C9E-0030

RIKEN KEIKI

CONDENSED CATALOG

PART-I

Portable Gas Detector

Gas Detector for Combustible Gases/Oxygen/Toxic Gases

RIKEN KEIKI Co.,Ltd.

"Creating safe working environments for workers"

RIKEN KEIKI was established in 1939 as part of RIKEN conglomerate (currently called RIKEN, a national R&D corporation). For nearly 8 decades since its birth, it has dedicated itself in developing unique technology for the industry.

In our living environment, environmental pollution is threatening our lives and precious assets.

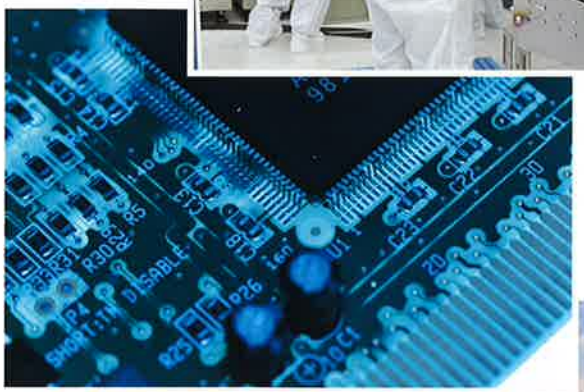
Even before there were any warnings of an environmental crisis, we have contributed to society with our industrial pollution/disaster prevention instruments.

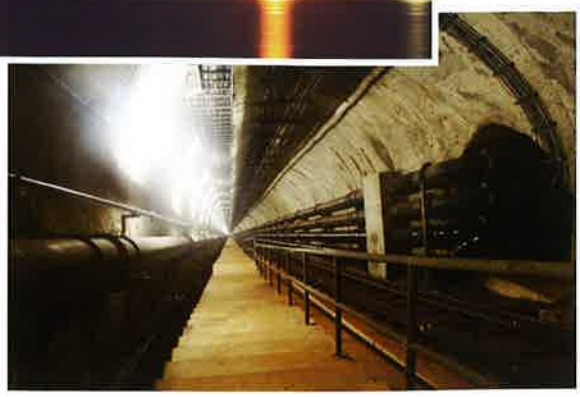
At present, we produce from large-scale gas detecting alarm systems to small-sized personal gas monitors for safety protection in many industries.

In addition, our gas detector are widely used in the semiconductor and space development industries.

We also have a large share of gas measuring instruments in the fields of pollution prevention and health care.

With growing needs for disaster prevention and environmental preservation, we are determined to continue developing reliable technologies utilizing our scientific knowledge and skills under the eternal goal of safety "Creating safe working environments for workers."





CONTENTS

Regarding Portable Gas Detector

A portable type gas detector is, as the name suggests, handheld type a worker can carry or attach to the body. It is possible to detect and measure toxic gas around a moving worker and/or in specific places which may be dangerous, different from fixed gas detect. It can discover the leakage at the early stage, of such as combustible gases which may stay in the air and might cause the explosion and of such as toxic gases that cause the adverse effect to the human body, and can also manage the concentration of indispensable oxygen for us. As the result, all the accidents that originate in the gases can be prevented.

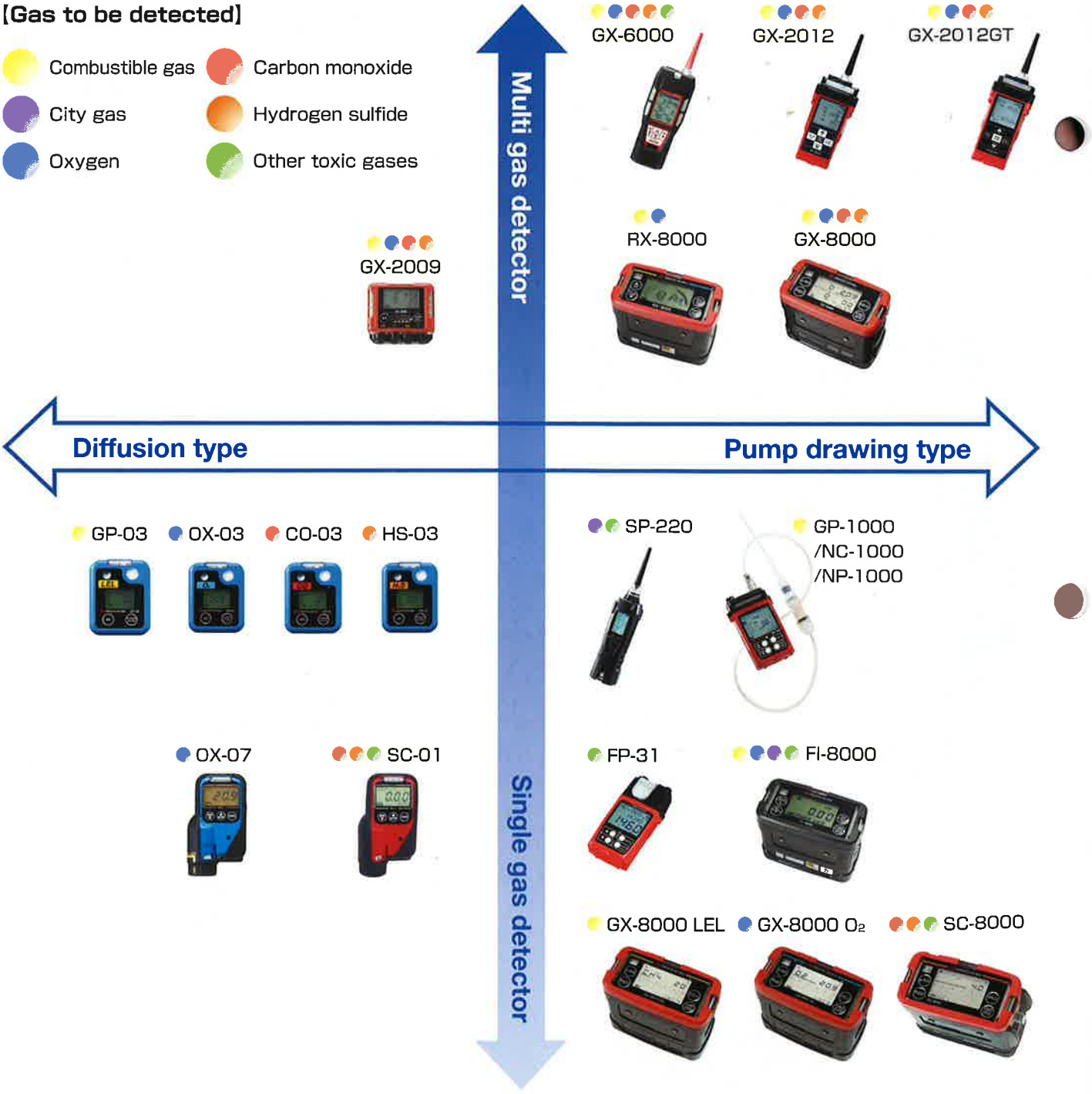
There are two gas sampling methods for the detector to adjust to miscellaneous environments. One is the pump drawing type. The usages of the sampling method are wide-ranging, such as finding a leaking position and/or inspecting the danger of potential gases prior to the working in a manhole and/or a tank utilizing the drawing function of the pump built in the main body of the device. The other is a diffusion type. The type is mainly used to monitor the peripheral safety of a worker in real time as the instrument is small and light due to the pump being not built in.

'Multi gas detector' which detects above-mentioned two or more gases such as the dangerous gas, oxygen etc. and displays their concentrations at the same time has been the main current stream of the detector, and RIKEN KEIKI has also lined up a wide series of detector.

Type of Portable Gas Detector

[Gas to be detected]

- Combustible gas
- Carbon monoxide
- City gas
- Hydrogen sulfide
- Oxygen
- Other toxic gases



Necessity of Maintenance

The implementation of regular maintenance is extremely important to maintain the performance and to improve reliability on disaster prevention and security in using the gas detector. Accurate detection cannot be implemented if the device is continued to use without maintenance.

There are maintenances that are the daily and monthly maintenances to be implemented by the workers and the regular maintenance to be implemented by the service engineer of RIKEN KEIKI. Daily maintenance is a visual check to be implemented by the worker before the beginning of the work. The monthly maintenance is the maintenance of the alarm circuit (alarm test) to be implemented by the worker once a month. The regular maintenance are checks such as the sensitivity calibration etc. to maintain the performance as the security equipment to be implemented once every six months.

In Japan, regarding the special high pressure gas, especially, is obligated in Exemplified Standards concerning Safety Regulations for General High Pressure Gas, saying that 'Calibration of the reading of gas leakage detection alarm equipment for special high pressure gas shall be carried out at least once every six months.'

With correct execution of maintenance, the performance and the function of the devices can be maintained to be excellent and the safety without the gas disaster can be secured, for a long term.

Enhanced Support Network

RIKEN KEIKI is working on the speed up of the emergency response and the regular maintenance.
RIKEN KEIKI has prepared the thorough system for after-sales service with technological members who have expertise and certain technical skill.

RIKEN KEIKI is aiming at the enhancement of the service network. RIKEN KEIKI as the manufacturer of the industrial disaster prevention devices always responds to the consultation and after-sales service with the responsibility concerning the product by allocating service engineers with expertise.

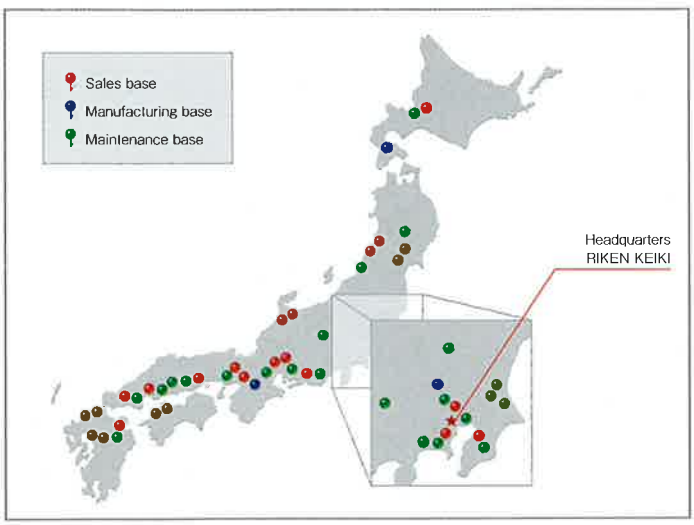
《International Bases》

International bases

North America	United States
South America	Brazil, Argentina, Peru, Chile, Uruguay
Asia-Pacific	China, South Korea, Taiwan, Singapore, Malaysia, Indonesia, Thailand, India, Vietnam, Philippines, Australia
Europe	Germany, Greece, Norway, Turkey, United Kingdom
The Middle East	United Arab Emirates, Israel
Africa	South Africa
Russia	Russian Federation

《Japanese Bases》

	Japanese sales bases	Japanese service bases
Hokkaido area	Sapporo	Sapporo
Tohoku area	Sendai, Tsuruoka	Iwate, Sendai, Tsuruoka
Kanto and Shinetsu area	Mito, Saitama, Chiba, Kanagawa	Tochigi, Mito, Kashima, Saitama, Chiba, Tokyo, Yokohama, Atsugi, Niigata, Matsumoto, Kofu
Tokai, Hokuriku and Kinki area	Hamamatsu, Nagoya, Yokkaichi, Kanazawa, Osaka, Kobe	Hamamatsu, Nagoya, Yokkaichi-higashi, Yokkaichi, Toyama, Keiji, Amagasaki, Himeji
Chugoku and Shikoku area	Mizushima, Shikoku, Hiroshima, Tokuyama	Mizushima, Shikoku, Higashihiroshima, Hiroshima, Tokuyama
Kyushu and Okinawa area	Fukuoka, Kumamoto, Oita	Tosu, Kumamoto, Oita



Multi Gas Detector

From the prevention of explosion accident to the voluntary management of chemical substances

Portable monitor for 6 gases

GX-6000

Explosion-proof ATEX, TIIS Explosion-proof authorized.
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

Drawing Pump drawing type

Features

- Up to 6 gases can be detected and displayed simultaneously.
- VOC can be detected by adoption of the PID sensor.
- Multi languages can be displayed (Japanese/English and others).
- Measurement in a dark place is safely done with the LED light.
- Equipped with panic alarm & man down alarm function.
- Intrinsic safety (Explosion-proof class: Exia II CT4X).

Specification

Model	GX-6000
Detection method	Pump drawing type Drawing flow rate: 0.45 L/min or more (open flow rate)
Gas to be detected	Refer to the following "List of gas to be detected".
Detection principle	
Detection range	
Alarm buzzer sound pressure	95 dB(A) or higher (30 cm) (with the protection cover mounted)
Display	LCD digital (full dot display) Display language: Japanese/English etc.
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)
Power supply	Lithium-ion battery unit or dry battery unit <3 AA alkaline battery>
Continuous operating time	Lithium-ion battery unit: approx. 14 hours (fully charged, 25°C, without alarm nor illumination) Dry battery unit: approx. 8 hours (new dry battery, 25°C, without alarm nor illumination)
External dimensions	approx. 70(W) × 201(H) × 54(D) mm (projection portions excluded)
Weight	approx. 500 g (lithium-ion battery unit is used) approx. 450 g (dry battery unit is used)
Protection level	IP67 equivalent

List of Gas to be Detected※1

Number mountable	No.	Gas to be detected	Detection principle	Detection range	1 digit
0 - 4 sensor (selectable)	1	Combustible gas (HC/CH_4)	New ceramic	0~100%LEL	1%LEL
	2	Oxygen (O_2)	Galvanic cell	0~40.0vol%	0.1vol%
	3	Hydrogen sulfide (H_2S)	Electrochemical	0~100.0ppm	0.5ppm
	4	Carbon monoxide (CO)		0~500ppm	1ppm
0 - 2 sensor (selectable)	5	Volatile organic compound (VOC)	PID	0~50000ppb	1ppb (~5000) ⇒10ppb (5000~)
	6	Volatile organic compound (VOC)		0~6000ppm	0.1ppm (~600.0) ⇒1ppm (600~)
	7	Sulfur dioxide (SO_2)	Electrochemical	0~100.00ppm	0.05ppm
	8	Nitrogen dioxide (NO_2)		0~20.00ppm	0.05ppm
	9	Hydrogen cyanide (HCN)		0~15.0ppm	0.1ppm
	10	Ammonia (NH_3)		0~400.0ppm	0.5ppm
	11	Chlorine (CL_2)		0~10.00ppm	0.05ppm
	12	Combustible gas (HC)	Non-dispersive infrared	0~100%LEL/0~30.0vol%※2	1%LEL/0.5vol%
	13	Carbon dioxide (CO_2)		0~10.00vol%	0.02vol%
	14	Combustible gas (CH_4)		0~100%LEL/0~100.0vol%※2	1%LEL/0.5vol%
	15	Carbon dioxide (CO_2)		0~10000ppm	25ppm

※ 1 In case of specific combination, caution might be necessary in use.
※ 2 The display automatically changes into vol% when the gas of 100% LEL or more is detected.

Multi Gas Detector

Personal multi gas monitor

HC or CH_4 | O_2 | H_2S | CO

GX-2009

Features

- Simultaneous detection of utmost 4 components possible.
- Protection level: IP67 equivalent.
- Intrinsic safety (explosion-proof class: Exia II CT4X).
- Peak holding function provided.
- Data logger function (utmost 600 hours) equipped.

Explosion-proof ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

HK HK (NIPPON HAKUYOHIN KENTEI KYOKAI)
Prototype approval accepted

MED MED (council directive 96/98/EC on marine equipment) acceptable

Specification

Model	GX-2009			
Detection method	Diffusion type			
Gas to be detected	HC / CH_4	O_2	H_2S	CO
Detection principle	New ceramic	Galvanic cell	Electrochemical	
Detection range	0 ~ 100% LEL	0 ~ 40.0vol%	0 ~ 100.0ppm	0 ~ 500ppm
1 digit	1% LEL	0.1vol%	0.5ppm	1ppm
Alarm setpoint value	1st 10% LEL 2nd 50% LEL OVER 100% LEL	L Alarm 19.5vol% H Alarm 23.5vol% OVER 40.0vol%	1st 5.0ppm 2nd 30.0ppm TWA 5.0ppm STEL 5.0ppm OVER 100.0ppm	1st 25ppm 2nd 50ppm TWA 25ppm STEL 200ppm OVER 500ppm
Range of operating temperature and relative humidity	-20 ~ +50°C and below 85% RH (no condensing)			
Power supply	Ni-MH battery (rechargeable)			
Continuous operating time	Combustible gas detection included: approx. 20 hours (fully charged, 25°C, without alarm nor illumination) Combustible gas detection not included: approx. 60 hours (fully charged, 25°C, without alarm nor illumination)			
External dimension/ Weight	approx. 76(W) × 69(H) × 26(D) mm (projection portions excluded)/approx. 130 g			
Protection level	IP67 equivalent			

Type List

TYPE		Gas to be detected
4 gas	TYPE A	HC or CH_4 / O_2 / H_2S / CO
3 gas	TYPE B	HC or CH_4 / O_2 / H_2S
	TYPE C	HC or CH_4 / O_2 / CO
2 gas	TYPE D	HC or CH_4 / O_2
	TYPE E	O_2 / H_2S
	TYPE F	O_2 / CO
	TYPE I	HC or CH_4 / CO

Handheld multi gas monitor

HC or CH_4 | O_2 | H_2S | CO

GX-2012 GX-2012GT

Features

- 1 ppm of hydrogen sulfide alarm settable.
  (detection of hydrogen sulfide is possible with GX-2012 only).
- Leak of the combustible gas can be checked
  (applicable only for GX-2012GT).
- Intrinsic safety (explosion-proof class: Exia II CT4X).
- Safe protection class for outdoors: IP67 equivalent.
- Alarm lamp easy to see from 3 directions.
- Sound pressure of alarm buzzer not less than 95 dB.
- Dry battery unit (standard) and lithium-ion battery unit (option) can be used together.

Explosion-proof ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

Drawing Pump drawing type

Specification

Model	GX-2012/GX-2012GT				
Detection method	Pump drawing type				
Gas to be detected	HC / CH_4		O_2	H_2S ※1	CO
Detection principle	Hot-wire semiconductor※2	New ceramic/Thermal conductivity	Galvanic cell	Electrochemical	
Detection range	HC : 0 ~ 2000ppm or CH_4 : 0 ~ 5000ppm	0 ~ 100% LEL/~ 100vol%※3	0 ~ 40.0vol%	0 ~ 100.0ppm	0 ~ 500ppm
Alarm setpoint value	-	1st 10% LEL 2nd 50% LEL OVER 100% LEL	L Alarm 19.5vol% H Alarm 23.5vol% OVER 40.0vol%	1st 5.0ppm 2nd 30.0ppm TWA 5.0ppm STEL 5.0ppm OVER 100.0ppm	1st 25ppm 2nd 50ppm TWA 25ppm STEL 200ppm OVER 500ppm
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (Non-condensing)				
Power supply	Dry battery unit <3 AA alkaline battery> (standard) or lithium-ion battery unit (option)				
Continuous operating time	Dry battery unit: approx. 15 hours (25°C, without alarm nor illumination)※4 Lithium-ion battery unit: approx. 10 hours (fully charged, 25°C, without alarm nor illumination)※4				
External dimension/ Weight	approx. 71(W) × 173(H) × 43(D) mm (projection portions excluded)/approx. 360 g (dry battery unit or lithium-ion battery unit installed)				
Protection level	IP67 equivalent				

※1 Detection of hydrogen sulfide is possible with GX-2012 only. ※2 Detection of Leakage (ppm detection) is possible with GX-2012GT only.
※3 Detection of high density combustible gas (vol%) is possible with the CH_4 specification model only. ※4 Continuous operating time of the GX-2012GT varies depending on the mode used.

Type List (GX-2012)

TYPE		Gas to be detected
5 gas	TYPE A	CH_4(% LEL) / CH_4(vol%) / O_2 / H_2S / CO
4 gas	TYPE B	HC or CH_4(% LEL) / O_2 / H_2S / CO
3 gas	TYPE C	HC or CH_4(% LEL) / O_2 / H_2S
	TYPE D	HC or CH_4(% LEL) / O_2 / CO
	TYPE E	CH_4(% LEL) / CH_4(vol%) / O_2
2 gas	TYPE F	HC or CH_4(% LEL) / O_2

Type List (GX-2012GT)

TYPE		Gas to be detected
5 gas	TYPE A	CH_4(leakage) / CH_4(% LEL) / CH_4(vol%) / O_2 / CO
4 gas	TYPE B	HC or CH_4(leakage) / HC or CH_4(% LEL) / O_2 / CO
	TYPE C	CH_4(leakage) / CH_4(% LEL) / CH_4(vol%) / O_2
3 gas	TYPE D	HC or CH_4(leakage) / HC or CH_4(% LEL) / O_2

Multi Gas Detector

Conforming to SOLAS convention amendments! Infrared portable gas monitor series

Combustible gases can be measured even in the inert gas and N2.

Features

- Simultaneous detection and display of combustible gas and oxygen possible.
- Intrinsic safety.
- Continuous operating time up to more than 10 hours.
- Residual CO_2 density in the repairing tank is measurable (RX-8500).
- High density hydrogen sulfide is measurable (RX-8700).

RX-8000

Explosion-proof — ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

MED — MED (council directive 96/98/EC on marine equipment) acceptable

Drawing — Pump drawing type

Specification

Model	RX-8000	
Measuring method	Pump drawing type	
Gas to be detected	HC / CH_4	O_2
Measuring principle	Non-dispersive infrared	Galvanic cell
Measuring range	0 ~ 100.0%LEL / ~ 100.0vol% Automatic range switching	0 ~ 40.0vol%
1 digit	0.5%LEL / 0.5vol%	0.1vol%
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)	
Power supply	Lithium-ion battery unit or dry battery unit <3 AA alkaline battery>	
Continuous operating time	Lithium-ion battery unit: approx. 15 hours (fully charged, 25°C, without alarm nor illumination) dry battery unit: approx. 10 hours (25°C, without alarm nor illumination)	
External dimension/ Weight	approx. 154(W) × 81(H) × 127(D) mm (projection portions excluded)/approx. 1.1 kg (lithium-ion battery unit is used) and (mm) 1.0 kg (dry battery unit is used).	
Protection level	IP67 equivalent	

Simultaneous measurement and display of 4 components is possible and corresponds to all the applications by 1 unit.

RX-8500

Explosion-proof — ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

Drawing — Pump drawing type

Specification

Model	RX-8500			
Measuring method	Pump drawing type			
Gas to be detected	CH_4	O_2	CO	CO_2
Measuring principle	Non-dispersive infrared	Galvanic cell	Electrochemical	Non-dispersive infrared
Measuring range	0 ~ 100.0%LEL/5 ~ 100.0vol% Automatic range switching	0 ~ 40.0vol%	0 ~ 1000ppm	0 ~ 20.0vol%
1 digit	0.5%LEL/0.5vol%	0.1vol%	1ppm	0.01vol% (0 ~ 2.00vol%) 0.05vol% (2.00 ~ 5.00vol%) 0.1vol% (5.00 ~ 20.0vol%)
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)			
Power supply	Lithium-ion battery unit or dry battery unit <3 AA alkaline battery>			
Continuous operating time	Lithium-ion battery unit: approx. 15 hours (fully charged, 25°C, without alarm nor illumination) Dry battery unit: approx. 8 hours (new dry battery, 25°C without alarm nor illumination).			
External dimension/ Weight	approx. 154(W) × 81(H) × 163 (D) mm (projection portions excluded)/ approx. 1.2 kg (lithium-ion battery unit is used) and approx. 1.1 kg (dry battery unit is used)			
Protection level	IP67 equivalent			

High concentration hydrogen sulfide can be measured!
Low and high concentration measuring modes can be switched with only 1 button.

