 % of the maximum indicated value. The specifications are acceptable for flammable gas detectors since the majority of the products adopt the contact burning type. The semiconductor type widely used for A1 and A2L refrigerants, however, is not able to meet these stability specifications. For this reason, tolerance range is set

wider in the stability test for this type, making specified concentration value of within ±50 % satisfactory. Verification tests were conducted and showed that this value is reasonable and acceptable. It is to be noted that there are specifications for stability are defined in **JIS M 7626** and not in the technical criteria presented by exemplified standard related to Refrigeration Safety Regulation. The **JIS** standard is believed to aim at guaranteeing continued use for one year by conducting the stability test. On the other hand, the durability test specified in **JIA E 001-15** is aimed at maintaining the specified accuracy for 5 years. Since conducting both tests is not necessary, Performance Criteria 1 calls for the stability test, and Performance Criteria 2 and Performance Criteria 3 for the durability test.

j) Detection delay and alarm delay The detection delay and alarm delay values have been established separately for Performance Criteria 1, Performance Criteria 2 and Performance Criteria 3. The alarm delay values for Performance Criteria 1 and Performance Criteria 2 have been based on technical criteria presented by exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation, with detection delay values based on **JIS M 7626** which is complementary to the technical criteria. It is to be noted that there are cases of delay in gas to reach the detection component in aspirating detector with extraordinarily long aspirating pipe, requiring 30 seconds to respond. For this reason, provisions of the technical criteria presented by exemplified standard (23. Gas leakage detector-alarm equipment and the installation location) related to General High-Pressure Gas Safety Regulation have been adopted, and "the delay shall be within 60 seconds if the delay is longer due to structural and theoretical characteristics of the detector-alarm (such as existence of a long aspirating pipe in a aspirating detector)." On the other hand, the delay time was set at 60 seconds in compliance with the provisions of **JIA E 001-15**.

k) Indication and specified concentration value Under the technical criteria presented by exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation, installation of an indicator device is required for manufacturers who use flammable gases and toxic gases and require the installation of detector-alarms under Refrigeration Safety Regulation of High Pressure Gas Safety Act. On the other hand, the technical criteria presented by exemplified standard (23. Gas leakage detector-alarm equipment and the installation location) related to General High-Pressure Gas Safety Regulation specified the range of indication for flammable gas detection-alarm devices to be "0 to the lower explosive limit (the value may be set at an appropriate value below LFL, with attention to the said specified concentration value, when setting the specified concentration value at a low level)." Semiconductor type detectors and detector-alarms suffer from decline in sensitivity when the concentration level exceeds roughly 10 000 ppm, resulting in smaller change in output. With extremely high concentration of gas, the properties of the detector surface is likely to be altered. For this reason, the specified concentration value should be set to below 10 000 ppm. Hence, this standard has been based on the technical criteria presented by exemplified standard (23. Gas leakage detector-alarm equipment and the installation location) related to General High-Pressure Gas Safety Regulation, setting the range of indication to "0 – LFL (when setting the specified concentration value at a low level, the value may be set at an appropriate value below LFL, with attention to the said specified concentration value)."

l) Definition of alarm, alarm initiation and termination **ISO 5149** defines alarm as "initiation of alert in both sound and light." According to the "19th Report of the Human Safety Committee of the Fire Prevention Council, Tokyo Fire Department: Fire Prevention Measures for Terminal Facilities that are Growing in Complexity" published in March 2011, the Japan Fire Alarms Manufacturers Association is promoting the installation of sound

and light alarm facilities at terminals, in view of the fact that installation of such facilities are being made compulsory in the US, UK, etc., for buildings and other commercial facilities accessed by persons with disabilities.