RX-8700

Explosion-proof — ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

Drawing — Pump drawing type

Specification

Model	RX-8700			
Measuring method	Pump drawing type			
Gas to be detected	HC	O_2	H_2S	
Measuring principle	Non-dispersive infrared	Galvanic cell	Electrochemical	
Measuring range	0 ~ 100.0%LEL/2 ~ 100.0vol% Automatic range switching	0 ~ 40.0vol%	[low concentration] 0 ~ 100.0ppm	[high concentration] 0 ~ 1000ppm
1 digit	0.5%LEL/0.5vol%	0.1vol%	0.5ppm	1ppm
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)			
Power supply	Lithium-ion battery unit or dry battery unit (3 AA alkaline battery)			
Continuous operating time	Lithium-ion battery unit: approx. 15 hours (fully charged, 25°C, without alarm nor illumination) Dry battery unit: approx. 8 hours (new dry battery, 25°C without alarm nor illumination)			
External dimension/ Weight	approx. 154(W) × 81(H) × 163 (D) mm (projection portions excluded)/ approx. 1.3 kg (lithium-ion battery unit is used) and approx. 1.1 kg (dry battery unit is used)			
Protection level	IP67 equivalent			

Multi Gas Detector

Simultaneous detection and display of utmost 4 components possible

GX-8000

Explosion-proof — ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

HK — HK (NIPPON HAKUYOHIN KENTEI KYOKAI)
Prototype approval accepted

MED — MED (council directive 96/98/EC on marine equipment) acceptable

Drawing — Pump drawing type

Features

- Easy carrying due to small size and lightness.
- Large screen with backlight easy to see.
- Display the concentration with both the value and the bar meter.
- Solid structure strong to impact and dirt.

Specification

Type	GX-8000			
Detection method	Pump drawing type			
Gas to be detected	HC/CH_4/H_2/C_2H_2	O_2	H_2S	CO
Detection principle	New ceramic/ Thermal conductivity	Galvanic cell	Electrochemical	
Detection range	0 ~ 100% LEL/ ~ 100vol%※	0 ~ 40.0vol%	0 ~ 100.0ppm	0 ~ 500ppm
1 digit	1% LEL/1vol%	0.1vol%	0.5ppm	1ppm
Alarm setpoint value	1st 10% LEL 2nd 50% LEL OVER 100% LEL	L Alarm 19.5vol% H Alarm 22.5vol% OVER 40.0vol%	1st 5.0ppm 2nd 30.0ppm TWA 10.0ppm STEL 15.0ppm OVER 100.0ppm	1st 25ppm 2nd 50ppm TWA 25ppm STEL 200ppm OVER 500ppm
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)			
Power supply	Lithium-ion battery unit (standard) or dry battery unit <3 AA alkaline battery> (option)			
Continuous operating time	Lithium-ion battery unit: approx. 12 hours (fully charged, 25°C, without alarm nor illumination) Dry battery unit: approx. 6 hours (25°C, without alarm nor illumination)			
External dimension/ Weight	approx. 154(W) × 81(H) × 127(D) mm (projection portions excluded)/ approx. 1.1 kg (lithium-ion battery unit is used) and approx. 1.0 kg (dry battery unit is used)			
Protection level	IP67 equivalent			

※Detection of high density combustible gas (vol%) is applicable, only for the CH_4 specification model.

Type List

TYPE		Gas to be detected
4 gas / 5 range	TYPE A	HC or CH_4 (%LEL, vol%) / O_2 / H_2S / CO
4 gas	TYPE B	HC or CH_4 (%LEL) / O_2 / H_2S / CO
3 gas	TYPE C	HC or CH_4 or C_2H_2 (%LEL) / O_2 / H_2S
	TYPE D	HC or CH_4 (%LEL) / O_2 / CO
2 gas / 3 range	TYPE E	HC or CH_4 or H_2 (%LEL, vol%) / O_2
2 gas	TYPE F	HC or CH_4 or C_2H_2 (%LEL) / O_2
	TYPE G	H_2 (%LEL) / O_2

Oxygen Monitor

Portable oxygen monitor

OX-07

Explosion-proof — ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT3X

HK — HK (NIPPON HAKUYOHIN KENTEI KYOKAI) Prototype approval accepted

MED — MED (council directive 96/98/EC on marine equipment) acceptable

Features

- Intrinsic safety.
- Large screen digital display.
- 30 m telemetry possible with remote cable.
- Robust protection rubber for impact equipped as the standard.

Specification

Model	OX-07	
Type	TYPE A	TYPE B
Detection method	Diffusion type	
Gas to be detected	O_2	
Detection principle	Galvanic cell	
Detection range	0 ~ 40.0vol%	
1 digit	0.1 vol%	
Alarm setpoint value	Low alarm 19.5 vol% High alarm 23.5 vol% Over 40.0 vol%	No alarm
Range if operating temperature and relative humidity	-20 ~ +50°C and below 95 RH (non-condensing)	
Power supply	2 AA alkaline battery	
Continuous operating time	approx.5000 hours (25°C without alarm nor illumination)	
External dimension/ Weight	approx. 77(W) x 131(H) x 40(D) mm (projection portions excluded) / approx. 230 g (clip is excluded)	

Portable oxygen monitor

GX-8000 (TYPE O_2)

Explosion-proof — ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

HK — HK (NIPPON HAKUYOHIN KENTEI KYOKAI) Prototype approval accepted

MED — MED (council directive 96/98/EC on marine equipment) acceptable

Drawing — Pump drawing type

Features

- Explosion-proof for hydrogen: Exia II CT4X and safe protection class even under a severe environment IP67 equivalent.
- Strong drawing with a large flow rate pump.
- An extension hose 30 m at the maximum can be used.

Specification

Model	GX-8000
Type	TYPE O_2, L (gas alarm provided specification)
Detection method	Pump drawing type
Gas to be detected	O_2
Detection principle	Galvanic cell
Detection range	0 ~ 40.0vol%
1 digit	0.1vol%
Alarm setpoint value	L Alarm 19.5% H Alarm 23.5% OVER 40.0%
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)
Power supply	Dry battery unit <3 AA alkaline battery> (standard) or lithium-ion battery unit (option)
Continuous operating time	Dry battery unit: approx. 12 hours (25°C, without alarm nor illumination) Lithium-ion battery unit: approx. 20 hours (fully charged, 25°C, without alarm nor illumination)
External dimension / Weight	approx. 154(W) × 81(H) × 127(D) mm (projection portions excluded) / approx. 1.0 kg (dry battery unit used) and approx. 1.1 kg (lithium-ion battery used)
Protection level	IP67 equivalent

Combustible Gas Detector

Handheld gas leakage detector

SP-220

Explosion-proof

TYPE M For City gas (CH_4)
TYPE L For LPG
TYPE ML For both City gas (CH_4) and LPG
TYPE F For CFC gas
TYPE H2 For Hydrogen and combustible gas

Non Explosion-proof

TYPE FUM For Fumigation gas
TYPE SC For Semiconductor material gas and general gas

Features

- Target gas changeable
- Quick and reliable detection for small amount of gas leakage.
- Strong for impact and dirt, robust and stylish body.
- The durability of the sensor has been improved with a built-in filter.
- Data logger function equipped (256 data at the maximum can be recorded).
- Safe even in a dark place with the LED light.

Explosion-proof: ATEX, TIIS Explosion-proof authorized *
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4
※TYPE M/TYPE L/TYPE ML/TYPE F/TYPE F only

Drawing: Pump drawing type

List of Gas to be Detected

●For CFC gas (TYPE F)

1	R600a (isobutane)	8	CFC 23
2	R290 (propane)	9	CFC 407C
3	CFC 123	10	CFC 410A
4	CFC 134a	11	CFC 404A
5	CFC 142b	12	2,3,3,3-Tetrafluoropropane (HFO-1234yf)
6	CFC 22	13	CFC 507A
7	CFC 32	14	CFC 407A

●For Hydrogen and combustible gas (TYPE H2)

1	Methane	8	Butadiene	15	CFC 134a
2	Hydrogen	9	Isobutylene	16	HFO-1234yf
3	Acethylene	10	n-butane		
4	Ethylene	11	Isobutane		
5	Ethane	12	Cyclopentane		
6	Propylene	13	n-hexane		
7	Propane	14	CFC 22		

●For fumigation gas (TYPE FUM)

1	Phosphine
2	Methyl bromide
3	Carbon disulfide※
4	Methyl iodide
5	Hydrogen cyanide
6	Sulfuryl fluoride
7	Ethylene dibromide※

※ Prohibited gas to use in Japan.

●For Semiconductor material gas and general gas (TYPE SC)

1	Phosphine	11	Methyl chloride	21	Propane	31	Hydrogen sulfide
2	Acetone	12	Xylene	22	CFC 134a	32	Diborane
3	Arsine	13	Ethylene oxide	23	CFC 22	33	Germane
4	Ammonia	14	Silane	24	CFC 32	34	Hydrogen bromide
5	Isobutane	15	Methyl bromide	25	Normal hexane	35	Hydrogen chloride
6	Isopropyl alcohol	16	Hydrogen	26	Benzene	36	CFC 407C
7	Carbon monoxide	17	Trichloroethylene	27	Formaldehyde	37	Hydrogen selenide
8	Ethyl alcohol	18	Toluene	28	Methane	38	CFC 410A
9	Ethylene	19	1, 2-Dichloroethane	29	Methyl alcohol	39	CFC 404A
10	Vinyl chloride	20	Sulfur dioxide	30	Methyl ethyl ketone	40	HFO-1234yf

Specification

Model	SP-220						
Type	TYPE M	TYPE L	TYPE ML	TYPE F	TYPE H2	TYPE FUM	TYPE SC
Detection method	Pump drawing type						
Gas to be detected	City gas	LPG	City gas / LPG (switch)	Refer to the "List of gas to be detected" above			
Calibration gas	CH_4	i-C_4H_{10}	CH_4/i-C_4H_{10}※	i-C_4H_{10}	H_2/CH_4	PH_3	
Detection principle	Hot-wire semiconductor						
Detection range	10 ~ 10000ppm			Depending on gas to be detected			
Alarm setpoint value	Initial value: 30 ppm (possible to set by 5 steps of 10, 30, 150, 500, and 2000 ppm)					Depending on gas to be detected	
Range of operating temperature and relative humidity	-20 ~ +55°C and below 95% RH (non-condensing)						
Power supply	2 AA alkaline battery						
Continuous operating time	approx. 13 hours (20°C, without alarm nor illumination)						
External dimension/ Weight	approx. 43(W) × 200(H) × 39(D) mm (the taper nozzle is excluded)/approx. 215 g (dry battery is excluded).						
Protection class	IP55 equivalent						

※Gas Calibration

Combustible Gas Detector

Portable combustible gas monitor

【For LEL detection】 【For ppm detection】

GP-1000 / NC-1000

【For VOL detection】

NP-1000

Explosion-proof ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4

Drawing Pump drawing type

GP-1000/NC-1000 List of Gas to be detected

No.	List of Gas kind	Display	Lower Explosive Limit LEL	Reading from methane in a different way	Reading from isobutane in a different way
1	Methane	CH_4	5.0vol%	—	×
2	Isobutane	$i\text{-}C_4H_{10}$	1.8vol%	○	—
3	Hydrogen	H_2	4.0vol%	○	○
4	Methanol	CH_3OH	5.5vol%	○	○
5	Acetylene	C_2H_2	1.5vol%	○	○
6	Ethylene	C_2H_4	2.7vol%	○	○
7	Ethane	C_2H_6	3.0vol%	○	×
8	Ethanol	C_2H_5OH	3.3vol%	○	○
9	Propylene	C_3H_6	2.0vol%	○	○
10	Acetone	C_3H_6O	2.15vol%	○	○
11	Propane	C_3H_8	2.0vol%	○	×
12	Butadiene	C_4H_6	1.1vol%	○	○
13	Cyclopentane	C_5H_{10}	1.4vol%	○	○
14	Benzene	C_6H_6	1.2vol%	○	○
15	n-hexane	$n\text{-}C_6H_{14}$	1.2vol%	○	○
16	Toluene	C_7H_8	1.2vol%	○	○
17	Heptane	$n\text{-}C_7H_{16}$	1.1vol%	○	○
18	Xylene	C_8H_{10}	1.0vol%	○	○
19	Ethyl acetate	EtAc	2.1vol%	○	○
20	IPA	IPA	2.0vol%	○	○
21	MEK	MEK	1.8vol%	○	○
22	Methyl methacrylate	MMA	1.7vol%	○	○
23	Dimethyl ether	DME	3.0vol%	○	○
24	Methyl isobutyl ketone	MIBK	1.2vol%	○	○
25	Tetrahydrofuran	THF	2.0vol%	○	○

Note 1) The alarm accuracy and response time, etc. are confirmed only by the calibration gas.
Note 2) Please contact RIKEN KEIKI in the case that calibration with other than methane, isobutane and hydrogen is required.
Note 3) Please note that switching of kind of detection gas is impossible if the calibration is implemented using other than methane and isobutane.

NP-1000 List of Gas to be detected

No.	List of Gas kind	Display
1	Methane	CH_4
2	Propane	C_3H_8
3	Isobutane	$i\text{-}C_4H_{10}$
4	Argon	Ar
5	Helium	He
※	Hydorogen	H_2

※Hydrogen is detected by NP-1000 H_2 version. H_2 version cannot convert the reading to other gases.

NP-1000 List of Base Gas

No.	List of Gas kind	Display
1	Air	Air
2	Nitrogen	N_2
3	Carbon dioxide	CO_2

Features

- Direct reading of the concentration values of combustible gases of 25 gases.
- Easy operation feature of changing the gas name display with 1 switch button.
- Long distance drawing possible with the pump booster function.
- Various combustible gases can be measured by the ppm order with NC-1000.

Specification

Model	GP-1000	NC-1000	NP-1000
Detection method	Pump drawing type		
Gas to be detected	Combustible gas and others		
Detection principle	Catalytic combustion	New ceramic	Thermal conductivity
Detection range	0 ～ 100% LEL <Automatic range switching> Low range : 0 ～ 10% LEL High range : 0 ～ 100% LEL	0 ～ 10000ppm <Automatic range switching> Low range : 0 ～ 1000ppm High range : 0 ～ 10000ppm	0 ～ 100 Vol% <Automatic range switching> Low range : 0 ～ 10 Vol% High range : 0 ～ 100 Vol%
Alarm setpoint value	1st 10% LEL 2nd 50% LEL	1st 250ppm 2nd 500ppm	Factory setting : OFF
Range of operating temperature and relative humidity	-20 ～ +50°C and below 95% RH (non-condensing)		
Power supply	4 AA alkaline battery		
Continuous operating time	approx. 20 hours※ (new dry battery, 25°C, without alarm nor illumination, and pump Low mode)		
External dimension/ Weight	approx. 80(W) × 124(H) × 36(D) mm (projection portions excluded) / approx. 260 g (dry battery is excluded).		
Protection level	IP67 equivalent		

※Different depending on the specification

For the Protection of Explosion due to Leakage of Combustible Gases

Combustible Gas Detector

Portable combustible gas monitor

GX-8000 (TYPE LEL)

Explosion-proof

ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4X

HK

HK (NIPPON HAKUYOHIN KENTEI KYOKAI) Prototype approval accepted

MED

MED (council directive 96/98/EC on marine equipment) acceptable

Drawing

Pump drawing type

Features

- Explosion-proof for hydrogen : Exia II CT4X, and safe protection class even under a severe environment IP67 equivalent.
- Strong drawing with a large flow rate pump.
- An extension hose 30 m at the maximum can be used.

Specification

Model	GX-8000
Type	TYPE LEL
Detection method	Pump drawing type
Gas to be detected	HC / CH_4 / H_2
Detection principle	New ceramic
Detection range	0 ~ 100% LEL
1 digit	1% LEL
Alarm setpoint value	1st : 10% LEL, 2nd : 50% LEL, OVER : 100% LEL
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)
Power supply	Dry battery unit <3 AA alkaline battery> (standard) or lithium-ion battery unit (option)
Continuous operating time	Dry battery unit: For approx. 6 hours (25°C, without alarm nor illumination) Lithium-ion battery unit: For approx. 12 hours (fully charged, 25°C, without alarm nor illumination)
External dimension/ Weight	approx. 154(W) × 81 (H) × 127 (D) mm (projection portions excluded) / approx. 1.0 kg (dry battery unit used) and approx. 1.1 kg (lithium-ion battery used)
Protection level	IP67 equivalent

Wide Variation of Usage

Super Toxic Gas Detector

For the patrol such as semiconductor factories

Portable super toxic gas detector

SC-8000

Features

- Intrinsic safety.
- Diverse target gases.
- Simultaneous display of gas concentration with digital numbers and gas concentration level with analog bar meter.
- Buzzer volume control function equipped.

Explosion-proof

ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4

HK

HK (NIPPON HAKUYOHIN KENTEI KYOKAI) Prototype approval accepted

Drawing

Pump drawing type

Gas to be Detected

PH_3	HCl	HF	F_2	ClF_3	HI
AsH_3	Br_2	CO	NH_3	HCN	H_2S
SiH_4	NO	Cl_2	HBr	PF_3	SO_2
B_2H_6	NO_2	O_3	H_2Se	GeH_4	

Specification

Model	SC-8000
Detection method	Pump drawing type
Gas to be detected	Refer to the list of target gases above
Detection principle	Electrochemical
Detection range	Depending on gas to be detected
1 digit	
Alarm setpoint value	
Range of operating temperature and relative humidity	-20 ~ +50°C and 20- 88% RH (no condensing)
Power supply	Dry battery unit <3 AA alkaline battery> (standard) or lithium-ion battery unit (option)
Continuous operating time	Dry battery unit: For approx. 18 hours (25°C, without alarm nor illumination) Lithium-ion battery unit: For approx. 25 hours (fully charged, 25°C, without alarm nor illumination)
External dimension/ Weight	approx. 154(W) × 154(H) × 81(D) mm (projection portions excluded) / approx. 1.0 kg (dry battery unit used) and approx. 1.1 kg (lithium-ion battery used)
Protection level	IP67 equivalent

Portable toxic gas monitor

SC-01

Explosion-proof

ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II BT3

Gas to be Detected

H_2S	NH_3	SO_2
Cl_2	HCN	PH_3
CO		

Features

- Intrinsic safety.
- Telemetry possible with remote cable.
- Robust protection rubber for impact equipped as the standard.

Specification

Model	SC-01
Detection method	Diffusion type
Gas to be detected	Refer to the table left
Detection principle	Electrochemical
Detection range	Depending on gas to be detected
1 digit	
Alarm setpoint value	
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)
Power supply	2 AA alkaline battery
Continuous operating time	For approx. 250 hours (25°C without alarm nor illumination)
External dimension/ Weight	approx. 77(W) × 131(H) × 40(D) mm (projection portions excluded)/approx. 240 g

Small Personal Size

Single Gas Detector

Personal gas monitor

03 series

Features

- Simple design not to disturb work.
- Light body of approx. 80 g with Intrinsic safety.
- Rechargeable battery (eneloop) specification lined up.

Explosion-proof

ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4 (GP-03, CO-03, HS-03)
Exia II CT4X (OX-03)
Exia II CT3Ga (rechargeable battery specification)

Specification

Model	GP-03	OX-03	CO-03	HS-03
Detection method	Diffusion type			
Gas to be detected	HC / CH_4	O_2	CO	H_2S
Detection principle	New ceramic	Galvanic cell	Electrochemical	Electrochemical
Detection range	0 ~ 100% LEL	0 ~ 40.0vol%	0 ~ 500ppm	0 ~ 100.0ppm
1 digit	1% LEL	0.1vol%	1ppm	0.5ppm
Alarm setpoint value	1st 10% LEL 2nd 50% LEL OVER 100% LEL	L Alarm 19.5vol% H Alarm 23.5vol% OVER 40.0vol%	1st 25ppm 2nd 50ppm TWA 25ppm STEL 200ppm OVER 500ppm	1st 5.0ppm 2nd 30.0ppm TWA 5.0ppm STEL 5.0ppm OVER 100.0ppm
Range of operating temperature and relative humidity	-20 ~ +50℃ Below 90% RH (no condensing)	-20 ~ +50℃ Below 95% RH (no condensing)	-20 ~ +50℃ 16 - 85% RH (no condensing)	
Power supply	2 AAA alkaline battery			
Continuous operating time*	For approx. 35 hours (25°C, without alarm nor illumination)	For approx. 3000 hours (25°C without alarm nor illumination)		
External dimension/ Weight	approx. 54(W) × 67(H) × 24(D) mm approx. 80 g			

※When dry battery is used.

From the Environment Measurement to the Leakage Detection

Miscellaneous Monitors

Formaldehyde gas monitor

FP-31

Ministry of Health, Labour and Welfare certified product (JAPAN)
Specified number 2701※1

Features

- Everyone can measure it by an easy operation.
- No anxiety owing to self-diagnosis function installed, and it is safety, and little interference influences.
- Large screen and big letters display easy to see.

Drawing Pump drawing type

Specification

Model	FP-31	
Detection method	Pump drawing type	
Gas to be detected	HCHO (formaldehyde)	
Detection principle	Photoelectric photometry method	
Detection range	TAB No.008	TAB No.009
	0.000 ~ 0.400ppm (however, less than 0.015 ppm is displayed to be < 0.01)	0.00 ~ 1.00ppm (however, less than 0.02 ppm is displayed to be < 0.02)
1 digit	0.005ppm	0.01ppm
Detection time	30 minutes (1800 seconds)	15 minutes (900 seconds)
Range of operating temperature and relative humidity	-10 ~ +40°C and below 90% RH (non-condensing)※2	
Power supply	4 AA alkaline battery	
Continuous operating time	For about 12 hours (new dry battery, 20°C without alarm nor illumination)	
External dimension / Weight	approx. 80(W) × 150(H) × 40(D) mm (projection portions excluded) / approx. 250 g (dry battery is excluded)	

※1 Never fail to use TAB No.008 (0 ~ 0.4ppm) when formaldehyde is to be detected according to the concentration in a room guideline value (0.08 ppm/100 μg/m³ as the average for 30 minutes) of WHO and the Ministry of Health, Labour and Welfare.
※2 Range of operating temperature and relative humidity of detection TAB is described to each detection TAB.

Gas Concentration Meter

For the accurate measurement of various gas concentrations

Optical interterometric gas concentration meter

FI-8000

Explosion-proof ATEX, TIIS Explosion-proof authorized
Explosion-proof construction: Intrinsic safety
Explosion-proof class: Exia II CT4

Drawing Pump drawing type

Features

- Up to 8 gases can be measured simultaneously with 1 instrument.
- Gas drawing method can be chosen (automatic drawing with pump or manual drawing).
- Continuous / intermittent measuring mode are installed.

Specification

Model	FI-8000	
Type	TYPE P	TYPE A
Measuring method	Automatic drawing type with built-in pump	Manual drawing type with hand aspirator
Gas to be detected	Anaesthetic gas / Fumigation gas / Combustible gas / Calorific value etc.	
Measuring principle	Optical inferferometric	
Measuring range	Depending on the measuring object gas	
Indication accuracy	±3% of reading (under the same condition)※	
Range of operating temperature and relative humidity	-20 ~ +50°C and below 95% RH (non-condensing)	
Power supply	Dry battery unit <3 AA alkaline battery> (standard) or lithium-ion battery unit (option)	
Continuous operating time	For approx. 12 hours (new dry battery, 25°C, without illumination)	For approx. 16 hours (new dry battery, 25°C, without illumination)
External dimension/ Weight	approx. 154(W) × 81(H) × 127(D) mm (projection portions excluded) approx. 1.1 kg (dry battery unit is used) and approx. 1.2 kg (lithium-ion battery unit is used)	
Protection level	IP67 equivalent	

※The indication accuracy is different depending on the measuring object gas.