Regarding alarm initiation and termination, technical criteria presented by exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation calls for the alarm "to be designed to continue transmitting alarm, once initiated, regardless of change in gas concentration until it is disabled." Because resetting the detector is effective only when the concentration has declined, the absence of an indicator is highly inconvenient in confirming refrigerant concentration decline where leakage had occurred. Hence, this standard sets forth that " If not equipped with indication, it is recommended that the device is able to change the initiated light and sound alarm system once the gas concentration level falls below the specified concentration value, to show that the gas concentration has fallen (such as with the change in sound quality, change in the power-on or flashing lamp scheme, etc.)." This clarifies detector operation if refrigerant concentration declines. This function is important when the indicator is removed from the detector in order to lower pricing.

m) Interlock For safe management of air conditioning and refrigeration equipment using A2L refrigerants, it is important that the refrigerant leak detector detects leakage and prevents creation of flammable region by means of ventilation, alarm, shut-off valve, etc., when the accepted refrigerant filling ratio (refrigerant volume divided by refrigerant quantity) exceeds the specified value. Such safety measures, however, are implemented at construction. For this reason, it is necessary to assure that safety measures are implemented without fail.

For this reason, the startup interlock function that prevents air conditioning and refrigeration equipment from starting up unless necessary safety measures are in place was introduced. Although the refrigerant leakage detector is not a safety measure in itself, the interlock function is also necessary for detectors and detector-alarms used on air conditioning and refrigeration equipment with interlock function, since safety measures cannot start up unless connected.

For interlock with equipment, this standard recommends that "For the start interlock function, there is the method to connect to contact points that are enabled by short-circuiting, etc." to serve as a reference for interlock function specifications. However, this comes with the proviso that this is to be implemented "If the provision is exist in a guideline, etc., related to the installed air conditioning and refrigeration equipment" because decision-making on the use of interlock function and other specific details are specified in the standard or guideline for each type of equipment.

n) Inspection Inspection for Performance Criteria 1 is based chiefly on **JIS M 7626** and the technical criteria presented by exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation. Performance Criteria 3 is based on **JIA E 001-15**. The technical criteria presented by exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation calls for inspection pertaining to detection and alarm to be conducted at least once per year." **JIA E 001-15** has 5 years as the effective period for gas detector qualification after detector type inspection. **JIA E 001-15** allows for continued use for 5 years with test equivalent to durability test stipulated in **10.8** and calls for replacement after 5 years. Under this standard herein, durability test identical to that of **JIA E 001-15** is to be conducted for detectors and detector-alarms under Performance Criteria 2 or Performance Criteria 3. In view of this provision, detectors and detector-alarms under Performance Criteria 1 is

required to have "inspection shall be conducted at least once per year," with those under Performance Criteria 2 or Performance Criteria 3 requiring replacement after 5 years. Regarding detectors and detector-alarms that require total product replacement and those that only require sensor replacement, this standard specified that products for which sensors can be replaced can be allowed to be used until the next regular inspection or next replacement date if the sensor is replaced.

Although the product life of detectors and detector-alarms should preferably be as long as possible, this standard has established provisions corresponding to each test and performance criteria (1 through 3). For this reason, those under Performance Criteria 2 and Performance Criteria 3 are required to be replaced after 5 years. However, this does not obstruct future advances in technology. When new durability test, etc., emerges for regulation under this standard, this standard is expected to undergo revision with attention to such developments and to guarantee usability with the corresponding product life.

Additionally, the detector and the detector-alarm as a whole "should preferably be replaced after 10 years" under this standard, in view of the fact that such products in the marketplace today have service life of as long as 10 years.

Furthermore, in order to prevent malfunction of the alarm it was defined as "As for the alarm, it shall ensure to inspect the alarm circuit and initiate the alarm at least once per year".

o) Installation location The refrigerant detectors and detector-alarms covered by this standard include those that are used outside the air conditioning and refrigeration equipment (such as indoor space, inside the machinery room and semi-underground space) or inside the equipment (inside the indoor unit, inside the outdoor unit, etc.). Depending on where the product is used, there are slight differences in specifications regarding condensation-resistant types, the need for moisture resistance, applicable temperature range, etc. in any of these locations, the device shall be installed in a location where refrigerant gas is likely to accumulate.

Furthermore, attention shall be paid to false alarm caused by miscellaneous gases, in the case of semiconductor type detector and detector-alarm. Fruit, for instance, can produce miscellaneous gas of some several hundred ppm in some cases. Attention shall also be paid to excessive water vapor that may adhere to the detection surface. In an environment where mental corrosion occurs, there is possibility of corrosion on the detection surface of the semiconductor. Silicon is regarded the most powerful enemy of the semiconductor. Adhesion of silicon gas on the detection service will degrade the product's detective function against gases. Further aggravation may render the detector dysfunctional. Commonly, however, efforts are made in design to mitigate such influences with filters. Although such impact is not likely for detector-alarms equipped with such resistance measures, caution on the environment for the detector had been added to ensure attention.

Also, infrared ray type detectors and detector-alarms may suffer from condensation in the light emission or light reception area of the detector in an environment where there is a high concentration of water vapor. In an environment with large quantity of dust particles, etc., such particles may accumulate in the light emission or reception area. Because the infrared ray type detects gas concentration by measuring the wavelength of each unique type of gas, condensation or dust particle accumulation on the light emission/reception area will cause variation in detection values. For this reason, caution on the environment has been added also for infrared ray type detectors. Attention is also required if filters are used for infrared ray type detectors because dirt may accumulate and might cause plugging, thus affecting performance.

p) Test conditions As test requirements, **JIS M 7626** calls for temperature of 20±5 °C, relatively humidity of

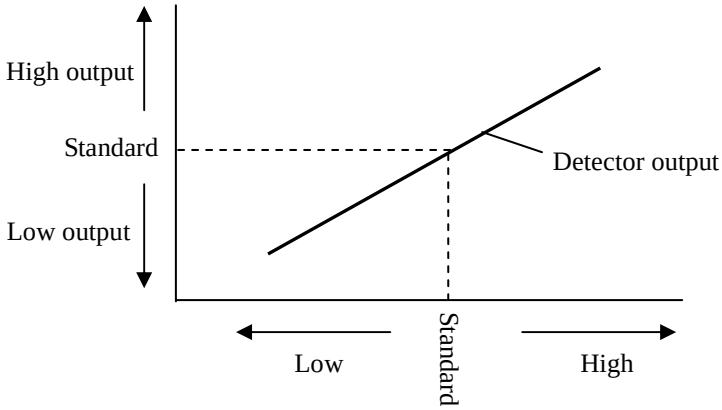
65±10 % and air pressure of 101.3±5 kPa. **JIS M 7653** requires temperature of 20±5°C, relative humidity of 65±10 % and air pressure of 101.3±3 kPa. **JIS T 8201** has temperature at 20±2 °C, relative humidity at 65±20 % and air pressure at 86-106 kPa, with fluctuation during the test to be within ±1 kPa. Also, the test requirement for foreign-made detector sensors very often requires temperature of 25 °C. In view of the above, the test requirements under this standard have been established at temperature of 20±5 °C or 25±5 °C and relative humidity of 65±10 %, to enable application on both Japanese and foreign sensors. The scope of test requirements has been made identical to **JIS** for flammable gases. For infrared ray type detectors and detector-alarms, which are affected by air pressure in detection measurements, air pressure of 101.3±5 kPa has been included as test requirement. However, this requirement has been excluded for the semiconductor type and other types that are not affected by air pressure.