Measuring gas list

<Chamber length: 5mm>

Gas to be detected	Base gas	Range
Methyl bromide	Air	0~100vol%
Sulfur Hexafluoride	Air	0~100vol%
Sulfur Hexafluoride	Air	0~99.9%up
Sulfur Hexafluoride	N_2	0~100vol%
Propane	Air	0~100vol%
Iso-butane	Air	0~100vol%
N-butane	Air	0~100vol%
Flon 22	Air	0~100vol%
Dimethyl Ether	Air	0~100vol%
Dimethyl Ether	N_2	0~100vol%
Xenon	Air	0~100vol%
Ethylene	Air	0~100vol%
Chorine	Air	0~100vol%
Vinyl chloride	N_2	0~100vol%

Gas to be detected	Base gas	Range
Propane	Air	0~101.3 MJ/m³ Gross 0℃
Butane	Air	0~134.2 MJ/m³ Gross 0℃
Propane	Air	0~93.15 MJ/m³ Net 0℃
Butane	Air	0~123.7 MJ/m³ Net 1℃

Detection gas for anaesthetic

Detection gas for fumigation

<Chamber length: 24mm>

Gas to be detected	Base gas	Range
Halothane	O_2	0~6vol%
Isoflurane	O_2	0~8vol%
Sevoflurane	O_2	0~10vol%
Desflurane	O_2	0~20vol%
Halothane	Air	0~6vol%
Isoflurane	Air	0~8vol%
Sevoflurane	Air	0~10vol%
Desflurane	Air	0~20vol%
Enflurane	O_2	0~10vol%
Enflurane	Air	0~10vol%

Gas to be detected	Base gas	Range
Helium	Air	0~100vol%
Helium	N_2	0~100vol%
Helium	Argon	0~100vol%
Hydrogen	Air	0~100vol%
Hydrogen	N_2	0~100vol%
Heavy Hydrogen	Air	0~100vol%
Heavy Hydrogen	N_2	0~100vol%
Carbon dioxide	Air	0~100vol%
Carbon dioxide	N_2	0~100vol%
Carbon dioxide	Argon	0~100vol%
Neon	Air	0~100vol%
Methane	Air	0~100vol%
Methane	N_2	0~100vol%
Nitrus Oxide	Air	0~100vol%
Ozone	O_2	0~100vol%

Gas to be detected	Base gas	Range
LNG or LNG+LPG	-	25~50 MJ/m³ Gross 0℃
LNG or LNG+LPG	-	22~45 MJ/m³ Net 0℃

<Chamber length: 48mm>

Gas to be detected	Base gas	Range
Toluene	Air	0~100%LEL
MEK	Air	0~100%LEL
Ethyl acetate	Air	0~100%LEL
Xylene	Air	0~100%LEL
Iso-proply alcohol	Air	0~100%LEL
M.E.K	Air	0~100%LEL
Methanol	Air	0~100%LEL
Propane	Air	0~100%LEL
Iso-butane	Air	0~100%LEL
Acetone	Air	0~100%LEL
Ethyl alcohol	Air	0~100%LEL
Methane	Air	0~100%LEL
Hydrogen	Air	0~100%LEL
Ethyl chloride	Air	0~100%LEL
Ethylene	Air	0~100%LEL
Styrene	Air	0~100%LEL
Ammonia	Air	0~100%LEL
Tetrahydroflane	Air	0~100%LEL
Dioxolane	Air	0~100%LEL
Methyl-isopropil-Keton	Air	0~100%LEL
Tetrafluoro-propane	Air	0~100%LEL
Butylacetate	Air	0~100%LEL

Gas to be detected	Base gas	Range
Methyl Bromide	Air	0~200g/m³
Methyl Iodide	Air	0~200g/m³
Sulfuryl Fluoride	Air	0~200g/m³
Methyl Bromide	Air	0~5vol%
Propylene oxide	Air	0~10vol%
Phosphine	Air	0~50g/m³
Hydrogen Cyanide	Air	0~200g/m³

Gas to be detected	Base gas	Range
Ammonia	N_2	0~100vol%
Oxygen	N_2	0~100vol%

Danger of Gas

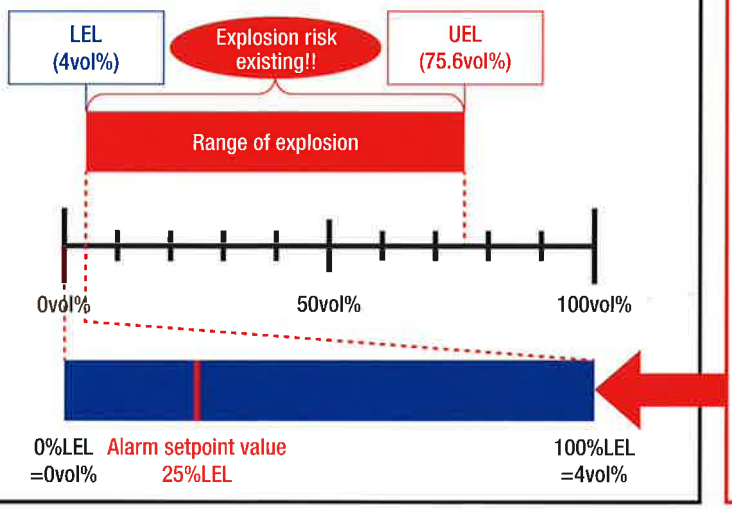
What is the Combustible Gas ...?

According to Safety Regulations for General High Pressure Gas (JAPAN), the combustible gas is;

- The lower limit of the explosion limit of it (it means the explosion limit when it is mixed with air. It is the same as follows.) is 10-percent or less.
- The difference between upper limit and lower limit of explosion limit of it is 20 percent or larger.

The combustible gas is a generic name of the gas with the possibility of causing combustion. There is a possibility of causing an explosion if the density range of the mixture of combustible gas and Oxygen (air) is in a certain range and ignition source exists. This density range is called the range of explosion, and the lowest concentration over the range of explosion is called Lower Explosive Limit (LEL) and the highest concentration are called Upper Explosive Limit (UEL).

1 Example of Lower Explosive Limit (LEL) and Upper Explosive Limit (UEL) of Hydrogen (H_2)



Regarding the Alarm Setpoint Value of the Combustible Gas

It is too late to annunciate the danger after the concentration of the combustible gas reaches Lower Explosive Limit (LEL)!!

The concentration control to inform the existence of the combustible gas before it reaches LEL is necessary.

Regarding the concentration control of less than the Lower Explosive Limit, the alarm setpoint value of the combustible gas is decided as follows in Exemplified Standards concerning Safety Regulations for General High Pressure Gas.

- The value of 1/4 or less of the Lower Explosive Limit

What is the Toxic Gas ...?

According to Safety Regulations for General High Pressure Gas (JAPAN), the toxic gas is,

- Threshold limit value is the 1 of 200/1,000,000 or less (= permissible level is 200 ppm or less)

Moreover, the alarm setpoint value of the toxic gas, according to Exemplified Standards concerning Safety Regulations for General High Pressure Gas, is

- The value below the permissible level value (twice value of the permissible level concentration value for the 1 which is difficult to prepare the calibration gas)

● Definition of permissible level

It is a concentration judged for the adverse effect on health not to be seen by almost all workers if the concentration of the toxic substance in air is below this value even if the worker is exposed to the toxic substance on the labor site.

RIKEN KEIKI adopts the threshold limit value of ACGIH (The United States industry hygiene expert meeting: American Conference of Governmental Industrial Hygienists) though the threshold limit value is recommended by ACGIH and Japan Association of Industrial Health.

● Kind of threshold limit value

- TWA (time weighted average): Time-weighted average value of that health problems might not be caused even if exposed repeatedly in the usual work of 8 hours per day, 40 hours during the week.
- STEL (short term exposure limit): Limit value of short time exposure 4 times or less a day within 15 minutes and interval of 1h or more, by which no health problems might be caused.
- C (ceiling value): Upper bound that must not be exceeded.

What are Oxygen Deficiency and the Hydrogen Sulfide Poisoning?

Oxygen Deficiency and the hydrogen sulfide poisoning are provided from Ordinance on Prevention of Oxygen Deficiency, etc. as follows.

- Oxygen Deficiency ..... The symptom that occurs because of inhalation of air in the state whose concentration of the atmospheric oxygen is less than 18% is observed.
- Hydrogen sulfide poisoning .... The symptom that occurs because of inhalation of air in the state whose concentration of the hydrogen sulfide exceeds 10/1,000,000 (10 ppm) is observed.

A usual alarm setpoint value is set to 18% according to Ordinance on Prevention of Oxygen Deficiency, etc (JAPAN).

Symptom of Oxygen Deficiency

Oxygen concentration (%)	Symptom
20.93	Oxygen concentration of atmosphere.
18	It is necessary to prepare the respiratory protective device such as continuous ventilation, the oxygen concentration measurements in the work environment, and the safety belts though it is a safety threshold. 
16 ~ 12	Increase of pulse and ventilatory frequency, mental concentration decrease, wrong simple calculation, poor precision muscle work, muscular depression, headache, the tinnitus aurium, the evil intention, and nausea appear. 
14 ~ 9	A judgment decrease, a state of exaltation, an unstable mental status, frequent sigh, abnormal tiredness, the state of drunkenness, headache, nausea, vomits, no memory at that time, pain in the wound not felt, escape power of whole body, temperature elevation, cyanosis, haze consideration, danger of the crash death from stairs and a ladder and drowning. 
10 ~ 6	Nausea, vomitus, loose freedom of the action, cannot move nor shout even if danger is felt, prostration, sensory hallucination, cyanosis, loss of consciousness, fainting, central nervous system disorder, generalized convulsion, crisis of death. 
6 or less	Several-time gasping respirations and syncope, fainting, bradypnea and stop, spasm, cardioplegic arrest, death.

Symptom of Hydrogen Sulfide Poisoning

Hydrogen sulfide concentration (ppm)	Symptom
0.025	Limitation of sense of smell.
0.2	Everyone can perceive the odour.
3 ~ 5	Odour of strength of revolted medium degree.
10	Mucous membrane stimulation thresholds of eyes.
20 ~ 30	Do not feel the strength in a concentration any more by the experience of the odour. Minimum boundary where lungs are stimulated.
100 ~ 300	It comes to be felt that the unpleasant odour decreased rather in 2 to 15 minute due to sense of smell neuroparalysis. Diaphragma flame (gas eyes), itching of eye, soreness, feeling that sand catches one's eye, dazzling, hyperemia and tumescence, turbidity of diaphragma, cornea fracture and sluff, distortion of view or bleariness, enhancement of soreness by light. Dead from suffocation due to bronchitis, pulmonitis and pulmonary oedema with 8 to 48 hrs. continuum exposure. Scorching soreness of mucous membrane of the air passages. Limitation that doesn't arrive at a serious symptom with an exposure of 1 hr. or less. 
350 ~ 600	Danger of the life with an exposure of 30 minutes to 1 hr.
700 ~ 1000	Respiratory paralysis, loss of consciousness, fainting, respiratory stoppage, and death at once after appearance of short time interval breath.
5,000	Instantaneous death. 

Reference : New anoxia danger work chief person text (October 26, 2007 3rd print issued)

List of Combustible Gas to be Detected※

Gas name	Chemical formula	Flash point (℃)	Ignition temperature (℃)	Explosion limit (vol%)		Specific gravity
				Lower limit	Upper limit	
Acetylene	C_2H_2	gas	305	1.5	100	0.9 (gas)
Acetone	C_3H_6O	-20	539	2.15	14.3 100℃	0.8
Isobutane	C_4H_{10}	gas	460	1.8	9.8	0.6
Ethanol	C_2H_6O	12	400	3.3	19	0.8
Ethane	C_2H_6	gas	515	3.0	15.5	1.0 (gas)
Ethylene	C_2H_4	gas	440	2.7	36.0	1.0 (gas)
Ortho-xylene	C_8H_{10}	30	470	1.0	7.6	0.9
Ethyl acetate	$C_4H_8O_2$	-4	470	2.1	12.8	0.9
Cyclohexane	C_6H_{16}	-17	245	1.3	8.3	0.8
Cyclopentane	C_5H_{10}	-37	320	1.4	—	—
Dimethyl ether	C_2H_6O	gas	240	3.0	32	—
Hydrogen	H_2	gas	560	4.0	75	0.07 (gas)
Styrene	C_8H_8	30	490	1.1	8.0	0.9
Tetrahydrofuran	C_4H_8O	-14	230	1.8	12.4	0.9
Toluene	C_7H_8	4	530	1.2	7.8	0.9
1,3-butadiene	C_4H_6	gas	420	1.1	16.3	0.6
Propane	C_3H_8	gas	450	2.0	10.9	1.6 (gas)
Propylene	C_3H_6	gas	455	2.0	11.1	—
n-hexane	C_6H_{14}	-22	223	1.2	7.5	0.7
n-heptane	C_7H_{16}	-7	204	1.1	6.7	0.7
Benzene	C_6H_6	-11	498	1.2	8.6	0.9
Methyl methacrylate	$C_5H_8O_2$	10	430	1.7	12.5	0.9
Methanol	CH_4O	9	440	5.5	36	0.8
Methane	CH_4	gas	600	5.0	15.0	0.6
Methyl isobutyl ketone	$C_6H_{12}O$	16	475	1.2 90℃	8 90℃	0.8

※ The value of each item is different according to the literature. The explosion limit in this list of gas to be detected is described based on the house standard. The flash point and the ignition temperature is according to [technological indicator of Labor health and safety General Institute: JNIOSH-TR-No.44 (2012) Factory explosion-proof facility guide for user] and the specific gravity is according to [danger and harmful handbook of chemical substance, June 20, 1991, 1st ed 1st print Issued]

List of Toxic Gas to be Detected

Gas name	Chemical formula	ACGIH recommendation value			Japan Association of Industrial Health recommendation value	RIKEN KEIKI standard	
		Threshold limit value (TLV)※1			Threshold limit value※1	Detection range※2	Alarm setpoint value※2
		TWA	STEL	C			
Arsine	AsH_3	5ppb	—	—	10ppb	0～15ppb	5ppb
Phosphine	PH_3	0.3ppm	1ppm	—	0.3ppm	0～1ppm	0.3ppm
Diborane	B_2H_6	0.1ppm	—	—	0.01ppm	0～0.3ppm	0.1ppm
Silane	SiH_4	5ppm	—	—	100ppm	0～15ppm	5ppm
Disilane	Si_2H_6	—	—	—	—	0～15ppm	5ppm
Germane	GeH_4	0.2ppm	—	—	—	0～0.8ppm	0.2ppm
Hydrogen selenide	H_2Se	0.05ppm	—	—	0.05ppm	0～0.2ppm	0.05ppm
Nitrogen trifluoride	NF_3	10ppm	—	—	—	0～30ppm	10ppm
Boron tribromide	BBr_3	—	—	1ppm	—	HBr 0～6ppm	HBr 2ppm
Arsenic trichloride	$AsCL_3$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Arsenic pentachloride	$AsCL_5$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Boron trichloride	BCL_3	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Germanium tetrachloride	$GeCL_4$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Molybdenum pentachloride	$MoCL_5$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Phosphorus trichloride	PCL_3	0.2ppm	0.5ppm	—	0.2ppm	HCL 0～6ppm	HCL 2ppm
Phosphorus pentachloride	PCL_5	0.1ppm	—	—	0.1ppm	HCL 0～6ppm	HCL 2ppm
Phosphorus oxychloride	$POCL_3$	0.1ppm	—	—	—	HCL 0～6ppm	HCL 2ppm
Antimony pentachloride	$SbCL_5$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Silicon tetrachloride	$SiCL_4$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Dichlorosilane	SiH_2CL_2	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Trichlorosilane	$SiHCL_3$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Tin tetrachloride	$SnCL_4$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Tungsten hexachloride	WCL_6	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Tungsten hexafluoride	WF_6	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Arsenic trifluoride	AsF_3	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Arsenic pentafluoride	AsF_5	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Boron trifluoride	BF_3	—	—	1ppm	0.3ppm	HF 0.4ppm～3ppm	HF 0.5ppm
Molybdenum hexafluoride	MoF_6	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Phosphorus pentafluoride	PF_5	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Sulfur tetrafluoride	SF_4	—	—	0.1ppm	—	HF 0.4ppm～3ppm	HF 0.5ppm
Silicon Tetrafluoride	SiF_4	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Hydrogen chloride	HCL	—	—	2ppm	5ppm	0～6ppm	2ppm
Hydrogen fluoride	HF	0.5ppm	—	2ppm	3ppm	HF 0.4ppm～3ppm	HF 0.5ppm
Hydrogen bromide	HBr	—	—	2ppm	—	0～6ppm	2ppm
Hydrogen iodide	HI	—	—	—	—	0～5ppm	2ppm
Chlorine	CL_2	0.5ppm	1ppm	—	0.5ppm	0～1.5ppm	0.5ppm
Fluorine	F_2	1ppm	2ppm	—	—	0～3ppm	1ppm
Bromide	Br_2	0.1ppm	0.2ppm	—	0.1ppm	0～1ppm	0.2ppm
Chlorine trifluoride	CLF_3	—	—	0.1ppm	—	0～0.6ppm	0.1ppm
Ozone	O_3	0.1ppm	—	—	0.1ppm	0～0.6ppm	0.1ppm
Nitrogen monoxide	NO	25ppm	—	—	—	0～100ppm	25ppm
Nitrogen dioxide	NO_2	0.2ppm	—	—	pending	0～9ppm	3ppm
Sulfur dioxide	SO_2	—	0.25ppm	—	pending	0～6ppm	2ppm／4ppm
Hydrogen sulfide	H_2S	1ppm	5ppm	—	5ppm	0～3ppm	1ppm
Carbon monoxide	CO	25ppm	—	—	50ppm	0～75ppm	25ppm
Ammonia	NH_3	25ppm	35ppm	—	25ppm	0～75ppm	25ppm
Monomethylamine (MMtA)	CH_5N	5ppm	15ppm	—	10ppm	0～15ppm	5ppm
Dimethylamine (DMA)	C_2H_7N	5ppm	15ppm	—	10ppm	0.2～15ppm	5ppm
Trimethylamine (TMA)	C_3H_9N	5ppm	15ppm	—	—	0～15ppm	5ppm
Diethylamine (DEA)	$C_4H_{11}N$	5ppm	15ppm	—	10ppm	0.2～15ppm	5ppm
Hydrogen cyanide	HCN	—	—	4.7ppm	5ppm	0.3～15ppm	5ppm
Hydrogen peroxide	H_2O_2	1ppm	—	—	—	0～3ppm	1ppm／2ppm

※1 Refer to [2013 TLVs R and BEIs R] for the threshold limit value recommended by ACGIH (American Coference of Governmental Industrial Hygienist).
Refer to [Industrial hygiene magazine Journal of Occupational Health Vol 55 No. 5 Issue September, 2013] for the threshold limit value recommended by Japan Association of Industrial Health.
RIKEN KEIKI adopts the threshold limit value of ACGIH.

※2 For the hydrolyzing gas, the range of detection and the alarm setpoint value of the gas generated after the gas is hydrolyzed are described.
TWA (time weighted average): Time-weighted average value of that health problems might not be caused even if exposed repeatedly in the usual work of 8 hours per day, 40 hours during the week.
STEL (short term exposure limit): Limit value of short time exposure 4 times or less a day within 15 minutes and interval of 1h or more, by which no health problems might be caused.
C (ceiling value): Upper bound that must not be exceeded.

Related Laws and Regulations (JAPAN)

In the work environments where combustible gases, toxic gases and other hazardous gases are used, it is mandatory to install gas detector to measure them in order to secure safety. This section provides excerpt of the laws and regulations relating to gas detector.

High Pressure Gas Safety Act (act no. 204 of June 7, 1951)

Latest Amendments: Act No. 66 of September 11, 2015

Chapter I General Provisions

Article 1 (purpose)

The purpose of this Act is to regulate the production, storage, sale, transportation and other matters related to the handling of high pressure gases, their consumption as well as the manufacture and handling of their containers and to encourage voluntary activities by private businesses and the High Pressure Gas Safety Institute of Japan for the safety of high pressure gases with the aim of securing public safety by preventing accidents and disasters caused by high pressure gases.

Article 2 (definitions)

The term "high pressure gas" as used in this Act means any gas that falls under any of the following items:

(i) Compressed gas, the pressure (meaning gauge; the same shall apply hereinafter) of which is not less than 1 megapascal at its normal operating temperature and which is currently not less than 1 megapascal, or compressed gas, the pressure of which is not less than 1 megapascal at a temperature of 35 degrees Celsius (except compressed acetylene gas in both cases);

(ii) Compressed acetylene gas, the pressure of which is not less than 0.2 megapascal at its normal operating temperature and which is currently not less than 0.2 megapascal, or compressed acetylene gas, the pressure of which is not less than 0.2 megapascal at a temperature of 15 degrees Celsius;

(iii) Liquefied gas, the pressure of which is not less than 0.2 megapascal at its normal operating temperature and which is currently not less than 0.2 megapascal, or liquefied gas, the temperature of which is 35 degrees Celsius or less in the case that the pressure is 0.2 megapascal; or

(iv) In addition to what is listed in the preceding item, those liquefied gases, the pressure of which exceeds zero Pascal at a temperature of 35 degrees Celsius, and which, inclusive of liquefied hydrogen cyanide and liquefied methyl-bromide, are specified by a Cabinet Order.

Cabinet Order of High Pressure Gas Safety Act (cabinet order no. 20 of february 19, 1997)

Latest Amendments: Cabinet Order No. 328 of October 27, 2004

The Cabinet establishes this Order in accordance with the provisions of the High Pressure Gas Safety Act (act no. 204 of 1951) and for implementation thereof.

Article 7 (type of high pressure gas specified in cabinet order)

The types of gases, among those high pressure gases of Paragraph 1 of Article 24-2 of the Act, specifically specified in a Cabinet Order as requiring special care for the prevention of accidents in their consumption shall be the following gases in compressed and liquefied form:

(i) silane
(ii) phosphine
(iii) arsine
(iv) diborane
(v) hydrogen selenide
(vi) monogermane
(vii) disilene

Safety Regulations for General High Pressure Gas (ministry of international trade and industry ordinance no. 53 of may 25, 1966)

Latest Amendments: Ministry of Economy, Trade and Industry Ordinance No. 68 of September 29, 2015

Chapter I General Provisions

Article 1 (scope)

This is to set forth, based on the High Pressure Gas Safety Act (act no. 204 of 1951, hereinafter referred to as the "act"), the regulations on the safety (excluding the safety on the production of high pressure gases pertaining to the specific production businesses specified in the Safety Regulations for Industrial Complex, etc. (Ministry of International Trade and Industry Ordinance No. 88 of 1986)) on the high pressure gases (excluding high pressure gasses subject to the provisions of Regulations for Refrigeration Safety (ministry of international trade and industry ordinance no. 51 of 1966) and Safety Regulations for Liquefied Petroleum Gas (ministry of international trade and industry ordinance no. 52 of 1966): the same shall apply hereinafter).

Article 2 (definitions)

For the purpose of these regulations, the terms listed in the following items shall be defined as follows:

(i) "combustible gases" shall mean: acrylonitrile, acrolein, acetylene, acetaldehyde, arsine, ammonia, carbon monoxide, ethane, ethylamine, ethyl benzene, ethylene, ethyl chloride, vinyl chloride, chloromethyl, ethylene oxide, propylene oxide, hydrogen cyanide, cyclopropane, disilene, diborane, dimethylamine, hydrogen, hydrogen selenide, trimethylamine, carbon disulfide, butadiene, butane, butylene, propane, propylene, bromomethyl, benzene, phosphine, methane, monogermane, silane, monomethylamine, methyl ether, hydrogen sulfide and other gases falling under either of the following a. or b.
   a. The lower explosion limit (meaning the explosion limit when mixed with air: the same shall apply hereinafter) being 10% or less
   b. The difference between the upper limit and lower explosion limit being 20% or more

(ii) "toxic gases" shall mean: acrylonitrile, acrolein, sulfurous acid gas, arsine, ammonia, carbon monoxide, chlorine, chloromethyl, chloroprene, arsenic pentafluoride, phosphorus pentafluoride, ethylene oxide, nitrogen trifluoride, boron trifluoride, phosphorus trifluoride, hydrogen cyanide, diethylamine, disilene, sulfur tetrafluoride, silicon tetrafluoride, diborane, hydrogen selenide, trimethylamine, carbon disulfide, fluorine, bromomethyl, benzene, phosgene, phosphine, monogermane, silane, monomethylamine, hydrogen sulfide and other gases with threshold limit value being 200 ppm or less.

(iii) "special high pressure gases" shall mean: arsine, disilene, diborane, hydrogen selenide, phosphine, monogermane and silane.

(iv) "inert gases" shall mean: helium, neon, argon, krypton, xenon, radon, nitrogen, carbon dioxide or fluorocarbon (excluding combustible type).