q) Miscellaneous gas resistance test The requirements for the miscellaneous gas resistance test has been based on the provisions of **JIA E 001-15**. In view of the fact that ethyl alcohol and hydrogen are leading examples of miscellaneous gas, provisions have been established for the same gas type and concentration as in **JIA E 001-15**. Ethyl alcohol is found in chemical solutions such as sterilizers used in medical hospitals and for cleaners used in business offices, supermarkets, etc. Hydrogen is generated by forklift power charging, cigarette smoking etc. Because of the high sensitivity of semiconductor type gas sensors to this gas, this gas is most appropriate for determining product aging. Also because ethyl alcohol absorption wavelength is included in the scope of fluorocarbon detection wavelength, it is appropriate for miscellaneous gas resistance test on infrared ray type sensors. Regarding temperature and humidity, **JIA E 001-15** specifies that tests are to be conducted at temperature of 38 to 40 °C and humidity of 85 % or higher, which appears to project application on ambient temperature and humidity for gas detectors in food preparation. The most important issue in resistance to miscellaneous gases is commercial refrigerating appliance where food-derived miscellaneous gases are found. Although the temperature and humidity requirements for such equipment differ from **JIA E 001-15**, the normal temperature and humidity range have been adopted, due to the problems involved in testing at low temperatures. This test enables determination of a product's resistance to false alarms caused by miscellaneous gases.

r) Influence of temperature and temperature test The temperature requirements for the temperature test have been set at ±3 °C from the lower limit of each temperature range and ±3 °C from the upper limit of each temperature range. On the other hand, the temperature requirements for the test in **JIS M 7626** are -10±3 °C and 40±3 °C. Detectors and detector-alarms suffer from wider variation in output as the temperature deviates from the standard temperature for which the output has been adjusted. In **Commentary Fig. 1** shows the image of detector output fluctuation for the same concentration level in case of temperature change (which is strictly conceptual image and does not necessary produce this result in reality; it does not represent linear change in detector output with temperature variations). Although the detector output does not necessary produce results as shown in the Figure because the temperature of the detector is compensated, wider range in operating environment temperature makes it difficult to guarantee detector functionality for the full range of temperature. For this reason, detectors and detector-alarms in temperature range 5 have been established to provide guarantee of accuracy in the temperature range of -10 °C to 40 °C, thus removing guarantee of accuracy for other temperature ranges.

It is to be noted also that **JIS M 7626** requires immersion "in isothermal chamber for 3 hours or more. Because of the differences in temperature stabilization by the structure (exterior wall, exterior material, etc.) of the detector and the detector-alarm, as well as the size of the isothermal chamber and its capacity, this standard specifies that

the test be conducted "after the temperature inside the detector and the detector-alarm stabilizes."



Commentary Fig. 1 - Change in detector output with temperature change at identical concentration

s) Detection delay test

JIS M 7626 provides for detection delay to be within 30 seconds for response set 60 % concentration of test gas. **JIS M 7653** calls for detection delay of less than 60 seconds in response time at 90 % concentration of test gas. If response of the detector and the detector-alarm is expressed as primary delay and waste time is set at 0, 30 seconds at 60 % and 60 seconds at 90 % defined roughly identical response speed. However, response time at 60 % has been decided as most common. For this reason, detection delay as described in **5.2.4.1** has been set at within 30 seconds at 60 % for Performance Criteria 1 and Performance Criteria 2.

For Performance Criteria 3, the detection delay test is to be implemented as in **JIA E 001-15** with exposure to test gas at concentration close to maximum specified concentration value. Defining delay as time until output of the specified signal, the delay time was set as 60 seconds as in **JIA E 001-15**.

t) Alarm delay test Alarm delay test 1 for Performance Criteria 1 and Performance Criteria 2 is to be conducted at concentration of 1.6 times the specified concentration value. This is based on the technical criteria presented by exemplified standard (13. Gas leakage detector-alarm equipment and the installation location) related to Refrigeration Safety Regulation and **JIS M 7626**. When the specified concentration value is set to approximate a quarter of LFL, which amounts to the maximum specified concentration value, 1.6 times the specified concentration will mean that it will exceed a quarter of LFL. If the concentration is lowered in the test, time will be consumed in reaching concentration when alarm is initiated, imposing stricter requirements. However, in view of the fact that manufacturers do not conduct full-lot inspection at shipment, it was decided that testing at high concentration level should not pose any problem.