Chapter II Permission, etc. concerning Production or Storage of High Pressure Gas

Section 1 Permission, etc. concerning Production of High Pressure Gas

Article 6 (technical standards concerning stationary production equipment)

Technical standards specified by an Ordinance of METI as referred to in Article 8, item (1) of the Act for the production facilities made up of stationary production equipment (excluding cold evaporator, compressed natural gas station, liquefied natural gas station and compressed hydrogen station) shall be as follows, provided, however, that this shall not apply in case of taking any safety measure which is approved by the Minister of Economy, Trade and Industry as having an equivalent effect, and refrigerating equipment for cooling of production equipment may be subject to the technical standards specified by the Regulations for Refrigeration Safety.

(xxvi) Electrical equipment concerning high pressure gas equipment for combustible gases (excluding ammonia and bromomethyl) shall be of a structure having explosion-proof capabilities suitable for its installation place and the type of the gas.

(xxxi) Production facilities of combustible gases or toxic gases specified by the Minister of Economy, Trade and Industry shall be installed with equipment to detect leak of such gases and trigger an alarm at places where gases leaked from such production facilities may accumulate.

(xxxvi) Piping concerning gas equipment for special high-pressure gas, arsenic pentafluoride, etc., sulfurous acid gas, ammonia, chlorine, chloromethyl, ethylene oxide, hydrogen cyanide, phosgene or hydrogen sulfide shall, wherever necessary, of double tube construction depending on the type, properties and pressure of these gases as well as on the nearby situation of the piping (including the concentrated condition of type 1 safety properties and type 2 safety properties in the vicinity of the business where the piping is installed), and necessary measures shall be taken to detect the leakage of the gas from such double tube, provided, however, that this shall not apply if the piping is prevented from being damaged by installing in a sheath or other protective structure and measures are taken to prevent any leaked gas from spreading to the vicinity.

Chapter VIII Notification concerning Consumption of High Pressure Gas

Article 55 (technical standards concerning consumers of specific high pressure gas)

Technical standards specified by an Ordinance of METI as referred to in Paragraph 1 of Article 24-3 of the Act shall be as follows.

(xxiv) Piping concerning consumption equipment for special high-pressure gas, liquefied ammonia or liquefied chloride shall, wherever necessary, of double tube construction depending on the type, properties and pressure of these gases as well as on the nearby situation of the piping (including the concentrated condition of type 1 safety properties and type 2 safety properties in the vicinity of the business where the piping is installed), and necessary measures shall be taken to detect the leakage of the gas from such double tube, provided, however, that this shall not apply if the piping is prevented from being damaged by installing in a sheath or other protective structure and measures are taken to prevent any leaked gas from spreading to the vicinity.

(xxvi) Consumption facilities shall be installed with equipment to detect leak of such gases and trigger an alarm at places where gases leaked from such production facilities may accumulate.

Exemplified Standards concerning Safety Regulations for General High Pressure Gas (enacted on march 26, 2001, amended on december 26, 2012)

23. Gas leakage detection and alarm equipment and place of installation

Relevant provisions

> Article 6 paragraph 1 item (xxxi), Article 7 paragraph 1 item (i), Article 7-3 paragraph 1 item (vii), paragraph 2 item (xvi), Article 12 paragraph 1 item (i), Article 22, Article 55 paragraph 1 item (xxvi)

Equipment to detect and trigger an alarm of any leakage of combustible gases and toxic gases (acrylonitrile, sulfurous acid gas, arsine, ammonia, carbon monoxide, chlorine, ethylene oxide, disilene, diborane, hydrogen selenide, carbon disulfide, benzene, phosphine, monogermane, silane and hydrogen sulfide) at production facilities, storage places and consumption facilities shall be in accordance with the following standards.

1. Function

Gas leakage detection and alarm equipment (hereinafter referred to as "Detection alarm

Related Laws and Regulations (JAPAN)

equipment" in 23 of these standards) shall be capable of detecting leakage of combustible gases or oxygen or toxic gases, indicating its concentration as well as triggering an alarm and shall have the following capabilities.

1.1 Detection alarm equipment shall be of catalytic combustion method, membrane type galvanic cell method, semi-conductor method or any other method to automatically trigger an alarm at the preset gas concentration (hereinafter referred to as "alarm setpoint") by detecting the change of detection element by an electrical mechanism.

1.2 Alarm setpoint shall be a quarter or less of a lower explosive limit for combustible gases, 25% for oxygen and acceptable concentration (twice the value of acceptable concentration for ammonia, chlorine and other toxic gases similar thereto with difficulty to prepare the calibration gas; the same shall apply to 1.6) or less for toxic gases, provided, however, that it shall be 0.1% or less for the Detection alarm equipment to be installed pursuant to 3.1 (6) c. In this case, Alarm setpoint shall be able to be set at any value.

1.3 The gas alarm accuracy of Detection alarm equipment shall be ±25% or less for combustible gases, ±5% or less for oxygen and ±30% or less for toxic gases of the Alarm setpoint.

1.4 The delay time for the Detection alarm equipment to trigger an alarm shall be inspected by applying the alarm delay test under the provision 6.7.2 of JIS M7626 (1994) correspondingly. This inspection shall be conducted by introducing the gas 1.6 times of the concentration of the Alarm setpoint and the delay then shall be within 30 seconds, provided, however, that it shall be within 1 minute for specific gases which delay more than that for the structure of the Detection alarm equipment or for theoretical reasons (ammonia, carbon monoxide or any other gases equivalent thereto).

1.5 Alarm accuracy shall not deteriorate even when there are ±10% fluctuations of power voltage, etc.

1.6 The scale of indicator shall, within each scale range, clearly indicate 0 to lower explosive limit (for those with the Alarm setpoint being low concentration, proper value of the lower explosive limit or less can be set in consideration of such Alarm setpoint), 0 to 50% for oxygen and 0 to 3 times the value of acceptable concentration for toxic gases.

1.7 Once an alarm is triggered, the alarm shall, in principle, continue even upon the change of gas concentration in the atmosphere and shall stop only by its inspection or measures to be taken.

1.8 Detection alarm equipment shall be regularly maintained in accordance with maintenance particulars described in instruction manuals or specifications. The results of maintenance shall also be recorded and retained for 3 years or more.

1.9 Calibration of the reading of gas leakage detection alarm equipment for special high-pressure gas shall be carried out at least once every 6 months.

1.10 Detection alarm equipment shall be checked at least once a month for triggering of an alarm upon the alarm circuit inspection and at least once a year for the proper operation by the detection and alarm inspection.

2. Construction

The construction of Detection alarm equipment shall be as follows.

2.1 It shall have sufficient strength (element and transmission circuit being particularly durable) and shall be easy to handle and maintain (particularly for the replacement of element, etc.)

2.2 The parts which come into contact with gases shall be made of corrosion-resistant materials or materials with sufficient anticorrosion treatment and other parts shall be finished with good coating or plating.

2.3 For explosion proof property, it shall have passed the test under Article 44 of Industrial Safety and Health Act (act no. 57 of 1972).

2.4 In the case of receiving alarms from 2 or more probes, receiving circuit shall be able to trigger an alarm if it is under the condition to activate the Detection alarm equipment and such point shall be identifiable even when the other triggers an alarm and activate the circuit.

2.5 Receiving circuit shall be made easily identifiable of it being activated.

2.6 Alarm shall trigger an alarm simultaneously with turning on or blinking of a lamp.

3. Installation place

Detection alarm equipment shall be installed as follows.

3.1 Installation place and quantity of probes of Detection alarm equipment in the production facilities (excluding piping: the same shall apply hereinafter in 3.1) shall be in accordance with the following items:

(1) In the circumference of a place where there are indoor-installed compressor, pump, reaction equipment, storage tank and other high-pressure gas equipment with high potential for gas leakage (excluding those specified in (3)) and where leaked gas is likely to accumulate: 1 or more per 10 meter circumference of these equipment group;

(2) If those high-pressure gas equipment as referred to in (1) are installed outdoor and are close to other high-pressure equipment, walls or other structures, or are installed inside a pit or the like, a place where leaked gas is likely to accumulate: 1 or more per 20 meter circumference of these equipment group;

(3) A place where leaked gas is likely to be accumulated in the circumference of production facilities including fire source such as a heating furnace: The number calculated by the ratio of 1 or more per 20 meter circumference of the place;

(4) Inside an instrument room (excluding the case where measure(note) is taken to prevent penetration of leaked gas): 1 or more;

(5) In the circumference of a group of filling ports of toxic gases: 1 or more;

(note) In principle, the measure to prevent penetration of leaked gas shall mean either of the following:

a. To retain the pressure inside the instrument room necessary for preventing penetration of gases from outside; or

b. To raise the entrance floor to at least 2.5 meters over the ground for the instrument room only for gases heavier than air.

(6) Notwithstanding the foregoing (1) to (5), the following standards shall apply to specific compressed hydrogen stations of Article 7-3, Paragraph 2:

a. 1 or more inside a steel casing or inside a fireproof room in which compressor is installed, provided, however, that for such fireproof room of which inside wall dimension exceeds 10 meters, the quantity shall be 1 or more for every 10 meters in such length;

b. 1 or more inside the dispenser case;

c. 1 each or more of Detection alarm equipment having 1 or more probes near the connection part such as the coupling between the filling hose and the container fixed onto a vehicle (see fig.1);

d. 1 or more on the upper piping module of accumulator (see fig.2);

e. 1 or more at a place where hydrogen is accumulated near the device to generate hydrogen such as a reformer.

3.2 Installation place and quantity of probes for Detection alarm equipment in a repository or consumption facilities (excluding piping; the same shall apply hereinafter in 3.2) shall be in accordance with the following items:

(1) In the circumference of a place where there are indoor-installed decompression equipment, storage equipment, consumption equipment (excluding part of burners, etc. which are equipped with an interlocking mechanism of pilot burner method and not likely to cause gas leakage) and other equipment with high potential for gas leakage and where leaked gas is likely to accumulate: 1 or more per 10 meters of the circumference of these equipment group;

(2) If those equipment as referred to in (1) are installed outdoor and are close to other equipment, walls or other structures, or are installed inside a pit or the like, a place where leaked gas is likely to accumulate: 1 or more per 20 meter circumference of these equipment group;

(3) If containers for special high-pressure gas, etc. are stored at a container depot: 1 or more in the circumference of a place of the container group where leaked gas is likely to accumulate;

(4) Inside a cylinder cabinet: 1 or more.

3.3 The height for the probe to be installed for the facilities of 3.1 or 3.2 shall be determined in accordance with conditions such as specific gravity of the gas, environment, height of gas equipment and so on.

3.4 A place where alarm is triggered and lamp is turned on or blinks shall be where parties concerned are stationed and is suitable for taking various countermeasures upon an alarm.

3.5 In cases where forced exhaust equipment is operated around the clock in production or consumption facilities, the provisions of 3.1 and (1), (2), (3) of 3.2 shall not apply and a probe shall be installed for every inlet of forced exhaust equipment.

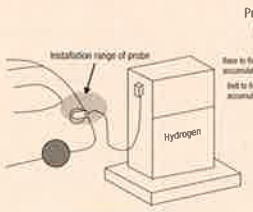


Fig.1 Example of Installation near the Connection like a Coupling

Fig.2 Example of Installation at Piping Module of Accumulators, etc.

27. Double tube for toxic gas piping

Relevant provisions
Article 6 paragraph 1 item (xxxvi), Article 12 paragraph 1 item (i), Article 22, Article 55 paragraph 1 item (xxiv)

With regard to double tube construction for gas equipment piping of special high-pressure gas, arsenic pentafluoride, etc., sulfurous acid gas, ammonia, chlorine, chloromethyl, ethylene oxide, hydrogen cyanide, phosgene and hydrogen sulfide, the following items shall apply:

1. Outer tube of the double tube construction shall have the standard inside diameter of 1.2 times or more of the outside diameter of the inner tube and material, wall thickness, etc. shall conform to the specifications under 7. Breakdown test and airtightness test, 8. Strength of high-pressure gas equipment and conduit, and 9. Standards of materials used for gas equipment, etc.

2. Any of the following measures shall be taken between the inside tube and outside tube of the double tube to detect leakage of gases:

2.1 To install a probe of gas leakage detection and alarm equipment between the inside tube and outside tube of the double tube;

2.2 To install a device to detect and alarm the rise of pressure between the inside tube and outside tube of the double tube;

2.3 To run inert gas such as nitrogen all the time between the inside tube and outside tube of the double tube, and to install a probe of gas leakage detection alarm equipment on its outlet; or

2.4 To suction between the inside tube and outside tube of the double tube all the time by exhaust equipment, etc. and to install a probe of gas leakage detection alarm equipment on its outlet.

Industrial Safety and Health Act (act no. 57 of june 8, 1972)

Latest Amendments: Act No. 17 of May 7, 2015

Chapter I General Provisions

Article 1 (purpose)

The purpose of this Act is to secure, in conjunction with the Labor Standards Act (Act No. 49 of 1947), the safety and health of workers in workplaces, as well as to facilitate the establishment of comfortable working environment, by promoting comprehensive and systematic countermeasures concerning the prevention of industrial accidents, such as taking measures for the establishment of standards for hazard prevention, clarifying the safety and health management responsibility and the promotion of voluntary activities with a view to preventing industrial accidents

Chapter IV Measures for Preventing the Dangers or Health Impairment of Workers

Article 20 (measures to be taken by employers, etc.)

The employer shall take necessary measures for preventing the following dangers:

Related Laws and Regulations (JAPAN)

(i) Dangers due to machines, instruments and other equipment (hereinafter referred to as "machines, etc.")
(ii) Dangers due to substances of an explosive nature, substances of a combustible nature and substances of an combustible nature
(iii) Dangers due to electricity, heat and other energy

Chapter V Regulations concerning Machines, etc. and Harmful Substances
Section 1 Regulations concerning Machines

Article 42 (restrictions on transfer, etc.)
Among machines, etc., other than specified machines, etc., which are listed in Appended Table 2, or require dangerous or harmful operations, or are used in a dangerous place, or used for preventing danger or health impairment, those defined by Cabinet Order shall not be transferred, leased or installed unless they conform to the construction code provided for by the Minister of Health, Labour and Welfare or are equipped with safety apparatus designated by the Minister of Health, Labour and Welfare.

Article 44-2 (type examination)
Of the machines, etc. as referred to in Article 42, 1 who has manufactured or imported a machine which is listed in Appended Table 4 and designated by the Cabinet Order shall have such manufactured or imported machine undergo the type examination to be conducted by the party registered by the Minister of Health, Labour and Welfare (hereinafter referred to as the "registered type examination agency") as prescribed by the Ordinance of the Ministry of Health, Labour and Welfare. However this provision shall not apply to the machines, etc., which have been imported, and which have undergone the examination set forth in the next paragraph.

Ordinance on Industrial Safety and Health (ministry of labour ordinance no. 32 of september 30, 1972)

Latest Amendments: Ministry of Health, Labour and Welfare Ordinance No. 175 of December 28, 2015

Part II Safety Standards

Chapter VI Prevention of Dangers in Excavating Work, etc.

Section 2 Construction Work of Tunnels, etc.

Subsection 1 Investigation, etc.

Article 382-2 (measurement, etc. of the concentration of combustible gas)
The employer shall, in the case of a construction work of tunnels, etc., the combustible gases are liable to be generated, designate a person charged with the measurement of the concentration of the combustible gases in order to prevent an explosion or fire and have the said person measure and record the concentration of the combustible gas at the places where the said combustible gases are liable to be generated or stagnate, every day before commencing the work for the day, after an earthquake of medium shock or heavier or when having found any abnormalities related to the said combustible gases.

Article 382-3 (installation, etc. of automatic alarms)
The employer shall, when it is found as a result of the measurement set forth in the preceding Article that the combustible gases exist and is liable to cause an explosion or fire, install automatic alarms at necessary places for an early detection of abnormal rise in the concentration of the combustible gases. In this case, the said automatic alarms shall have system, which is able to quickly alert workers who are working around the area of the detector of the automatic alarms to the abnormal rises in the concentration of the said combustible gas.
2. The employer shall, as regards the automatic alarm device set forth in the preceding paragraph, check the following matters before commencing the work for the day, and immediately repair when having found any abnormalities:
(i) Abnormalities in the measuring gauges
(ii) Abnormalities in detector
(iii) Function of the alarms

Subsection 1-3 Prevention of Explosions, Fires, etc.

Article 389-2 (measures in the case of automatic alarms sound)
The employer shall establish measures in advance that the workers concerned should take to prevent an explosion or fire due to combustible gas when the automatic alarms set forth in Article 382-3 sound, and make the said measures known to the said workers.

Part III Health Standards

Chapter I Harmful Working Environment

Article 583 (standards of concentration of carbon dioxide gas in a pit)
The employer shall ensure that the concentration of carbonic dioxide gas in the air is kept at 1.5% or less in workshop in pits. However, this shall not apply to lifesaving or danger prevention work using air respirators, oxygen respirators or hose masks.

Article 589 (workplace to be measured for work environment)
The workshops in pits prescribed by the Ordinance of the Ministry of Health, Labour and Welfare set forth in item (iv) of Article 21 of the Order shall be as follows:
(i) Workshops in pits where carbon dioxide gas stagnates or is liable to stagnate;
(ii) Workplace in a pit where temperature exceeds or is likely to exceed 28°C;
(iii) Workshops in pits provided with ventilation facilities.

Article 592 (measurement, etc., of concentration of carbon dioxide gas in a pit)
The employer shall, as regards a workshop in pit set forth in item (i) of Article 589, measure concentration of carbon dioxide gas, periodically once every period within a month.
2. The provisions of paragraph (2) of Article 590 shall apply mutatis mutandis to the case that measurements pursuant to the provision of the preceding paragraph have been carried out.

Ordinance on Prevention of Anoxia, etc. (ministry of labour ordinance no. 42 of september 30, 1972)

Latest Amendments: Ministry of Health, Labour and Welfare Ordinance No. 175 of December 19, 2003

In accordance with the provisions of Industrial Safety and Health Act (act no. 57 of 1972) and for the purpose of implementing the Act, ordinance on prevention of anoxia, etc. shall be set forth as follows:

Chapter I General Provisions

Article 1 (duties of the employer)
The employer shall make efforts to establish working methods, maintain a proper working environment and take measures necessary for preventing anoxia, etc.

Article 2 (definitions)
In this ordinance, the meanings of the terms are as defined respectively in the following items:
(i) Oxygen deficiency: States under which the oxygen concentration in the air is less than 18%.
(ii) Oxygen deficiency, etc.: The state defined in the preceding item or the state in which the concentration of hydrogen sulfide in the air is 10ppm or more.
(iii) Anoxia: The symptom observed in 1 who has inhaled oxygen-deficient air.
(iv) Hydrogen sulfide poisoning: The symptom observed in 1 who has inhaled the air in which the concentration of hydrogen sulfide is 10 ppm or more.
(v) Anoxia, etc.: Anoxia or hydrogen sulfide poisoning.
(vi) Hazardous work of oxygen deficiency: Those jobs to be carried out in places with the hazard of oxygen deficiency (hereinafter referred to as "oxygen-deficient place") designated in Attached Table 6 of the Enforcement Order (hereinafter referred to as "Cabinet Order") of the Industrial Safety and Health Law (cabinet ordinance no. 318 of 1972).
(vii) Class-1 hazardous work of oxygen deficiency: The oxygen deficiency-hazard work other than class-2 hazardous work of oxygen deficiency out of the oxygen-deficiency-hazard works.
(viii) Class-2 hazardous work of oxygen deficiency work: The work to be carried out in the oxygen-deficiency-hazard place designated in item 3-3, item 9 or item 12 of Attached Table 6 of the Cabinet Order (to be restricted to the places designated by the Minister of Health, Labour and Welfare as the places with the hazard of anoxia and hydrogen sulfide poisoning for the places designated in the said items) from among the oxygen-deficiency-hazard places.

Chapter II General Preventive Measures

Article 3 (working environment measurement, etc.)
For the workplace designated in item 9 of Article 21 of Cabinet Order, the employer shall measure the concentration of the oxygen in the air before having the workers start the day's work, providing that the concentrations of both the oxygen and hydrogen sulfide shall be measured for workplaces where class-2 hazardous work of oxygen deficiency is to be carried out.
2. When the employer has made the measurements of the oxygen concentrations in the air provided for by the preceding paragraph, he shall make a record of the items given below, every time the said measurements have been made, and shall keep the recorded results of the said measurements in custody for a period of 3 years.
(i) Date and time of the measurements
(ii) Method of measurement
(iii) Places at which the said measurements were carried out
(iv) Conditions of measurements
(v) Results of the measurements
(vi) Name of the measurer
(vii) Outline of the measures taken for prevention of anoxia based on the results of the measurements

Article 4 (measuring instruments)
When the employer has workers engage in hazardous work of oxygen-deficiency, he shall provide the instruments necessary for measurement of oxygen concentration in the air stipulated in Paragraph 1 of the preceding Article, or shall take measures for enabling the workers to easily make use of said instruments.

Article 5 (ventilation)
The employer whose workers engage in hazardous work of oxygen deficiency shall keep the concentration of oxygen in the air at least at 18% or more in the workplace (the concentration of the oxygen shall be 18% or more, and the concentration of the hydrogen sulfide, less than 10 ppm in the case of class-2 hazardous work of oxygen deficiency) by installing an appropriate ventilating system except in cases where a ventilating system cannot be installed in order to prevent explosion or oxidization, etc., and where it is extremely difficult to install a ventilating system due to the nature of the work to be carried out.
2. The employer shall not be allowed to use pure oxygen while the workplace is ventilated conforming to the provision of the preceding paragraph.

Other Relevant Laws and Regulations

In addition to the foregoing laws and regulations, there are following relevant laws and regulations:

- Working Environment Measurement Act
- Fire Service Act
- Ship Safety Act
- Act on Maintenance of Sanitation in Buildings (building maintenance act)
- Act on Securing of Safety and Optimization of Transaction of Liquefied Petroleum Gas (liquefied petroleum gas act)
- Gas Business Act
- Act on Hot Springs

Explosion-proof Construction

Explosion-proof electrical equipment are currently classified based on 2 types of standards.
1 is Constructional Requirements for Electrical Equipment for Explosive Atmospheres of the Ministry of Labour Notification No. 16 of 1969 and another is its partial amendment, Recommended Practices for Explosion-Protected Electrical Installations in General Industries as referred to in the Ministry of Health, Labour and Welfare, Labour Standards Bureau Chief Notification No. 2 of August 24, 2010 issued by Labour Standards Bureau (JAPAN).

【Constructional Requirements for Electrical Equipment for Explosive Atmospheres】

Types of Explosion-proof Construction of Electrical Equipment for Explosive Atmospheres and their Corresponding Symbols

Kind of type of gas-explosion protection	Symbol
Intrinsic safety	ia or ib
Flameproof enclosures	d
Pressurized enclosures	f
Increased safety	e
Oil-immersion	o
Type of protection 'n'	nA, nC, nR or nL
Encapsulation	ma or mb
Special	s

Explosion Class Classification of Combustible Gases or Vapors

Explosion class	Limit of flame propagation (mm)
1	Over 0.6
2	Over 0.4 and less than 0.6
3 (a,b,c,n) ※1	Equal to or less than 0.4

※1 3a, 3b, 3c and 3n in the explosion class denote hydrogen and water gas, carbon disulfide, acetylene and all gases and vapors, respectively.

Ignition Point Classification of Combustible Gases or Vapors

Ignition point	Ignition point (°C)	Permissible temperature of electrical equipment (°C)
G1	Over 450	360
G2	Over 300 and less than 450	240
G3	Over 200 and less than 300	160
G4	Over 135 and less than 200	110
G5	Over 100 and less than 135	80

Ignition points of representative explosive gas classes under the Constructional Requirements for Electrical Equipment for Explosive Atmospheres

Temperature class / Explosion-proof class	G1	G2	G3	G4	G5
1	Acetone Ammonia Carbon monoxide Ethane Acetic acid Ethyl acetate Toluene Propane Benzene Methanol Methane	Ethanol Isopentyl acetate Butane	Gasoline Hexane	Acetaldehyde	
2		Ethylene Ethylene oxide			
3	Water gas Hydrogen	Acetylene			

【Recommended Practices for Explosion-Protected Electrical Installations in General Industries】

Types of Explosion-proof Construction of Electrical Equipment for Explosive Atmospheres and their Corresponding Symbols※2

Kind of type of gas-explosion protection	Symbol
Intrinsic safety	ia or ib
Flameproof enclosures	d
Pressurized enclosures	px or py
Increased safety	e
Oil-immersion	o
Type of protection 'n'	nA, nC, nR or nL
Encapsulation	ma or mb
Special	s

※2 To indicate the explosion-proof construction under the Recommended Practices for Explosion-Protected Electrical Installations in General Industries, "Ex" needs to be added in front of each explosion-proof class symbol.

Classification of Explosion-proof Electrical Equipment Corresponding to the Maximum Experimental Safe Gap※3

Electrical equipment group of flameproof enclosure	Maximum experimental safe gap (mm)
ⅡA	Equal to or more than 0.9
ⅡB	Over 0.5 and less than 0.9
ⅡC	Equal to or less than 0.5

Classification of Explosion-proof Electrical Equipment Corresponding to the Minimum Ignition Current※3

Electrical equipment group of intrinsic safety	Minimum ignition current ratio (methane = 1)
ⅡA	Over 0.8
ⅡB	Equal to or more than 0.45 and equal to or less than 0.8
ⅡC	Less than 0.45

※3 Electrical equipment groups are classified into IIA, IIB and IIC but classification may differ depending on the type of explosion-proof construction.

Classification of Combustible Gases or Vapors Corresponding to the Temperature Class of Electrical Equipment

Maximum surface temperature of electrical equipment (°C)	Temperature class	Ignition temperatures of combustible gases or vapors (°C)
Less than 450	T1	Over 450
Equal to or less than 300	T2	Over 300 and less than 450
Equal to or less than 200	T3	Over 200 and less than 300
Equal to or less than 135	T4	Over 135 and less than 200
Equal to or less than 100	T5	Over 100 and less than 135
Equal to or less than 85	T6	Over 85 and less than 100

Temperature Classes of Representative Explosive Gases under the Recommended Practices for Explosion-Protected Electrical Installations in General Industries

Temperature class / Explosion-proof class	T1	T2	T3	T4	T5	T6
ⅡA	Acetone Ammonia Isobutane Ethane Acetic acid Ethyl acetate Toluene Benzene Methane	Isopentyl acetate Acetic anhydride Butane Propane Methanol	Hexane	Acetaldehyde		
ⅡB	Carbon monoxide	Ethanol Ethylene Ethylene oxide				
ⅡC	Water gas Hydrogen	Acetylene				Carbon disulfide

Explosion-proof Class of Model GX-2012

Explosion-proof class: Exia II CT4X

Ex: Symbol to indicate explosion-proof construction under the Recommended Practices for Explosion-Protected Electrical Installations in General Industries

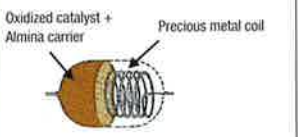
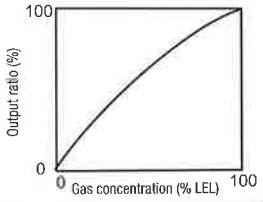
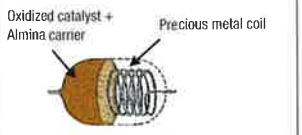
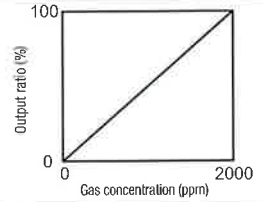
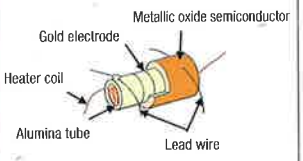
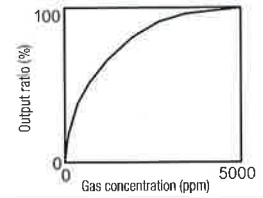
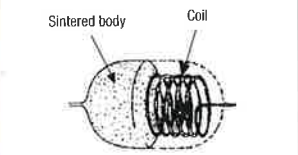
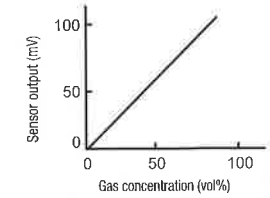
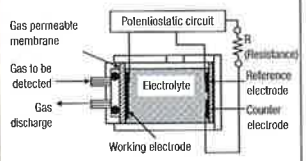
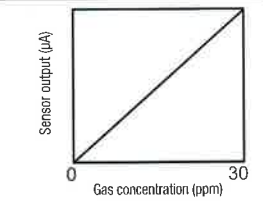
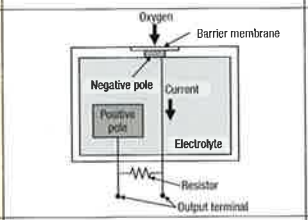
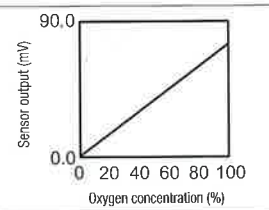
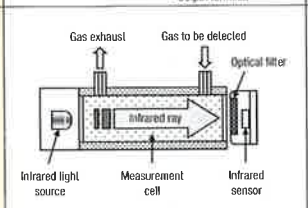
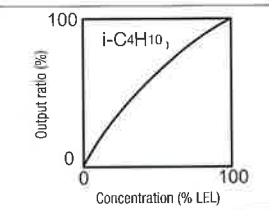
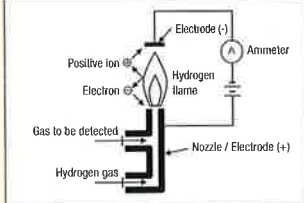
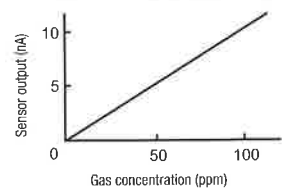
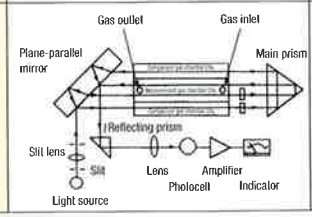
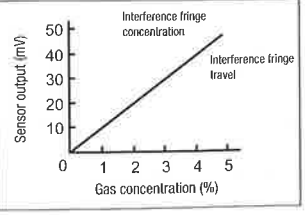
ia: Intrinsic safety

IIC: Minimum ignition current ratio (methane = 1) less than 0.45

T4: Ignition temperature of combustible gases or vapors over 135°C and less than 200°C

X: Symbol to indicate separate precautionary statement

List of Detection Principles

	Principle and advantage	Construction	Output characteristics
Catalytic Combustion HW	This method uses calorific power generated by combustible gases burning on oxidation catalyst (resistance variation of precious metal coil). ● The sensor output is almost proportional (linear) to the concentration of gas up to the lower explosive limit. ● There is almost no effect from the temperature and humidity of usage environment. ● Good response with speedy reaction and excellent in accuracy and reproducibility.		
New Ceramic NC	This method uses calorific power generated by combustible gases burning on the originally developed super-atomization oxidative catalyst (new ceramics). ● A single sensor can detect a wide range of concentrations from ppm to % LEL. ● There is almost no effect from the temperature and humidity of usage environment. ● Compared to the conventional catalytic combustion method sensor, it has excellent poisoning resistance, less sensitivity deterioration and prolonged stability.		
Semiconductor SG	This method uses resistance variations that occur when metallic oxide semiconductor cotacts gases. ● It has high sensor output in the low concentration range and has high sensitivity. ● It can detect not only combustible gases but also various gases including toxic gas. ● While controlling the sensitivity for miscellaneous gases, methane or isobutene can be detected selectively. ● Compared to other methods, this method has large tolerance under the harsh environmental conditions.		
Thermal Conductivity TE	This method uses the difference in thermal conduction unique to gases when they contact heated element. ● Up to 100 vol% gas concentration, the output is almost proportional (linear) to the concentration. ● Without chemical reaction such as a combustion reaction, no deterioration or poisoning of catalyst ensures long and stable use. ● With compensation element, it is almost free from the effect of the ambient environment. ● Nonflammable gases such as high-concentration argon, nitrogen and carbon dioxide can be detected.		
Electrochemical ES	Gas is subject to electrolysis on electrodes kept at constant potential and the current generated then is detected as gas concentration. ● Toxic gas can be detected with high sensitivity (e.g. arsine 0 to 0.2 ppm). ● By choosing bias voltage, gas to be detected can be detected selectively. ● Linear output enables accurate measurement of low-concentration gases.		
Galvanic cell OS	The current generated upon the electrolysis of oxygen on electrodes is detected as oxygen concentration. ● Product can be made smaller and lighter. ● No external power supply is needed for sensor operation. ● Output up to 100 vol% is proportional to oxygen concentration. ● Temperature compensation by a thermistor built in a sensor makes the temperature dependence of reading virtually nonexistent.		
Non-dispersive Infrared DE	This method uses the absorbed amount by gas of infrared rays radiated from the light source in the sensor. ● It provides accurate and stable measurement. ● Less sensitivity deterioration ensures stable measurement results for a long time. ● It has less influence from coexisting gas, water vapor and the like and is excellent in selectivity. ● As oxygen concentration has no effect, measurement is possible even in inert gas or N2.		
Flame ionization FID	This method uses the changes in current value by ionization of carbon hydride and other gases in hydrogen flame. ● It features quick response and high sensitivity. ● Output is almost proportional to the number of carbon in carbon hydride and will not be affected by inorganic carbon compound at all. ● Output shows high linearity within the measurement range of concentration.		
Optical interferometric FI	This method uses the nature of light being refracted by gas. ● Without using any chemical reaction, it has no deterioration in sensitivity and is excellent in prolonged stability. ● Continuous measurement of gas concentration can be conducted with accuracy for various processes. ● Measurement is possible in the order from 1000 ppm to 100 vol%.		

International Bases

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C9E-0030-170220 (S)

C9E-0040

RIKEN KEIKI

CONDENSED CATALOG

PART- II

Fixed Gas Detector and other instruments

Gas Detector for Combustible Gases/Oxygen/Toxic Gases

RIKEN KEIKI Co.,Ltd.

"Creating safe working environments for workers"

RIKEN KEIKI was established in 1939 as part of RIKEN conglomerate (currently called RIKEN, a national R&D corporation). For nearly eight decades since its birth, it has dedicated itself in developing unique technology for the industry.

In our living environment, environmental pollution is threatening our lives and precious assets.

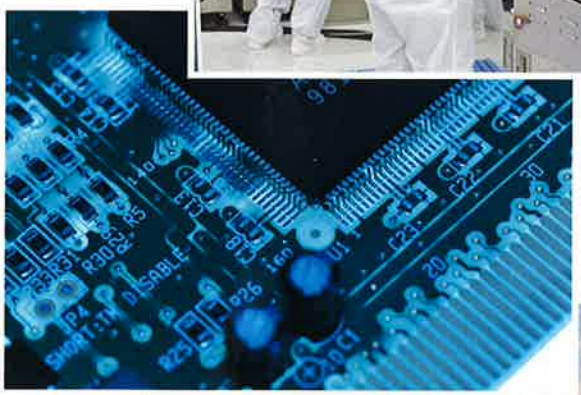
Even before there were any warnings of an environmental crisis, we have contributed to society with our industrial pollution/disaster prevention instruments.

At present, we produce from large-scale gas detecting alarm systems to small-sized personal gas monitors for safety protection in many industries.

In addition, our gas detector are widely used in the semiconductor and space development industries.

We also have a large share of gas measuring instruments in the fields of pollution prevention and health care.

With growing needs for disaster prevention and environmental preservation, we are determined to continue developing reliable technologies utilizing our scientific knowledge and skills under the eternal goal of safety "Creating safe working environments for workers."



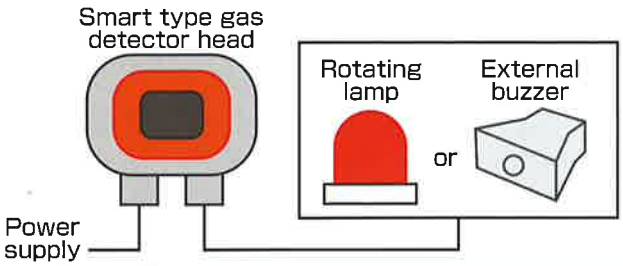
CONTENTS

System Configuration Example

As for the gas detector, they are divided into one that furnishes the detector head to detect the gas and the indicator/alarm unit to indicate and to alarm the concentration in one unit and one that the combination of the gas detector head and the indicator/alarm unit. Products of gas detector head are divided roughly into two kinds. One is the smart type gas detector head with the gas concentration display part which is possible to use also by the sole unit. The detector head is used to confirm the concentration around the detector head in situ. It is also possible to install combined with the indicator/alarm unit to confirm the concentration at the nonhazardous area apart from the detector head. The other is a gas detector head that is combined with the indicator/alarm unit to use because it does not have the gas concentration display. It is used with the indicator/alarm unit assembled to confirm the concentration only at the nonhazardous area and the concentration confirmation in situ where the gas detector head is set up is unnecessary.
As for the indicator/alarm unit, there are single point indicator/alarm unit which is one indicator/alarm unit combined to one gas detector head and multi point indicator/alarm unit to monitor multiple gas detector heads together.
Additionally, there is a system configuration that intensively monitors the signals that each indicator/alarm unit outputs in the monitoring system.

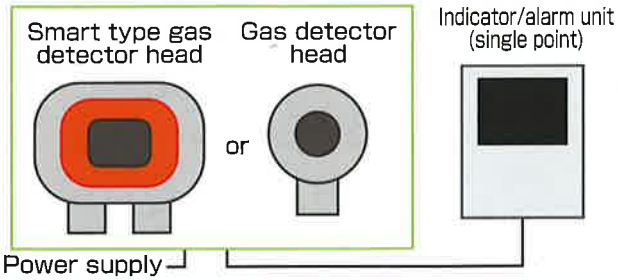
Example of setting up only gas detector head

With applying the smart type gas detector head, a rotating lamp and an external buzzer can be controlled by only the gas detector head.

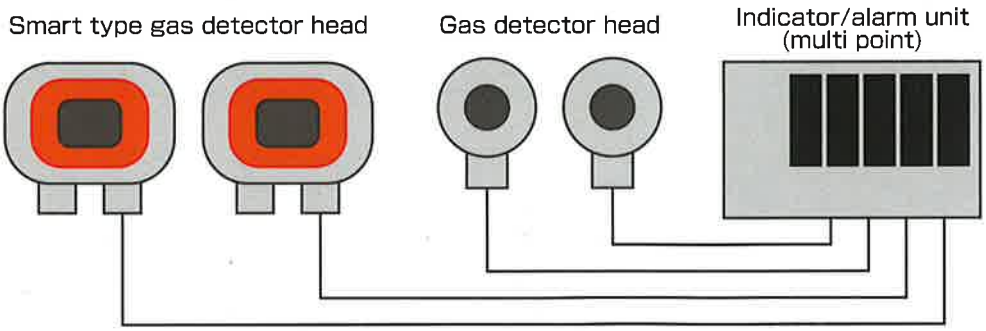


Example of setting up gas detector head and indicator/alarm unit (single point)

By combining the gas detector head with the indicator/alarm unit, the concentration can be confirmed not only in situ but also at the remote nonhazardous area.



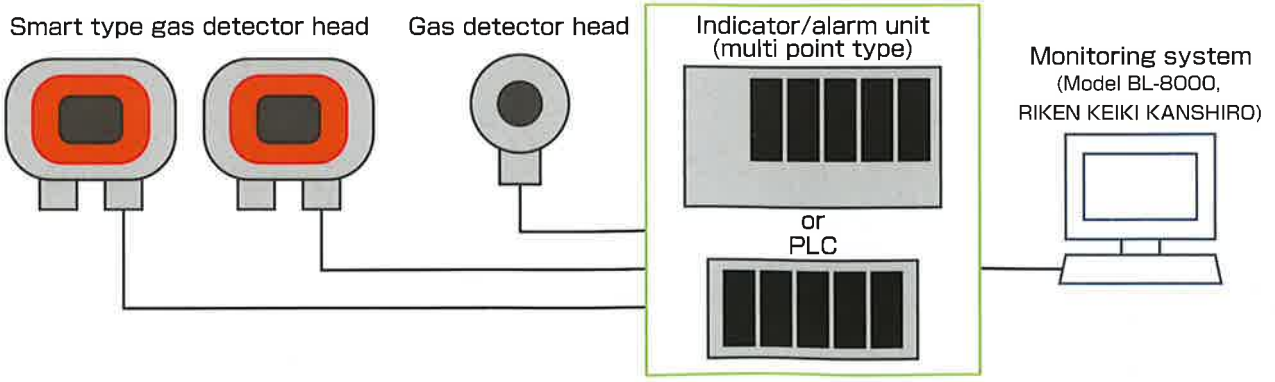
Example of setting up the gas detector head and the indicator/alarm unit (multi point type)



By combining of multiple gas detector heads with an indicator/alarm unit, the concentrations of multiple gas detector heads set up in the site can be confirmed in one place.

An example of setting up of a gas detector head, indicator/alarm unit and concentrated monitoring system

The gas concentration detected by the gas detector head can be monitored with the monitoring system via the indicator/alarm unit. In the case of a smart type gas detector head is to be used, a system can be composed by incorporating PLC between the smart type gas detector head and the monitoring system, without use of the indicator/alarm unit.



Necessity of Maintenance

The implementation of regular maintenance is extremely important to maintain the performance and to improve reliability on disaster prevention and security in using the gas detector. Accurate detection cannot be implemented if the device is continued to use without maintenance.

There are maintenances that are the daily and monthly maintenances to be implemented by the workers and the regular maintenance to be implemented by the service engineer of RIKEN KEIKI. Daily maintenance is a visual check to be implemented by the worker before the beginning of the work. The monthly maintenance is the maintenance of the alarm circuit (alarm test) to be implemented by the worker once a month. The regular maintenance are checks such as the sensitivity calibration etc. to maintain the performance as the security equipment to be implemented once every 6 months.

In Japan, regarding the special high pressure gas, especially, is obligated in Exemplified Standards concerning Safety Regulations for General High Pressure Gas, saying that 'Calibration of the reading of gas leakage detection alarm equipment for special high pressure gas shall be carried out at least once every 6 months'.

With correct execution of maintenance, the performance and the function of the devices can be maintained to be excellent and the safety without the gas disaster can be secured, for a long term.

Enhanced Support Network

RIKEN KEIKI is working on the speed up of the emergency response and the regular maintenance.
RIKEN KEIKI has prepared the thorough system for after-sales service with technological members who have expertise and certain technical skill.

RIKEN KEIKI is aiming at the enhancement of the service network. RIKEN KEIKI as the manufacturer of the industrial disaster prevention devices always responds to the consultation and after-sales service with the responsibility concerning the product by allocating service engineers with expertise.

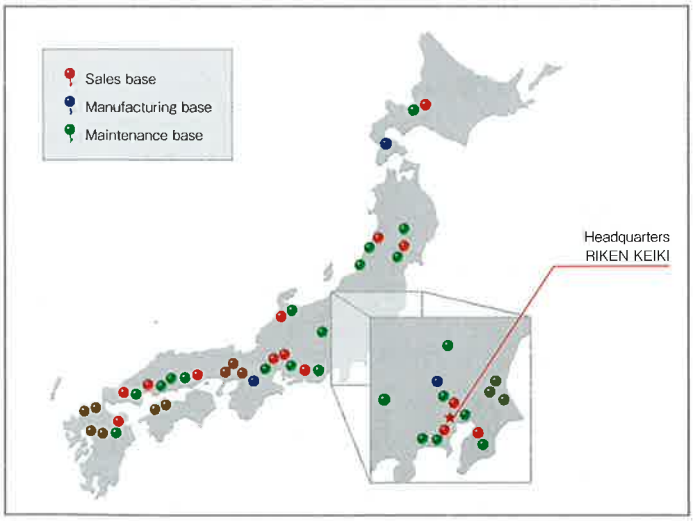
《International Bases》

International bases

North America	United States
South America	Brazil, Argentina, Peru, Chile, Uruguay
Asia-Pacific	China, South Korea, Taiwan, Singapore, Malaysia, Indonesia, Thailand, India, Vietnam, Philippines, Australia
Europe	Germany, Greece, Norway, Turkey, United Kingdom
The Middle East	United Arab Emirates, Israel
Africa	South Africa
Russia	Russian Federation

《Japanese Bases》

	Japanese sales bases	Japanese service bases
Hokkaido area	Sapporo	Sapporo
Tohoku area	Sendai, Tsuruoka	Iwate, Sendai, Tsuruoka
Kanto and Shinetsu area	Mito, Saitama, Chiba, Kanagawa	Tochigi, Mito, Kashima, Saitama, Chiba, Tokyo, Yokohama, Atsugi, Niigata, Matsumoto, Kofu
Tokai, Hokuriku and Kinki area	Hamamatsu, Nagoya, Yokkaichi, Kanazawa, Osaka, Kobe	Hamamatsu, Nagoya, Yokkaichi-higashi, Yokkaichi, Toyama, Keiji, Amagasaki, Himeji
Chugoku and Shikoku area	Mizushima, Shikoku, Hiroshima, Tokuyama	Mizushima, Shikoku, Higashihiroshima, Hiroshima, Tokuyama
Kyushu and Okinawa area	Fukuoka, Kumamoto, Oita	Tosu, Kumamoto, Oita



Explosion-proof Calorimeter

Model OHC-800

Calorific value

Specific gravity

Wobbe Index

Methane number

OHC-800 and sampling system RS-400 series

Features

- Explosion-proof type calorimeter possible to measure calorific value (MJ/m^3), specific gravity and Wobbe Index continuously.
- Highly accurate and reliable calorimetry of the fuel gas is possible, because the influences of gases (such as N_2 O_2 and CO_2, etc.) having no calorific value in the fuel gas can be removed by the adoption of optosonic calculation developed originally by RIKEN KEIKI.

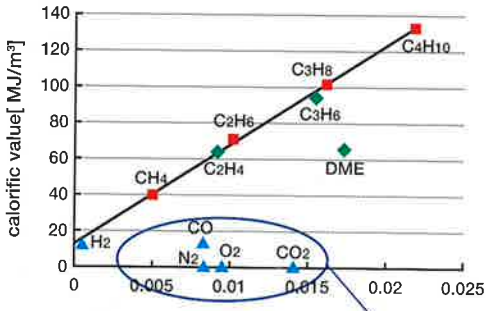
In every country in the world, there is movement to use various fuel gases such as Liquefied natural gas, shale gas, biogas, coal gasification, coke oven gas and methane hydrate, etc. as the safe energy source effectively. OHC-800 is a product of aiming at the enhancement of combustion efficiency/energy efficiency by measuring 'calorific value', 'Specific gravity' and 'Wobbe Index' of the fuel gas.

The highly accurate and reliable measurement has been possible by adopting the calculation method of our original development named optosonic calculation method that combines the optical sensor and the sonic sensor.

It prevents no measurement status owing to the improvement of self-diagnosis function such as diagnostic before the failure. The running cost is excellent as the use of consumables are hardly generated.

Influence of interference gas for optical sensor and sonic sensor

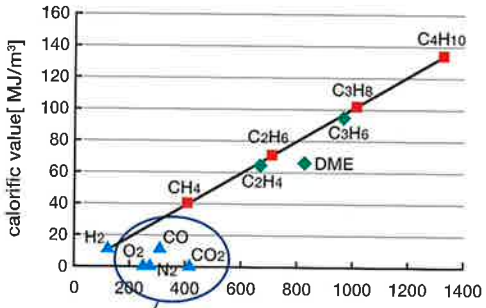
Both of an optical sensor with results as the principle of calorimeter and sonic sensor (densitometer) were influenced by the interference gases such as N_2 O_2 and CO_2.



Relation between speed of sound and calorific value (sonic sensor)

Inert gas group

The optical sensor and the sonic sensor are influenced by them though they have no calorific value.