Also, **JIA E 001-15** requires alarm delay test to be conducted with gas concentration of a quarter of LFL. For this reason, alarm delay test 2 for Performance Criteria 3 provides for testing with "test gas at concentration close to the maximum specified concentration value." Although a quarter of LFL is too high for A2L refrigerant and imposes stress on the detector, this provision was determined as acceptable in view of the fact that full-lot inspection is not conducted and that satisfaction of the specified delay time is possible at lower concentration levels.

u) Durability test

1) **Relationship with regular inspection** The requirements for the durability test has been based on the provisions of **JIA E 001-15**. The durability test is designed as acceleration test. With this test, **JIA E 001-15** guarantees that accuracy will be between two-hundredth to a quarter of LFL for 5 years. Performance Criteria 3 has been established in this standard to correspond to this, setting forth that replacement is to be made after 5 years and not requiring regular inspection. However, durability test has been established for Performance Criteria 2, in addition to Performance Criteria 1 calling for high level of accuracy close to the specified concentration value. Products in Performance Criteria 1 is required to open quote conduct regular inspection at least once per year" instead of the durability test. It is to be noted also that in Performance Criteria 2, slight degradation is anticipated in the durability test. For this reason, the performance requirement after the durability test is set at "within ±50 % under the specified concentration value" allowing for slightly wider tolerance in terms of detection accuracy and alarm accuracy. In providing for a durability test for Performance Criteria 2, verification tests were conducted and showed that accuracy of ±25 % of the specified concentration value was realized. For this reason, it was decided that within ±50 %, combined with ±25 % for accuracy, was acceptable for the durability test for Performance Criteria 2.

2) **Gas types** The gas types and concentrations in the gas resistance were made identical to those in **JIA E 001-15**. The value of 12 500 ppm is equivalent to a quarter of LEL, the lower explosive limit for methane.
Methane is not easily degradable due to the low activation level, while fluorocarbons are highly active and degradable even at low energy level. For this reason, degradation in the semiconductor gas sensor will result in decline in response to methane even when response to fluorocarbons does not decline. In other words, methane is a gas that can be used to easily identify degradation in semiconductor gas sensors. Also, methane is a flammable gas with higher flame propagation compared to fluorocarbon refrigerants. Hence, there is high possibility of catalyst in the semiconductor gas sensor burning, with higher temperature accelerating degradation of the detector and the detector-alarm. For this reason, methane accelerates the degradation of the semiconductor gas sensor more than fluorocarbon refrigerants. In the inspection of city gas alarm detectors that use semiconductor gas sensors, methane is used in gas resistance test and has a sufficient track record in testing durability of such sensors. However, similar gas resistance test using gas other than methane cannot guarantee functionality for 5 years. The semiconductor sensor is heated to 300-400 °C but, because of the small contact surface between the refrigerant and the heated area and temperature being not very high, thermal decomposition of fluorocarbon gas may generate hydrogen fluoride but only in minute quantity. For this reason, impact on the detection surface was determined minimal, and decision was made that fluorocarbon gas does not accelerate degradation of semiconductor sensors in comparison to methane. Furthermore, provisions for inspection, calibration and replacement after refrigerant leakage detection or alarm removes concern for detector and detector-alarm degradation in case of massive refrigerant leakage. Additionally, because fluorocarbon gases cannot be released into the atmosphere, the use of the gas in gas resistance test is extremely difficult at present. For the reasons mentioned above, the type and concentration of gas to be used in the gas resistance was determined to be identical to that of **JIA E 001-15**, with 10 000-12 500 ppm of methane.