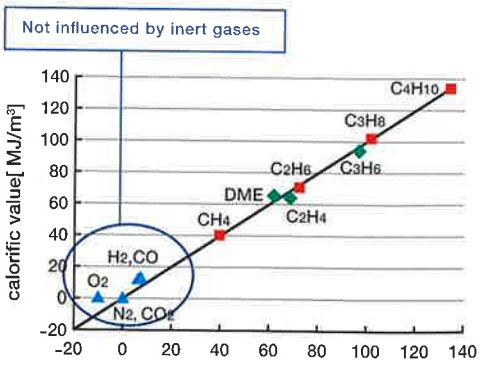


Relation between refractive index and calorific value (optical sensor)

Accuracy improvement with optosonic calculating method (our original development)

Patent No. 518483

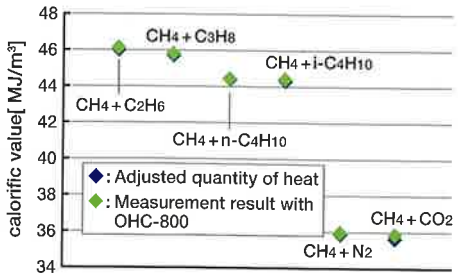
The calculation of our original development named optosonic calculation that combines the optical sensor and the sonic sensor has been adopted. Highly accurate and reliable calorimetry of the fuel gas is possible, because the influences of gases (such as N_2 O_2 and CO_2, etc.) having no calorific value in the fuel gas can be compensated by the adoption of calculation with different two sensors.



Relation between optosonic calculation result and calorific value

Establishment of highly accurate and reliabile measurement

High accuracy has been confirmed by Chemicals Evaluation and Research Institute, Japan (CERI)



Assessment results by Chemicals Evaluation and Research Institute, Japan (CERI)

Model of sampling device

OHC-800 is designed to have it incorporated in the specific sampling device RS-400 series. The model of sampling device is selected in accordance with the location where the calorimeter is installed and gas sampling point pressure condition etc.

Sampling device model

RS-400-□□□□

Enclosure
0: No enclosure
1: Enclosure for outdoor (SUS) with shading plate
2: Enclosure for indoor (SPCC) with window

Use of pressure reducing valve for measuring gas
0: Pressure reducing valve not used
1: Pressure reducing valve used

Bypass flow rate of measuring gas
0: Not bypassed
1: 0.5 - 5 L/min
2: 1 - 10 L/min
3: 2 - 20 L/min
*"0: Not bypassed" is applied for the case without pressure reducing valve.

Pressure gauge unit
1: MPa
2: MPa/PSI double units
*"1: MPa" is selected for the use in Japan because of the Measurement Act.

Accurate measurement possible owing to the optosonic calculation

Highly accurate and reliable calorimetry of the fuel gas is possible, because the influences of gases (such as N_2 O_2 and CO_2, etc.) having no calorific value in the fuel gas are to be compensated by the adoption of optosonic calculation developed originally by RIKEN KEIKI.

Continuous measurement of calorific value (MJ/m^3), specific gravity and the Wobbe Index is possible.

As the continuous measurement of calorific value (MJ/m^3), specific gravity and the Wobbe Index is possible, monitoring of the calorific value in situ is possible.

The display switching among calorific value (MJ/m^3), specific gravity and the Wobbe Index is possible.

No calculation is required as the switching of the display unit is possible by only the key operation.

Explosion-proof for hydrogen

It is possible to use in the hydrogen atmosphere with a robust flameproof enclosure (explosion-proof class: Exd II B+H_2T4).

Specification

Model	OHC-800
Measuring principle	Opt-Sonic calculation through measurement of refractive index and sound speed
Measuring gas	CH_4 basis Paraffinic Hydrocarbon gases as represented by Natural Gas *1
Measuring targets	Calorific value (density / WOBBE index selectable)
Measuring range *2	Calorific value : 25.00~50.00 MJ/m³ (gross, 0°C, 101.325kPa converted) Density : 0.500~1.500 MJ/m³ (specific gravity converted)
Measuring method	Constant-flow-rate gas introduction using external sampling devices
Display	Full-dot LCD (with backlight), 3 color LED lamp
External Output	4-20 mA DC (isolated, source current type) maximum load resistance of 300 Ω RS-485 communication
FAILURE alarm	Low flow, Sensor unit abnormality, Low light amount
FAILURE alarm display	Lamp (red) / Content indication on LCD
FAILURE alarm contact *3	No-voltage contact 1a or 1b De-energize (energize with alarming) or Energize (de-energize with alarming) Contact capacity of 2 A, 30 VDC (resistance load)
Self-diagnostic function	FUNCTION CHECK (warm-up or maintenance mode), MAINTENANCE REQUIRED, OUT OF SPECIFICATION
Self-diagnostic display	FUNCTION CHECK, OUT OF SPECIFICATION : Lamp (orange) / Content indication on LCD MAINTENANCE REQUIRED : Lamp (green) / Content indication on LCD
Self-diagnostic contact	FUNCTION CHECK, OUT OF SPECIFICATION : No-voltage contact 1a or 1b De-energize (energize with alarming) or Energize (de-energize with alarming) Contact capacity of 2 A, 30 VDC (resistance load) MAINTENANCE REQUIRED : SSR contact, contact capacity of 20 W, 240 VAC (resistance load)
Power supply	100 ~ 240 VAC ±10% 50/60 Hz, max, 18 VA or 24 VDC ±10% max 5 W (the setting can be changed to either the AC or DC)
Ingress Protection level	Equivalent to IP66 and IP67
Operation temperature	-20~+57°C (TIIS)/-20~+60°C (ATEX/IECEx)
Operation humidity	95% RH or less (no condensing)
Outer dimensions / Weight	approx. 286 (W) × 453 (H) × 150 (D) mm / approx. 23 kg
Explosion-proof structure	Flame-proof enclosures (explosion-proof class: Ex II B+H_2 T4 <TIIS>/ II 2GExd II B+H_2T4<ATEX/IECEx>)

*1 Total concentration of interference gases such as N_2, O_2, CO_2, and CO, etc. containned in a target gas is estimated as less than 20%
*2 Contact RIKEN KEIKI for the other measuring ranges
*3 Contact setting is adjustable

Smart Type Gas Detector Head

GD-70D series

GD-70D

GD-70D series is a gas detector head to detect toxic gas, oxygen, and combustible gas generated at semiconductor and liquid crystal factory, etc.
The reduction of an environmental load has been achieved by reuse of the sensor substrate and recycling of components.
Moreover, it also conform to CE marking that is the international standard, and it covers to RoHS Directive.

Specification

Model	GD-70D	GD-70D-NT	GD-70D-EA
Transmission system	4~20 mADC	DC Power Line Communication	Ethernet /4~20 mADC
Detection principle	Electrochemical, New ceramic, Semiconductor, Galvanic cell or Pyrolysis-particle		
Gas to be detected	Depending on the Detection principle		
Concentration value display	Character LCD display (white backlight) Digital & bar meter display: gas concentration, Alarm setpoint value		
Detection method	Pump drawing type		
Power supply	24VDC±10%	24VDC±10% (dedicated line by blocking filter)	24 VDC ±10% or PoE connection
Power consumption	24 VDC supply: max. 6.5 W PoE supply: max. 8.5 W		
Range of operating temperature and relative humidity	0~40°C (no sudden change) and 30~70% RH (by the installed sensor unit, and non-condensing)		
External dimension/Weight	approx. 70 (W) × 120 (H) × 145 (D) mm (projection portions excluded)/approx. 0.9 kg		

Gas to be Detected

Target gas	Chemical formula	House standard		ACGIH
		Detection range	Alarm setpoint value	Permissible concentration
Phosphine	PH_3	0~1ppm	0.3ppm	0.3ppm
Diborane	B_2H_6	0~0.3ppm	0.1ppm	0.1ppm
Silane	SiH_4	0~15ppm	5ppm	5ppm
Nitrogen trifluoride	NF_3	0~30ppm	10ppm	10ppm
Hydrogen chloride	HCl	0~6ppm	2ppm	2ppm (C)
Hydrogen fluoride	HF	0.4~3ppm	1ppm	0.5ppm
Tetraethoxysilane	TEOS	0~15ppm	10ppm	10ppm
Hydrogen bromide	HBr	0~6ppm	2ppm	2ppm (C)
Chlorine	Cl_2	0~1.5ppm	0.5ppm	0.5ppm
Fluorine	F_2	0~3ppm	1ppm	1ppm
Chlorine trifluoride	ClF_3	0~0.6ppm	0.2ppm	0.1ppm (C)
Ozone	O_3	0~0.6ppm	0.2ppm	0.2ppm
Nitrogen monoxide	NO	0~100ppm	25ppm	25ppm
Arsine	AsH_3	0~0.2ppm	0.05ppm	5ppb
Carbon monoxide	CO	0~75ppm	25ppm	25ppm
Ammonia	NH_3	0~75ppm	25ppm	25ppm
Disilane	Si_2H_6	0~15ppm	5ppm	-
Germane	GeH_4	0~0.8ppm	0.2ppm	0.2ppm
Hydrogen selenide	H_2Se	0~0.2ppm	0.05ppm	0.05ppm
Bromine	Br_2	0~1ppm	0.3ppm	0.1ppm
Nitrogen dioxide	NO_2	0~15ppm	5ppm	3ppm
Sulfur dioxide	SO_2	0~6ppm	2ppm	0.25ppm
Monomethylamine	CH_3NH_2	0~15ppm	5ppm	5ppm
Dimethylamine	$(CH_3)_2NH$	0~15ppm	5ppm	5ppm
Trimethylamine	$(CH_3)_3N$	0~15ppm	5ppm	5ppm
Diethylamine	$(CH_3CH_2)_2NH$	0~15ppm	5ppm	5ppm
Oxygen	O_2	0~25vol%	18vol%	-
Hydrogen	H_2	0~2000ppm	500ppm	-

Contact RIKEN KEIKI for other gas than above.

Gas to be detected can be changed.

As the sensor units became completely common, gas to be detected became to be able to change among combustible gas, toxic gas, oxygen, etc. only by exchange of the sensor unit.

Multifunctional sensor unit

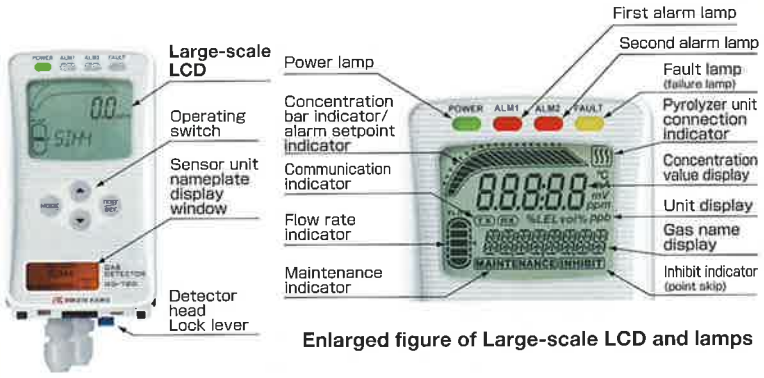
As a CPU is built in the sensor unit, the sensor information can be always managed, and the operation information (adjustment and trend data) can be understood. Operating information can be recorded in the memory, and a smooth analysis can be expected.

*Galvanic cell does not conform to RoHS

Electrochemical type	Semi-conductor method	Pyrolysis-particle type
		
Galvanic cell type	**New ceramic catalytic method**	
		

Screen display that sees easily

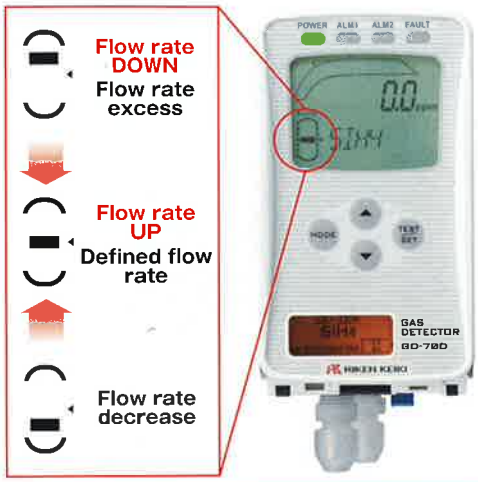
The concentration and the gas name, etc. displayed on the screen became easy to read because the screen is large. Moreover, information can be confirmed at a glance by the concentration value display and the concentration level display with the concentration bar.



Enlarged figure of Large-scale LCD and lamps

Flow rate automatic control function installed

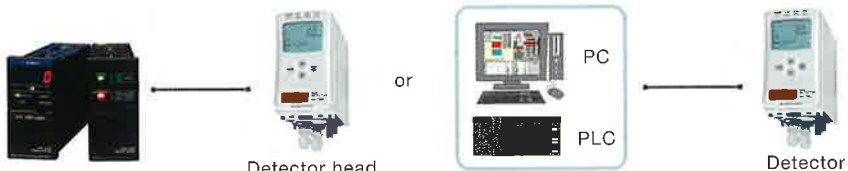
Stable gas detection became possible by automatc control of the flowrate of the gas to be detected drawn to the main body to the pre-defined flow rate.



Covering many kinds of communication methods

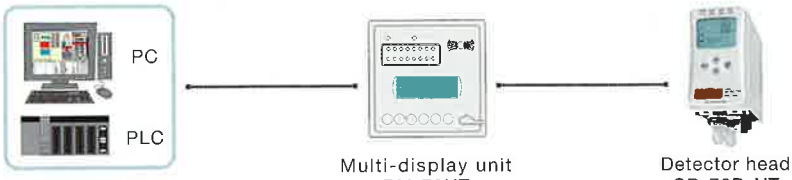
● Analogue 4 ~ 20mA DC type (using detector head: GD-70D)

Construction of flexible system with gas concentration data output of generic instrumentation signal (4 ~ 20 mA DC) is possible.



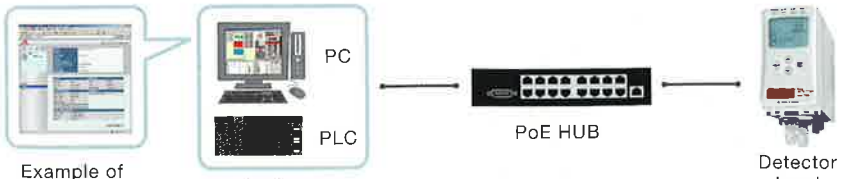
● DC Power Line Communication system (using detector head: GD-70D-NT)

As both of the power and the signal lines of the detector head are conbined as a communication line, it becomes single. Wire reduced construction can be realized.



● Ethernet System (using detector head: GD-70D-EA)

By means of PoE HUB, power supply with LAN cable is possible.
The construction cost can extensively be reduced. Moreover, the operational status etc. of the detector head can be confirmed by Web browser.



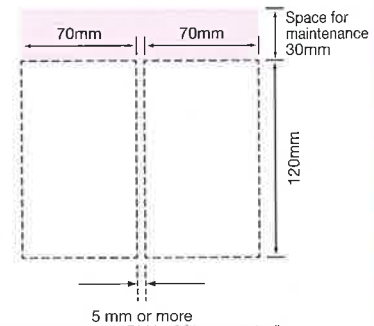
TEOS and NF_3 detection is possible.

Gas of TEOS and NF_3 detection is possible by connecting the pyrolyzer to the main body.

TEOS and NF_3 covered!

High-density mounting is available.

When two main bodies or more are set up in parallel, the space-saving mounting closely located down to min 5 mm (10 mm or more recommended) can be implemented.



Explosion-proof Diffusion Gas Detector Head

SD-1 series

SD-1

The SD-1 series is a small, light, smart type gas detector mainly developed for security and the disaster prevention of such as oil refineries and the petrochemical plants, etc.
The gas detector for Combustible gas, toxic gas and oxygen are lined to this product, and excellent functions such as self-diagnosis etc. based on the intelligent function are provided.
It acquired the certificate for the flameproof enclosures (explosion-proof: Exd II CT5), and covers the use in the hydrogen and acetylene atmosphere.

■ Model SD-1 series

SD-1 D TypeGP -AS

Detection method	Detection principle		Drawing method
Without D: Diffusion type With D : Drawing type	Type GP: Catalytic combustion type NC: New ceramic catalytic method RI: Nondispersive infrared ray system	GH: Semi-conductor method EC: Electrochemical type OX: Galvanic cell type	Without AS: Pump drawing type With AS: Aspirator drawing type

Covering the use in the hydrogen and acetylene atmosphere

By acquiring the certificate of flameproof enclosures (explosion-proof: Exd II CT5), it can be used in the places such as oil refinery and petrochemistry based product factory, etc. that become hydrogen or acetylene atmosphere.

Ex d IIC T5

- Symbol to indicate explosion-proof construction
- Kind of explosion-proof construction, Flameproof enclosures
- Temperature class
- Group of target gas and vapor for factory

Temperature class		T1	T2	T3–T6
Group of target gas and vapor for factory	IIA	Acetone Ethane 〃	Ethanol Butane 〃	〃
	IIB	〃	〃	〃
	IIC	Hydrogen	Acetylene	〃

Group classification of target gas and vapor for industry

Group sign	Maximum experimental safe gap (mm)
II A	Equal to or more than 0.9
II B	Over 0.5 and less than 0.9
II C	Equal to or less than 0.5

Classification of temperature class

Temperature class	Range of maximum surface temperature (℃)
T1	Over 450
T2	Over 300 and not more than 450
T3	Over 200 and not more than 300
T4	Over 135 and not more than 200
T5	Over 100 and not more than 135
T6	Over 85 and not more than 100

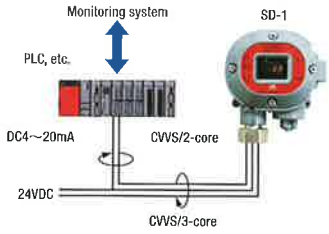
Easy operation only to touch of control key

As this device can be operated with the control key (magnet) without opening and closing the cover, it can be safely operated even in the explosion-proof place.

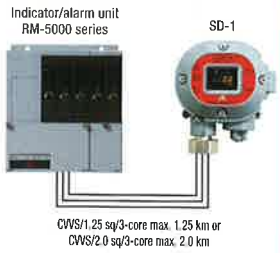
Connection example

Connection cable for Power supply (24 VDC) and gas concentration signal (4 ～ 20 mA DC) is 3 cores. When using contact outputs it is 5 cores.

■ Connection example with alarm monitoring system



■ Connection example with indicator/alarm unit



Specification

Model	SD-1		SD-1RI	SD-1GH
Type	Type GP	Type NC	—	—
Detection principle	Catalytic combustion	New ceramic	Non-dispersive infrared	Semiconductor
Gas to be detected	Combustible gas			Combustible gas or toxic gas
Detection range	0～100%LEL	Depending on gas to be detected	0～100%LEL	Depending on gas to be detected
Concentration value display	7 segments LED (4 digits) display			
Detection method	Diffusion type			
Alarm accuracy	Within ±25% to the alarm setpoint value			Within ±25% to the alarm setpoint value (combustible gas) Within ±30% to the alarm setpoint value (toxic gas)
Alarm delay time	Within 30 seconds after giving 1.6 times of gas of alarm setpoint value			Within 30 or 60 seconds after giving 1.6 times of gas of alarm setpoint value (depending on gas to be detected)
Power supply	24VDC (17.0～26.4VDC)			
Power consumption	Max. 3.0 W		Max. 2.0 W	Max. 3.1 W
Range of operating temperature and relative humidity	-20～+53°C (no sudden change), below 95% RH (non-condensing)			
Explosion-proof construction	Flameproof enclosures (Exd II CT5X)		Flameproof enclosures (Exd II CT6X)	Flameproof enclosures (Exd II CT5X)
External dimension/Weight	approx. 148 (W) × 161 (H) × 88 (D) mm (projection portions excluded)/approx. 2.0 kg			

Smart type gas detector head
SD-1EC (for hydrogen sulfide, carbon monoxide detection)

Features

- To detect hydrogen sulfide leakage around a desulfurization equipment.
- To prevent carbon monoxide poisoning in an ironworks.

Specification

Model	SD-1EC
Type	—
Detection principle	Electrochemical
Gas to be detected	Hydrogen sulfide or carbon monoxide
Detection method	Diffusion type
Detection range	Hydrogen sulfide: 0 ~ 30 ppm/Carbon monoxide: 0 ~ 75 ppm * Changeable
Alarm setpoint value	Depending on gas to be detected
Alarm delay	Within 30 seconds after giving 1.6 times of gas of alarm setpoint value
Power consumption	Max. 1.1 W
Range of operating temperature and relative humidity	-10~+40°C (no sudden change) 30~80% RH (non-condensing)
External dimension/Weight (projection portions excluded)	approx. 148 (W) × 203 (H) × 88 (D) mm/approx. 2.2 kg
Explosion-proof	Flameproof enclosures (Exd II CT6X)

Smart type gas detector head
SD-1OX (for oxygen detection)

Features

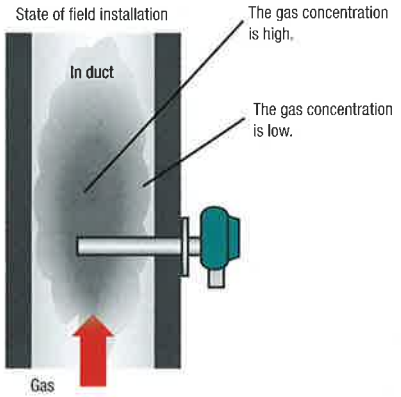
- For the safety management of checking and cleaning works in underground tunnels.
- For the hypoxia prevention in such as underground culverts.

Specification

Model	SD-1OX
Type	—
Detection principle	Galvanic cell
Gas to be detected	Oxygen
Detection method	Diffusion type
Detection range	0~25.0vol%
Alarm setpoint value	18.0 vol% (1-step alarm)
Alarm delay	Within 5 seconds after giving gas of 10 ~ 11 vol% and letting it detected in hypoxia alarm
Power consumption	Max. 1.1 W
Range of operating temperature and relative humidity	-10~+40°C (no sudden change) 95% RH (non-condensing)
External dimension/Weight (projection portions excluded)	approx. 148 (W) × 208 (H) × 88 (D) mm/approx. 2.5 kg
Explosion-proof	Flameproof enclosures (Exd II CT6X)

In-furnace Safety Monitor

SD-2500



As the length of the in-furnace insertion part is 250 mm, the detection at the core part of high gas concentration is possible.

Features

- High boiling point solvent can be detected.
- Temperature range being assayed for Explosion-proof.
  (0~160°C: Only models GD-A2400 or the SD-2500 covers.)
  (0~200°C: Only model SD-2600 covers.)
- Can be used even in 200°C or higher.
  (operating temperature range 0~250°C: Only model SD-2700 is applicable.)
- The concentration at the core part in the facilities is obtained accurately.
- Concentration display part is integrated to the main body.
  (dedicated indicator/alarm unit not required: effective to Models SD-2500/2600/2700)
- Simple operation only to touch of control key for adjustment.

Specification

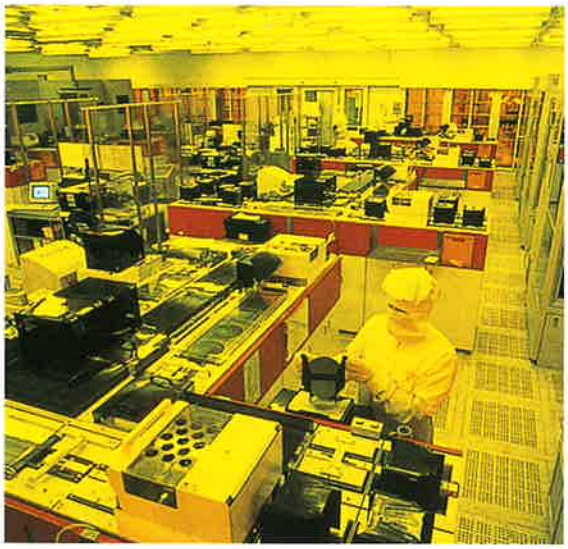
Model	GD-A2400	SD-2500	SD-2600	SD-2700
Detection principle	Catalytic combustion			
Gas to be detected	Combustible gas			
Detection range	0~100%LEL*	0~100%LEL		
Concentration value display	With an instructor/alarm unit	7 segments LED digital (4 digits)		
Detection method	Direct insertion type			
Alarm delay time	Within 30 seconds after giving 1.6 times of gas of alarm setpoint value *1			
Power supply	Supplied by the indicator/alarm unit	24VDC±10%		24VDC (20~26.4VDC)
Power consumption	—	Max. 3 W		
Range of operating temperature and relative humidity	In-furnace insertion part: 0~160°C (no sudden change) Main body case (ambient temperature): 0~50°C (no sudden change)		In-furnace insertion part: 0~200°C (no sudden change) Main body case: 0~50°C (ambient temperature) (no sudden change)	In-furnace insertion part: 0~250°C (no sudden change) Main body case: 0~50°C (ambient temperature) (no sudden change)
Explosion-proof construction	Flameproof enclosures (Exd II CT3)		Flameproof enclosures (Exd II CT2)	Non-explosion-proof
External dimension/Weight	approx. 148 (W) × 167 (H) × 458 (D) mm (projection portions excluded) In-furnace insertion part: ϕ 34 × 250/approx. 4.6 kg			

* When an indicator/alarm unit is connected

Multipoint Indicator/alarm Unit

RM series

■ Multipoint indicator/alarm unit RM series have design and function that can correspond to the densified security instrumentation system. It is a typical series as the gas detection terminal.
RM series can combinate optimally for wide-ranging use and the usage as it can be used by combining with the gas detector head suitable for various usages.



RM-5000 series

Features

- Various gases can be detected by abundant variations.
- Gas concentration is displayed with 2 ways (the bar meter and digital).
- Increased visibility of the detected status by 3 color high contrast LCD adoption.
- Energy-saving achieved (1/4 to 1/6 compared to our old unit).
- Equipped with RS-485 communication function.

Multi case

Single case (Buzzer unit)

Single case (indicator/alarm unit)

GP-5001 (for combustible gas)
NC-5001 (W) (for combustible gas)
NP-5001 (for combustible gas and inert gas)
SP-5001 (for combustible gas and toxic gas)
GH-5001 (for combustible gas and toxic gas)

EC-5002/5002i * (for toxic gas)
OX-5001 (for oxygen)
OX-5002/5002i * (for oxygen)
RM-5002/5002i/5003 (for 4 ~ 20 mA transmission)
TAN-5000 (L) (Buzzer unit)

* Isolation type (insulated type)

RM-590 series

Features

- Digital display easy to see gas concentration.
- Alarm pattern selectable.
- Flow rate decrease signal can be input.
- To-network connectable (optional).

Multi case

Single case (indicator/alarm unit)

Single case (Buzzer unit)

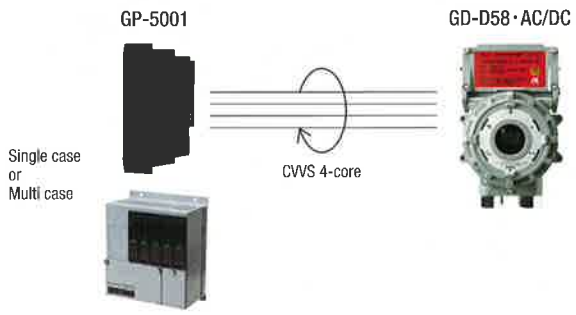
GP-591 (for combustible gas)
NC-591 (W) (for combustible gas)
GH-591 (for combustible gas and toxic gas)
EC-592 (for toxic gas)

OX-591 (for oxygen)
OX-592 (for oxygen)
RM-592/593 (for 4 ~ 20 mA transmission)
TAN-590 (Buzzer unit)

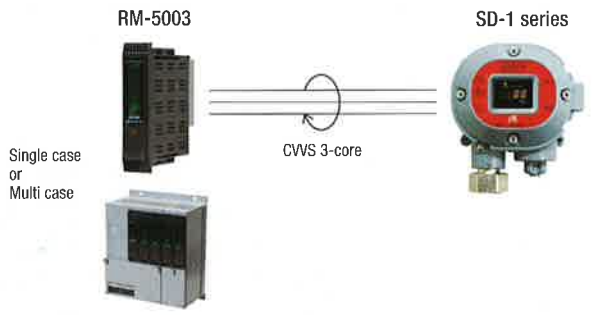
Specification

Model	GP-5001 NC-5001(W)	NP-5001	SP-5001	GH-5001	EC-5002 EC-5002i	OX-5001	OX-5002 OX-5002i	RM-5002 RM-5002i RM-5003	RM-5003T	Buzzer unit TAN-5000(L)
Detection principle of suited detector head	Catalytic combustion New ceramic	Thermal conductivity	Hot-wire semi-conductor	Semiconductor	Electrochemical Pyrolysis-particle	Galvanic cell		General measurement signal	Semiconductor	–
Gas for indication	Combustible gas	Combustible gas, Inert gas	Combustible gas, Toxic gas		Toxic gas	Oxygen		Combustible gas, Toxic gas, Oxygen, etc.	Carbon monoxide	–
Detector head signal	Direct signal of sensor output				Current signal (4~20mADC)	Sensory output Direct signal	Current signal (4~20mADC)		Current signal (4~30mADC)	–
Transmission distance to the detector head	Within 2.0 km with CVV 2.0 mm² cable	Within 2.0 km with CVVS 2.0 mm² cable	Within 2.0 km with CVV 2.0 mm² cable	Within 2.0 km with CVVS 2.0 mm² cable		Within 600 m with CVVS 2.0 mm² cable	Within 2.0 km with CVVS 2.0 mm² cable	Depending on detector head to be connected.		–
Concentration value display	Character LCD (digital and bar meter <3 colors: green, orange, red>)									–
Range of operating temperature and relative humidity	-10~+40°C (no sudden change), below 10~90% RH (non-condensing)									
Alarm contact	Dry contact 1a or 1b each (2 step independent) De-energized in a normal state (energized at an alarm state) or energized in a normal state (de-energized at an alarm state)									
Power supply	24VDC (21.6~26.4VDC)									
Power consumption	Max. 7 W (detector head included)				Max. 3 W (detector head included)	Max. 2 W (detector head included)	Max. 3 W (detector head included)	Max. 2 W (detector head excluded)	Max. 5 W (detector head excluded)	Max. 2 W
External dimensions	approx. 29.6 (W) × 120 (H) × 92 (D) mm (projection portions excluded)									
Weight	approx. 100 g (only for unit)									approx. 80 g

Connection example between the indicator/alarm unit and the detector head



RM-5000 series can be connected with the detector head corresponding to the gas for indication.



EC-/OX-/RM-5002 and RM-5003 are able to connect with a detector head of 4~20 mA transmission 2 and 3 wire system respectively.

Specification

Model	GP-591 NC-591 (W)	GH-591	EC-592	OX-591	OX-592	RM-592 RM-593	RM-593-T	Buzzer unit TAN-590
Detection principle of suited detector head	Catalytic combustion New ceramic	Semiconductor	Electrochemical/ Pyrolysis-particle	Galvanic cell		General measurement signal		–
Gas for indication	Combustible gas	Combustible gas, Toxic gas	Toxic gas	Oxygen		Combustible gas, Toxic gas, Oxygen, etc.	Carbon monoxide	–
Detector head signal	Direct signal of sensor output		Current signal (4~20mADC)	Direct signal of sensor output	Current signal (4~20mADC)		Current signal (4~30mADC)	–
Transmission distance to the detector head	Within 1.25 km with CVV 1.25 mm² cable	Within 1.25 km with CVVS 1.25 mm² cable		Within 600 m with CVVS 1.25 mm² cable	Within 1.25 km with CVVS 1.25 mm² cable	Depending on detector head to be connected	Within 1.25 km with CVVS 1.25 mm² cable	–
Gas concentration display	7 segments LED degital (4 digits)							–
Range of operating temperature and relative humidity	0~40°C (no sudden change), 10~90% RH (non-condensing)							
Alarm contact	Dry contact 1a or 1b each (2 step independent) De-energized in a normal state (energized at an alarm state) or energized in a normal state (de-energized at an alarm state)							
Power supply	24VDC±10%							
Power consumption	Max. 10 W (detector head included)		Max. 5 W (detector head included)			Max. 5 W	Max. 10 W (detector head included)	Max. 2 W
External dimensions	approx. 36 (W) × 72 (H) × 134 (D) mm							
Weight	approx. 100 g (only for unit)							

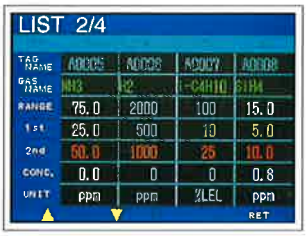
Multipoint Indicator/alarm System

Multi gas monitoring system

RM-700

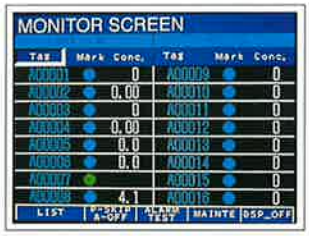
Features

- Easy operation with touch panel.
- Multifunctional screen by LCD graphic.
- Information on all points are offered in real time.
- Trend graphs of all points are available at any time.
- Extension facility to BL-NET (multiplex transmission) provided.
- Connectable with various gas detector head.
- Mountable to 19-inch rack.
- Same size as BL-2300 amplifier rack.
- Online maintenance function provided.
- Alarm off function during maintaining provided.



Example of display list

Whole screen



Example of trend graph

Specification

Model		RM-700						
Suitable detector head		Covering 16 units at maximum according to the selection of amplifier unit						
	Model of amplifier unit	700-GP	700-NC	700-GH	700-SP	700-EC	700-OX	700-CU*1
	Detection principle of suited detector head	Catalytic combustion	New ceramic	Semiconductor	Hot-wire Semiconductor	Electrochemical	Galvanic cell	General instrument signal
Gas concentration display		LCD (6-inch TFT) Graphic panel display						
Range of operating temperature and relative humidity		0~40°C, 20~90% RH						
Integrated alarm contact output		(1) WARNING (1 point) (2) ALARM (1 point) (3) TROUBLE (1 point) (4) CPU DOWN (1 point) 100 VAC 0.5 A (resistance load) De-energized in a normal state (energized type: factory presettable for shipping) A contact (B contact: presettable)						
Individual alarm contact output		Option (OUT1 OUT2 unit required) (1) WARNING or Fault (16 points) (2) ALARM or Fault (16 points) 100 VAC 0.5 A (resistance load) De-energized in a normal state (energized type: factory presettable for shipping) A contact (B contact: presettable)						
Power supply		100VAC±10% 50/60Hz						
Electric power consumption		Max. 180 VA						
Structure		Mountable to 19-inch rack						
External dimensions		approx. 435 (W) × 150 (H) × 346 (D) mm						
Weight		approx. 10 kg						

*1 General measurement signals other than gas detector can be input (the amplifier unit is 700-CU) <Note> Separate power supply and terminal plate for pump power supply required.

Single point Indicator/alarm Unit <for marine, semiconductor factory and petrochemical industries>

RM-6000 series

This unit is a one point continuous monitoring type for both marine and land use combinedly. The function, structure and performance are conforming to the related regulations and standards of 'High Pressure Gas Safety Act'.

GP-6001
(for combustible gas)

NC-6001 (W)
(for combustible gas)

GH-6001
(for combustible gas and toxic gas)

SP-6001
(for combustible gas and toxic gas)

EC-6002 (for toxic gas)

OX-6001/6002 (for oxygen)

RM-6002/6003
(for 4 ~ 20 mA transmission)

Features

- Small, light one point independent continuous monitoring type.
- Easy to install by the independent unit adoption.
- Stepwise management on gas alarm by 2 step alarm type.
- Connectable to various gas detection heads by selecting the unit.

Specification

Model	GP-6001 NC-6001 (W)	SP-6001	GH-6001	EC-6002	OX-6001	OX-6002	RM-6002	RM-6003	RM-6003T
Detection principle of suited detector head	Catalytic combustion New ceramic	Hot-wire Semiconductor	Semiconductor	Electrochemical Pyrolysis-particle	Galvanic cell		General measurement signal		Carbon monoxide (CO)
Gas for indication	Combustible gas	Combustible gas, Toxic gas		Toxic gas	Oxygen		Combustible gas, Toxic gas Oxygen, etc. (general measurement signal)		Semiconductor detector head (GD-A44V)
Detector head signal	Direct signal of sensor output			Current signal (4~20mADC)	Direct signal of sensor output	Current signal (4~20mADC)			Current signal (4~30mADC)
Alarm display	1st: ALM1 red lamp blinking or lighting (after reset) and buzzer sounding 2nd: ALM2 red lamp blinking or lighting (after reset) and buzzer sounding								
Alarm contact	Dry contact 1a or 1b each (2 step independent) De-energized in a normal state (energized at an alarm state) or energized in a normal state (de-energized at an alarm state)								
Power supply	AC specification: 100~240 VAC ±10% 50/60 Hz, DC specification: 24 VDC ±10% (21.6~26.4 VDC) [option]								
Power consumption (pump excluded)	Max.15VA Max.8.5W (detector head included)	Max.11.5VA Max.6W (detector head included)		Max.7.5VA Max.3.5W (detector head included)	Max.6.5VA Max.3W (detector head included)	Max.7.5VA Max.3.5W (detector head included)	Max.7.5VA Max.3.5W (detector head excluded)		Max.10.5VA Max.7.5W (detector head included)
External output	4~20 mADC (non-insulated, load resistance 300 Ω or less)/digital transmission: RS-485 [option]								
External dimension/Weight	approx. 110 (W) × 190 (H) × 54 (D) mm (projection portions excluded)/wall type: 580 g, embedding type: 650 g								

Model GP-147

Specification

Model	GP-147
Detection principle of suited detector head	Catalytic combustion type, New ceramic type
Gas for indication	Combustible gas
Detector head signal	0~6~12 VDC (10 mA or less) [standard] or 4~20 mADC (load resistance 300 Ω or less) [option]
Transmission distance to the detector head	Within 300 m with CVV 0.75 mm² cable Within 500 m with CVV 1.25 mm² cable Within 500 m with CVV 2.0 mm² cable
Concentration value display	Character LCD (bar meter display of 2 colors (red and green))
Range of operating temperature and relative humidity	-10~+50°C (no sudden change), 10~90% RH (non-condensing)
Alarm contact	Dry 1a contact [standard] or 1b contact [option] (contact capacity: 250 VAC 1 A)
Power supply	100~120 VAC or 200~240 VAC Input automatic switching between 50/60 Hz
UPS (uninterrupted power supply)	Lead battery 12 V 2.3 Ah × 2 pieces * With backup point selecting function
External dimension/Weight	2 point type:approx.305 (W)×290 (H)×73 (D) mm/approx.3.9kg 4 point type:approx.395 (W)×290 (H)×73 (D) mm/approx.5.0kg 6 point type:approx.485 (W)×290 (H)×73 (D) mm/approx.5.8kg 8 point type:approx.575 (W)×290 (H)×73 (D) mm/approx.6.6kg 10 point type:approx.665 (W)×290 (H)×73 (D) mm/approx.7.4kg 12 point type:approx.755 (W)×290 (H)×73 (D) mm/approx.8.2kg

Features

- 12 units at maximum can be mounted. Extension is easy owing to the connecting case adoption.
- Respective existence of backup by UPS (uninterrupted power supply) for each connected detector head can be set.
- LCD display of 2 colors (green and red) easily identifiable from even remote place.
- Thunderbolt cared specification.

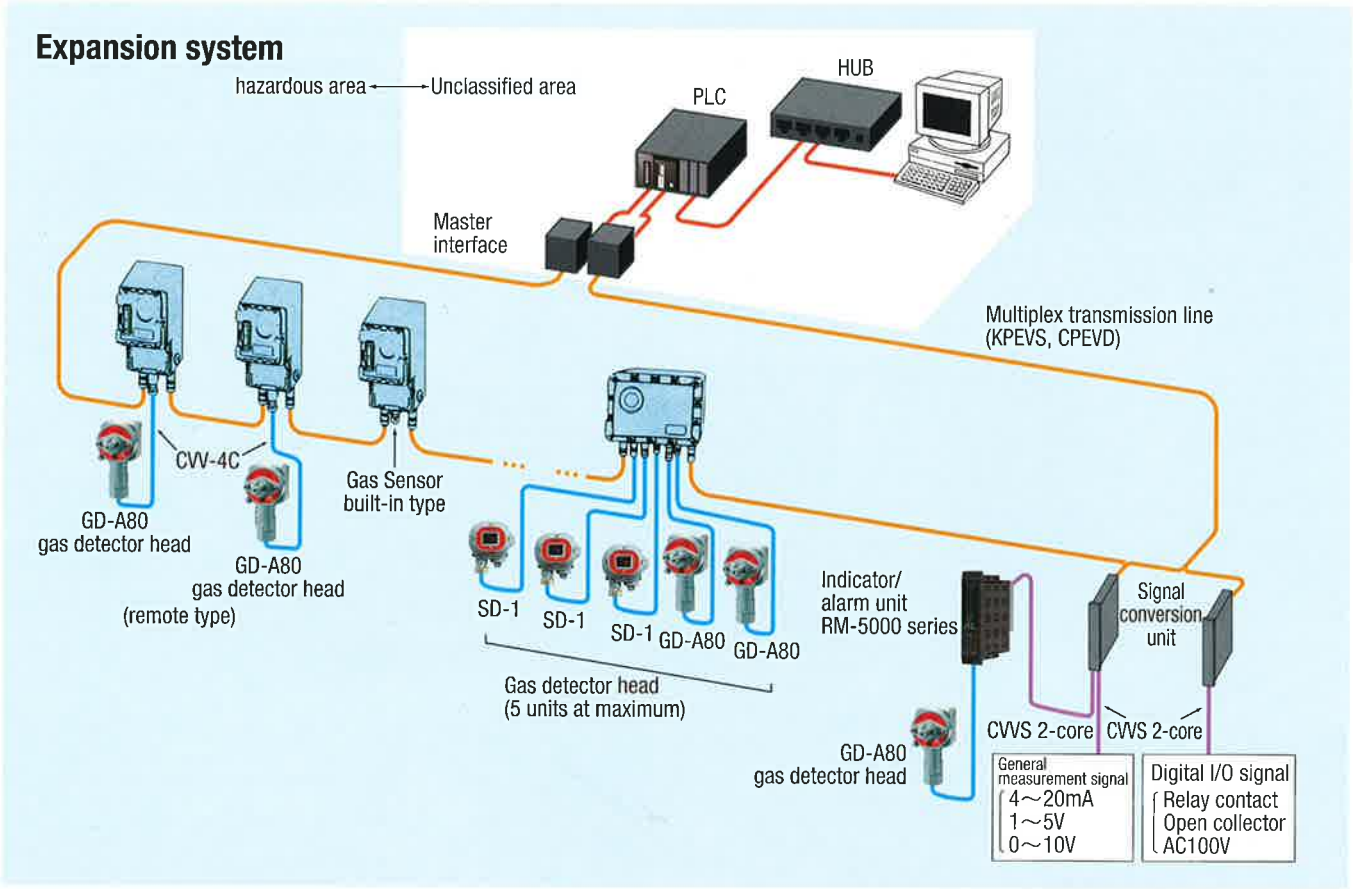
Multiplex Transmission System

Model BL-8000

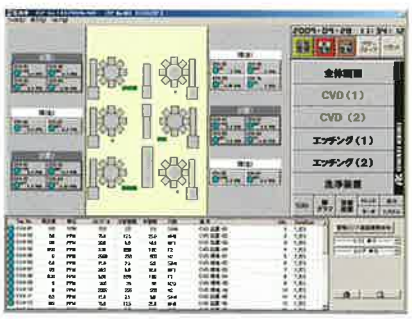
Model BL-8000 is a gas detector alarm system with a multiplex transmission optimal for an integrated monitoring from small scale (tens of points) to medium scale (several thousand points).

Features

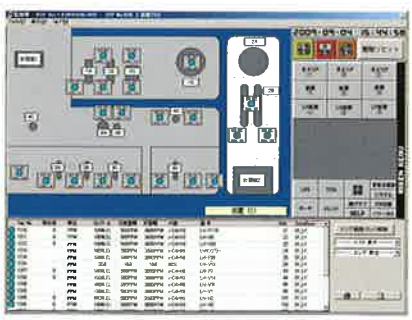
- Data can be collected and monitored by disposing the factory computer and sharing a multiplex transmission line with other signal conversion units.



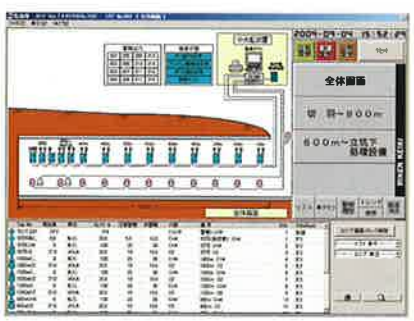
Example of screen



Semiconductor factory



Oil refinery plant



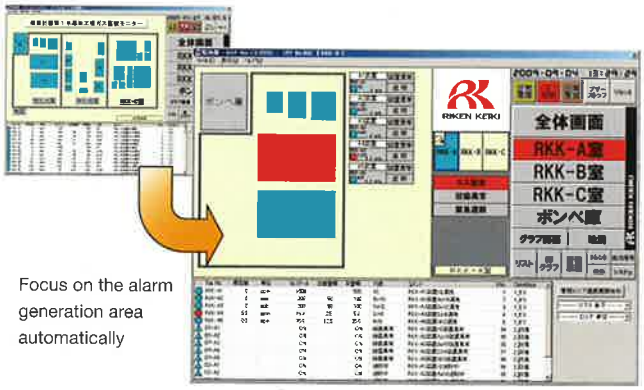
Tunnel work

RIKEN KEIKI KANSHIRO

Features

- **Does not overlook the danger on the site**
  When the gas leakage is happened, it is automatically displayed on the generation area of the screen, and the site of incidence is informed.
- **Easy operation which can be remembered if it is used once**
  Easy to see and required information is available soon with an easy operation. Trend graphic display that tends to become complex is simple and intuitive.
- **Help for report making**
  Please utilize print data or data taken out into a removable disk for report making, etc. by the output function of information such as the alarm history and the trend graph.

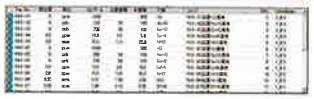
Alarm pattern



Focus on the alarm generation area automatically

Basic display

List screen



The place wanted to see can be searched soon by switching over the area scale or data base scale.

Bar chart

The state of the alarm can be confirmed at one view of the graph, the color of which changes.

Alarm history record

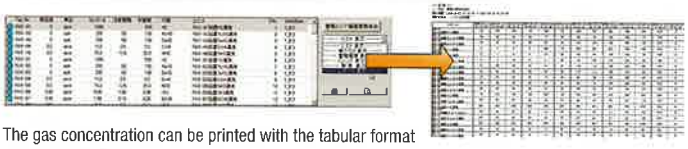
20,000 data stored at maximum. The retrieval function has been enhanced, too.

Trend graph

10 seconds cycle, preserved for more than 1 month. Easy operation only with a mouse.

Advanced function

Report (daily report and monthly report)



The gas concentration can be printed with the tabular format of a day or a month.

Print function

The screen, the list, and the alarm history table can be printed by an easy click operation.