3) **Infrared ray type** The durability test specified in this standard herein is for a semiconductor and other types other than the infrared ray type. The semiconductor type undergoes repeated gas adhesion on the detection surface in the durability test, accelerated to examine degradation of the detection surface. In the case of infrared ray detectors and detector-alarms, the durability test in this standard has been applied only to Performance

Criteria 1, due to absence of degradation of the light emission and reception components. If a method is found for accelerated testing of the infrared ray type, it may be added to this standard herein.

v) Condensation resistance test The condensation resistance test consists of condensation at the door opening and freezing at door closing for reach-in-type refrigerated display cabinets, etc. The temperature and humidity requirements for the test was based on **ISO 23953-2**. **ISO 23953-2** calls for temperature of 25±1 °C and humidity of 60±5 %. In order to simplify the test in terms of device and method, the requirements were set at 25 °C or higher and relative humidity of 60 % or higher. In terms of test repetition, the detectors have adequate moisture protection of IPX3 or higher specified in **IEC 60529**. For this reason, it was decided that confirmation test is adequate. The frequency was set at 36 as in **ISO 23953-2**, with others set at 1 000 identical to the **JIA E 001-15** gas resistance test. Since the exposure time is aimed at condensation of the surface of the detector and the detector-alarm followed by freezing, the time was set at "for 3 minutes or until condensation occurs on the surface" due to the difference in the exterior conditions of the detector and the detector-alarm.

w) Response of detectors and detector-alarms to low temperature and high temperature Nearly all semiconductor type detectors and detector alarms are not designed for use at temperature of -40 °C or lower, and the infrared ray type not used at temperature of -20 °C or lower. For use of the detector or detector-alarm in such temperatures, it is necessary to use aspirating detector that aspirate the gas to be measured into the environment where the detector and the detector-alarm is used. In the temperature ranges described in **4.2**, the aspirating detector can be applied even for detectors and detector-alarms that are not capable of functioning at temperatures close to the upper limit or close to the lower limit. In the use of such a device, however, it is necessary to confirm that such a configuration can be actually installed and approval is obtained from the user on the use of such a type. In such a case, the detector and the detector-alarm does not cover the temperature range (such as temperature range 4) of the target. The use of aspirating detector and detector-alarm corresponding to a different temperature range (such as temperature range 1) corresponding to the ambient temperature for the target temperature range (such as temperature range 4) is acceptable. In such a case, however, cautionary notes on indication and handling described in body **10** herein shall be those of the different temperature range (such as temperature range 1), with addition of supplementary explanation as needed.

Roster of Working Group

Refrigerant leak detector and alarm specification study WG

Chair	Koji Yamashita	Mitsubishi Electric Corporation
Member	Kazuhiro Hiugano	Toshiba Carrier Corporation
	Masahiro Honda	Daikin Industries, Ltd.
	Hideya Ikeda	Panasonic Corporation
	Takashi Ikeda	Mitsubishi Electric Corporation
	Akihiro Inoue	Takagi Refrigerating. Co. Ltd
	Osamu Ishiyama	Fuji Electric Co., Ltd.
	Ken Kumagai	Ichinen Jikco Ltd.
	Fumihiko Kurita	Panasonic Corporation
	Yasushi Nakamura	Hitachi-Johnson Controls Air Conditioning, Inc.
	Yoshio Ogawa	Fujikoki Corporation
	Toshimi Ohashi	Asada Corporation
	Takashi Sakurai	Hitachi-Johnson Controls Air Conditioning, Inc.
	Takahiro Senda	Ebara Refrigeration Equipment ＆ Systems Co., Ltd.
	Kazuki Wajima	Mitsubishi Heavy Industries thermal systems, Ltd.
Secretariat	Kazuhiro Hasegawa	The Japan Refrigeration and Air Conditioning Industry Association
	Hiroshi Takada	The Japan Refrigeration and Air Conditioning Industry Association

Japanese Text

Established by The Japan Refrigeration and Air Conditioning Industry Association

Date of Establishment: 2016- 5-23

Date of Amendment: 2016- 9-26

This English translation is Published by

The Japan Refrigeration and Air Conditioning Industry Association

3-5-8, Shibakoen, Minato-ku

Tokyo, 105-0011 JAPAN