Applicable PLC

Omron	CS1 series CJ1 series CJ2 series
Mitsubishi Electric	MELSEC Q series

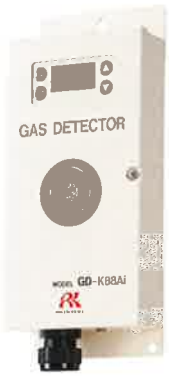
Specification

Item		Specification
Recommended system requirements	OS	Windows7 professional
	CPU	Intel Celeron processor 2.8 GHz or better
	Memory	2 GB or more
	HDD	80 GB or more
	Display	Resolution XGA (1024 × 768) or more
Display function	List screen	Unit of data base and unit of area screen Display item [Tag No./present value/unit/full scale/warning alarm/real alarm/object/comment/S No./DATABASE]
	Bar chart	Unit of data base and unit of area screen Display item [Tag No./present value/unit/full scale/warning alarm/real alarm/object]
	Alarm history record	Return history display, Tag No. retrieval and object retrieval Can retrieve the State, DataBase/S No. and comment. 20,000 display at maximum
	Trend	Can be preserved for 1 month or more (depending on HDD capacity). 7 points at maximun simultaneous display
	Print	List, alarm history and screen image
Advanced function	Report	Display and print of daily and monthly report
	Alarm history record	CSV file export
	Trend	CSV file export

Gas Detector Head <for semiconductor and liquid crystal relation>

Explosion proof detector head for semiconductor material gas

4～20 mA transmission system



GD-K88Ai

GD-K88Di

Features

- The power supply and the sensory output to the main body can be covered by only 2 lines.
- Intrinsic safety. Note) Accomplished by the combination with the safety holder (barrier).
- The specification with built-in aspirator is lined up. [option]

Specification

Model	GD-K88Ai	GD-K88Di
Gas to be detected	Toxic gas	
Detection method	Diffusion type	Drawing type (a pump is separately required).
Detection principle	Electrochemical	
Detection range	Depending on gas to be detected	
Concentration value display	7 segments LCD (4 digits)	
Transmission system	4～20 mADC loop power (load resistance 300 Ω or less)	
Power supply	24VDC±10%	
Transmission cable	Shielded cable admitted by explosion-proof construction such as CVVS (2-core), etc.	
Range of operating temperature and relative humidity	0～40°C (no sudden change), 30～70% RH (non-condensing)	
Explosion-proof construction	Intrinsic safety (explosion class: Exia II CT4X) * When safety holder (barrier) is used	
Safety holder (recommended)	Zener barrier (MTL728ac) Insulation barrier (MTL5541)	
External dimension (projection portions excluded)	approx. 100 (W) × 241 (H) × 48 (D) mm	approx. 220 (W) × 265 (H) × 90 (D) mm
Weight	approx. 1.0 kg	approx. 2.5 kg

Smart type gas detector head <portable desktop type>

TP-70DG II

Specification

Model	TP-70DG II	
Detection principle	Electrochemical + pyrolysis (catalyst)	
Type	TYPE C4F6	TYPE COS
Gas to be detected	C4 F6 (detection range: 0～5 ppm)	COS (detection range: 0～15 ppm)
Alarm setpoint value	1st: 2 ppm/2nd: 4 ppm	1st: 5 ppm/2nd: 10 ppm
Concentration value display	Character LCD (digital and bar meter display)	
Detection method	Pump drawing type (drawing flow rate: 0.5 L/min ±10%)	
Power supply display	POWER lamp turning on (green)	
Various displays	Gas name display/flow rate display/mode display/communication state display/ pyrolyzer connection display	
External output	Gas concentration signal/gas alarm contact/fault alarm contact	
Alarm accuracy	±30% of alarm setpoint value (under the same condition)	
Alarm delay time	Within 60 seconds after giving 1.6 times of gas of alarm setpoint value * Piping delay not included (under the same condition).	
Gas alarm display	1st: ALM1 lamp blinking or lighting (red)/2nd: ALM2 lamp blinking or lighting (red)	
Gas alarm pattern	Non latching (auto-reset) or fault alarm pattern	
Various functions	White backlight/alarm delay/suppression/zero follower/sensitivity correction Flow control/calibration history/alarm trend history/event history	
Power consumption	Max. 150 VA	
External dimension/Weight	approx. 180 (W) × 225 (H) × 285 (D) mm (projection portions excluded)/ approx. 3.8 kg	

Features

- Influence of interference is reduced by adopting the pyrolyzer with catalyst.
- New intelligent sensor equipped.
- Automatic flow rate adjusting function installed.

Specification

Model	TP-70D
Detection principle	Electrochemical, New ceramic, Semiconductor, Galvanic cell
Gas to be detected	Toxic gas, combustible gas, oxygen
Concentration value display	Character LCD display (white backlight), digital & bar meter display
Detection method	Pump drawing type
Power supply	100VAC～240VAC±10% 50/60Hz
Power consumption	Max. 20 VA
Range of operating temperature and relative humidity	0～40°C, 30～70% RH (by the installed sensor unit, and non-condensing)
External dimension/Weight	approx. 160 (W) × 210 (H) × 260 (D) mm (projection portions excluded)/approx. 4.3 kg

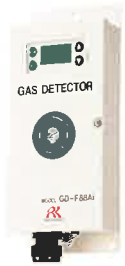
Specification

Model	TP-70DG
Detection principle	Electrochemical + pyrolysis
Gas to be detected	NF3
Concentration value display	Character LCD (white backlight), digital & bar meter display
Detection method	Pump drawing type
Power supply	100VAC～240VAC±10% 50/60Hz
Power consumption	Max. 45 VA
Range of operating temperature and relative humidity	0～40°C, 30～70% RH (by the installed sensor unit, and non-condensing)
External dimension/Weight	approx. 160 (W) × 210 (H) × 260 (D) mm (projection portions excluded)/approx. 5.4 kg

Gas Detector Head <for oxygen detection>

Explosion proof oxygen detector head

4～20 mA transmission system



GD-F88Ai

GD-F88Di

Specification

Model	GD-F88Ai	GD-F88Di
Gas to be detected	Oxygen	
Detection method	Diffusion type	Drawing type (a pump is separately required)
Detection principle	Galvanic cell	
Detection range	0～25.0vol%	
Concentration value display	7 segments LCD (4 digits)	
Transmission system	4～20 mADC loop power (load resistance 300 Ω or less)	
Power supply	24VDC±10%	
Transmission cable	Shielded cable admitted by explosion-proof construction such as CVVS (2-core)	
Range of operating temperature and relative humidity	-10～+40°C (no sudden change), below 95% RH (non-condensing)	
Explosion-proof construction	Intrinsic safety (Exia II CT4X) * When safety holder (barrier) is used	
Safety holder (recommended)	Zener barrier (MTL728ac) Insulation barrier (MTL5541)	
External dimension (projection portions excluded)	approx. 100 (W) × 241 (H) × 48 (D) mm	approx. 220 (W) × 265 (H) × 90 (D) mm
Weight	approx. 1.0 kg	approx. 2.5 kg

Features

- The power supply to the main body and the sensory output can be covered by only 2 lines.
- With pressure correction function (influence of the atmospheric fluctuation is corrected).
- Intrinsic safety. Note) Accomplished by the combination with the safety holder (barrier)
- The specification with built-in aspirator is lined up. [option]

Explosion proof oxygen detector head

GD-F3A-A

GD-F3A-SC-A

GD-F4A-A

GD-F4A-SC-A

Specification

Model	GD-F3A-A	GD-F3A-SC-A	GD-F4A-A	GD-F4A-SC-A
Detection principle	Galvanic cell			
Detection method	Diffusion type		Drawing type (a pump is separately required)	
Gas to be detected	Oxygen			
Detection range	0～25.0vol%			
Explosion-proof construction	Intrinsic safety by the combination with the Zener barrier (Ex ia II CT4X)			
Cable to be used	Equivalent to CVVS 2-core			
Power supply	–		Depending on the specification of the drawing pump separately used	
Detector head signal	Sensory output Direct signal	Current signal (4～20mADC)	Sensory output Direct signal	Current signal (4～20mADC)

Explosion-proof Gas Detector Head <for Semiconductor, Electric power, Gas, Civil engineering and various Plants>

Diffusion type gas detector head Specification

GD-A80 series

GD-A80

GD-A80V

Specification

Model	GD-A80	GD-A80V	GD-A80S	GD-A80N	GD-A80-70
Detection principle	Catalytic combustion or New ceramic	Semiconductor	Hot-wire Semiconductor method	Thermal conductivity	Catalytic combustion or New ceramic
Gas to be detected	Combustible gas	Combustible gas, Toxic gas	Combustible gas, Toxic gas	Combustible gas, Inert gas	Combustible gas
Detection method	Diffusion type				
Transmission cable	Cable such as CVV/4-core	Cable such as CVVS/3-core	Cable such as CVVS/4-core	Cable such as CVVS/4-core	Cable such as CVV/4-core
Transmission distance	Depending on each indicator unit				
Power supply	Supplied by each indicator unit				
Range of operating temperature and relative humidity	-20~+53°C (no sudden change), below 95% RH (non-condensing)				-40~+70°C (no sudden change) Below 95% RH (non-condensing)
Explosion-proof construction	Flameproof enclosures (explosion-proof: Exd II CT4)				
External dimension/ Weight	approx. 78 (W) × 154 (H) × 105 (D) mm (projection portions excluded)/approx. 1.0 kg				

Drawing type gas detector head

GD-D58 series

GD-D58·AC

Features

- Drawing pump of large flow rate built-in.
- Flow rate decreasing detector sensor installed.
- Easy maintenance owing to unitizing components to be exchanged periodically.

Specification

Model	GD-D58·AC		GD-D58·AC·GH	GD-D58·DC		GD-D58·DC·GH
Type	Type GP	Type NC	–	Type GP	Type NC	–
Detection principle	Catalytic combustion	New ceramic	Semiconductor	Catalytic combustion	New ceramic	Semiconductor
Gas to be detected	Combustible gas		Combustible gas, Toxic gas	Combustible gas		Combustible gas, Toxic gas
Detection method	Pump drawing type					
Transmission cable	Cable such as CVV 4-core *1- or 6-core *2		Shielded cable such as CVVS/3-core *1- or 5-core *2	Cable such as CVV 4-core *1- or 6-core *2		Shielded cable such as CVVS 3-core *1- or 5-core *2
Transmission distance	Depending on each indicator unit					
Power supply	100~110VAC±10% · 50/60Hz			24VDC (21.6~26.4VDC)		
Range of operating temperature and relative humidity	-20~+50°C (no sudden change) Below 95% RH (non-condensing)			-20~+53°C (no sudden change) Below 95% RH (non-condensing)		
Explosion-proof construction	Flameproof enclosures (explosion-proof: Exd II B+H_2T4)					
External dimension/ Weight	approx. 197 (W) × 286 (H) × 140 (D) mm (projection portions excluded)/approx. 5.8 kg					

*1 For the case of wiring power supply and transmission cables separatedly
*2 For the case of wiring power supply and transmission in one cable

Drawing type gas detector head <Concentration value display furnished>

SD-D58 series

SD-D58·AC

Features

- Drawing pump of large flow rate built-in.
- Flow rate decreasing detector sensor installed.
- Easy maintenance owing to unitizing components to be exchanged periodically.
- One-man maintenance possible.

Specification

Model	SD-D58·AC		SD-D58·AC·GH	SD-D58·DC		SD-D58·DC·GH
Type	Type GP	Type NC	–	Type GP	Type NC	–
Detection principle	Catalytic combustion	New ceramic	Semiconductor	Catalytic combustion	New ceramic	Semiconductor
Gas to be detected	Combustible gas		Combustible gas, Toxic gas	Combustible gas		Combustible gas, Toxic gas
Concentration value display	7 segments LED degital (4 digits)					
Detection method	Pump drawing type					
Alarm accuracy	Combustible gas: within ±25% of the alarm setpoint value, Toxic gas: within ±30% of the alarm setpoint value.					
Alarm delay time	Within 30 or 60 seconds after giving 1.6 times of gas of alarm setpoint value (depending on gas to be detected. Neither piping delay nor communication delay is included.)					
Transmission cable	Cable such as CVVS 2- or 4-core			Cable such as CVVS 3- or 5-core		
Transmission distance	Depending on each indicator unit					
Power supply	100~110VAC±10% · 50/60Hz			24VDC (21.6~26.4VDC)		
Range of operating temperature and relative humidity	-20~+50°C (no sudden change), below 95% RH (non-condensing)			-20~+53°C (no sudden change), below 95% RH (non-condensing)		
Explosion-proof construction	Flameproof enclosures (explosion-proof: Exd II B+H_2T4)					
External dimension/ Weight	approx. 197 (W) × 286 (H) × 140 (D) mm (projection portions excluded)/approx. 5.8 kg					

Drawing pump with hydrogen explosion proof

RP-D58

Specification

Model	RP-D58 · AC	RP-D58 · DC
Power supply	100~110VAC±10% · 50/60Hz	24VDC (21.6~26.4VDC)
Power consumption	Max. 13 VA	Max. 8.6 W
Range of operating temperature and relative humidity	-20~+50°C (no sudden change) Blow 95% RH (non-condensing)	-20~+53°C (no sudden change) Blow 95% RH (non-condensing)
Explosion-proof construction	Flameproof enclosures (explosion-proof: Exd II B+H_2T4)	
External dimension/Weight	approx. 197 (W) × 286 (H) × 140 (D) mm (projection portions excluded)/approx. 5.8 kg	

Optical Interferometric Gas Monitor <for Electric power, Gas, Solvent, and Food manufacturing>

IF series

Commercialized to be able to use more advanced function of optoelectronics stably for a long term by combining optical technique of RIKEN KEIKI for 80 years and the latest electronic technologies. The function corresponding to the user needs of specialized field equipped.

Features

- Optical interferometric principle to be able to measure concentration of all gases by refractive index.
- Continuous accurate measurement of calorie of natural gas and LPG, etc.
- Range of measurement wide selectable.
- Automatic zero and span calibration.
- Long-term stability owing to microcomputer-control of the metering section temperature.
- Economical running cost owing to few consumable introduced.
- Gases in N_2, H_2 and He, etc. measurable (optional specification).

Optical Interferometric Gas Monitor

FI-800

Features

- Hydrogen explosion-proof assayed (ExdIIB + H_2T4X)

Specification

Model	FI-800
Measuring principle	Optical interferometric
Measuring object gas	Combustible gas/Solvent vapor/Inert gas
External output	4~20 mA load resistance 300 Ω or less
Concentration value display	LCD digital
Detection method	Drawing type (introduction with external unit)
Alarm display	LED lamp blinking (AL1, AL2)
Alarm contact	Dry contact (AL1, AL2)
Fault alarm	Decrease of flow rate, light intensity and contrast
Power supply	100~220 VAC ±10% 50/60 Hz, power consumption: Max. 8 VA
Range of operating temperature and relative humidity	-10~+40°C (no sudden change), below 80% RH (non-condensing)
Explosion-proof construction	Flameproof enclosures (Exd II B+H_2T4)
External dimension/Weight	approx. 220 (W) × 332 (H) × 122 (D) mm (projection portions excluded)/approx. 16 kg

FI-815A

Specification

Model	FI-815A
Measuring principle	Optical interferometric
Measuring object gas	Various solvent vapors in atmosphere
Measuring range	0~100%LEL
Structure	Rack mount type
Measuring method	Pump drawing type (drawing flow rate: 1.0 L/min or more)
Response time	T90 Within 15 second (put in the gas from gas IN).
Concentration value display	LCD digital (the least digit 1% LEL)
Concentration output	4~20 mA (electric current discharge type) permissible load resistance 300 Ω or less
Alarm contact	AL1 and AL2 1a each Contact capacity: 125 VAC 1 A/30 VDC 1 A (resistance load)
Fault alarm	Decrease of flow rate, light intensity and contrast
Power supply	100 VAC ±10% 50/60 Hz, power consumption: Max. 17 VA
Range of operating temperature and relative humidity	-10~+50°C and below 95% RH (gases dewing/condensing in the unit unapplicable)
External dimension/Weight	approx. 370 (W) × 150 (H) × 266 (D) mm/approx. 6 kg

Chemical Tape Gas Detector <Transportable>

Highly sensitive toxic gas monitor optimal for low concentration gas management

FP series

This is a highly sensitive toxic gas monitor that is hardly influenced by interference gases because of using detection tape.
As the detection tape reacts with gas to be detected chemically, the detection is hardly influenced by hydrogen and organic solvents, etc. and the tape shows its true ability for the low concentration management of the target gases at the exit, etc. of the detoxifying apparatus. Moreover, for the detection tape exchange, as one-touch cassette system is adopted, the tape detaching can easily be executed without fail.

Features

- Optimal for the environment monitor of a clean room.
- The detection sensibility is extremely high and it is optimal for the monitoring of the low concentration (ppb detection).
- It excels in selectivity, and is not interfered with other gases.
- The exchange of tapes is easy owing to the cassette in system.
- Remaining quantity indicator of the tape is provided.

FP-300
FP-301

FP-300AGZS

Specification

Model	FP-300
Detection principle	Chemical tape method
Gas to be detected	Toxic gas: Semiconductor special material gas
Alarm accuracy	Within ±20% of alarm setpoint value (under the same condition)
Detection tape and time used	1 month (without alarm) Remaining tape quantity indication provided With a prior notice and warning of tape end
Alarm setpoint value (2 steps)	Depending on gas to be detected
External output signal	4~20 mADC (load resistance 300 Ω or less)
Power supply	Desktop: 100 ~ 240 VAC ±10% 50/60 Hz Panel mount type: 24 VDC ±10%
Power consumption	Desktop: approx. 16 VA/max. 30 VA (tape feeding) Panel mount type: approx. 10 W/max. 20 W (tape feeding)
External dimensions	Desktop: approx. 164 (W) × 198 (H) × 263 (D) mm Panel mount type: approx. 164 (W) × 164 (H) × 263 (D) mm
Weight	Desktop: approx. 6.5 kg Panel mount type: approx. 5.5 kg

Specification

Model	FP-301	
Detection principle	Chemical tape method	
Gas to be detected	H_2Se	AsH_3
Alarm accuracy	Within ±20% of alarm setpoint value (under the same condition)	
Detection tape and time used	1 month (without alarm) Remaining tape quantity indication provided With a prior notice and warning of tape end	
Alarm setpoint value (2 steps)	1st (WARNING):50ppb 2nd (ALARM):100ppb	1st (WARNING):5ppb 2nd (ALARM):10ppb
External output signal	4~20 mADC (load resistance 300 Ω or less)	
Power supply	Desktop: 100 ~ 240 VAC ±10% 50/60 Hz Panel mount type: 24 VDC ±10%	
Power consumption	Desktop: approx. 16 VA/max. 30 VA (tape feeding) Panel mount type: approx. 10 W/max. 20 W (tape feeding)	
External dimensions	Desktop: approx. 164 (W) × 198 (H) × 263 (D) mm Panel mount type: approx. 164 (W) × 164 (H) × 263 (D) mm	
Weight	Desktop: approx. 6.5 kg Panel mount type: approx. 5.5 kg	

Specification

Model	FP-300AGZS	
Detection principle	Chemical tape method	
Gas to be detected	C_5F_8	C_4F_6
Alarm accuracy	Within ±30% of alarm setpoint value (under the same condition)	
Detection tape and time used	2 months (without alarm) Remaining tape quantity indication provided With a prior notice and warning of tape end	
Alarm setpoint value (2 steps)	1st (WARNING): 2.0ppm, 2nd (ALARM): 4.0ppm	
External output signal	4~20 mADC (load resistance 300 Ω or less)	
Power supply	100~240VAC±10% 50/60Hz	
Power consumption	Max. 150 VA	
External dimensions	approx. 250 (W) × 198 (H) × 300 (D) mm	
Weight	approx. 9.5 kg	

Infrared Gas Detector

RI series

RI series was made into a series as a summarization of long years' RIKEN KEIKI's technology with the infra-red analysis meter.
It cover various sites with abundant variations.

Features

- Easy installation with the space-saving design.
- A little influence of the interference gas.
- Excellent long-term stability.

RI-257

Specification

Model	RI-257
Detection principle	Non-dispersive infrared
Gas to be detected	CFC gas, PFC gas and various solvent gases
Detection range	Depending on gas to be detected
Detection method	Pump drawing type
Alarm	2 step alarm [1st (WARNING), 2nd (ALARM)] Operation: Fault alarm pattern (non latching (auto-reset) after alarm confirmed) Alarm light: Lamp display (yellow/red) Contact output: open contact at a normal state (normal closed contact optional) Contact rating: 125 VAC 0.1 mA~0.5 A (for load resistance)
Alarm setpoint value	Depending on gas to be detected
Alarm accuracy	±30% of alarm setpoint value (under the same condition)
Alarm delay time	Within 30 seconds after giving 1.6 times of gas of alarm setpoint value
External output	4~20 mA load resistance 300 Ω or less
Power supply	100VAC±10% 50/60Hz
Power consumption	Max. 50 W
Range of operating temperature and relative humidity	0~40°C, 30~90% RH (non-condensing)
External dimension/Weight	approx. 180 (W) × 355 (H) × 97 (D) mm (projection portionss excluded)/ approx. 3.8 kg

RI-557 <portable>

Specification

Model	RI-557
Detection principle	Non-dispersive infrared
Gas to be detected	CO, CO_2, CH_4, etc. in atmosphere
Detection range	Depending on gas to be detected
Detection method	Pump drawing type
Concentration output	4~20 mADC, load resistance 300 Ω or less, or 0~1 VDC
Power supply	100~220VAC±10% 50/60Hz
Power consumption	Max. 25 VA (100 V), Max. 35 VA (220 V)
Range of operating temperature and relative humidity	0~40°C, below 90% RH (non-condensing)
External dimension/Weight	approx. 220 (W) × 200 (H) × 320 (D) mm (projection portions excluded)/ approx. 5.7 kg

RI-215A (diffusion type)

RI-215D (drawing type)

Specification

Model	RI-215A	RI-215D
Detection principle	Non-dispersive infrared	
Gas to be detected	Carbon dioxide	
Concentration value display	LCD display	
Detection range	0~2000ppm (TYPE-2000) 0~5000ppm (TYPE-5000) 0~9990ppm (TYPE-9990) 0~5vol% (TYPE-5)	0~2000ppm (TYPE-2000) 0~5000ppm (TYPE-5000) 0~9990ppm (TYPE-9990) 0~2vol% (TYPE-2) 0~5vol% (TYPE-5)
Concentration display resolution	ppm specification: 1 ppm (detection range: 0 ~ 2000 ppm), 10 ppm (detection range: 2000 ~ 9990 ppm)	
	vol% specification: 0.005 vol% (detection range: 0~2 vol%), 0.010 vol% (detection range: 2~5 vol%)	
Repeatability	Within ±5% F.S (under the same condition)	
Detection method	Diffusion type	Pump drawing type
Drawing flow rate	—	1.0 L/min or more
External output signal	0~10 VDC (load resistance: Min. 500 kΩ) or 4~20 mADC (load resistance: Max. 300 Ω)	
Alarm setpoint value (set value optional)	ppm specification: 1000 ppm	
	vol% specification: 1 vol% [TYPE-2], 2.5 vol% [TYPE-5]	
Alarm contact output	Dry contact 1a	
Range of operating temperature and relative humidity	0~40°C, below 10~90% RH (non-condensing)	
Power supply	24VDC±10% 24VAC±10% 50/60Hz	100VAC±10% 50/60Hz 110VAC±10% 50/60Hz 220VAC±10% 50/60Hz
Power consumption	Max. 4 VA	Max. 12 VA
External dimensions	approx. 78 (W)× 78 (H) ×31 (D) mm (projection portions excluded)	approx. 220 (W) × 265 (H) × 76 (D) mm (projection portions excluded)
Weight	approx. 0.2 kg	approx. 3.6 kg

Infrared Gas Detector

RI-2000W(R)

RI-2000W <wall type>

Features

- For leak detection of N_2O.
- For leak detection of medical application anesthetic gas cylinder.

Specification

Model	RI-2000W (wall type)/RI-2000R (19-inch rack installation type)
Detection principle	Non-dispersive infrared
Gas to be detected	N_2O (nitrous oxide)
Detection range	0~200ppm
Detection method	Pump drawing type
Drawing flow rate	approx. 1.0 L/min or more
Kind of alarm	Gas alarm: 2 step alarm Fault alarm: System abnormal, Flow rate decrease, motor abnormal, etc.
External output	4~20 mA (non-insulated, linear, load resistance 300 Ω or less)
Alarm accuracy	Within ±30% of alarm setpoint value (under the same condition)
Power supply	100 VAC ±10% 50/60 Hz, power consumption: Max. 400 VA
External dimension/Weight (projection portions excluded)	Wall type: approx. 350 (W) × 440 (H) × 160 (D) mm, approx. 17 kg 19-inch rack installation type: approx. 482 (W) × 180 (H) × 402 (D) mm, approx. 16 kg

Single Point Gas Monitor

● Sensor built-in type and remote sensor type, selectable

OX-600

Main body

Remote sensor [option]

Specification

Model	OX-600
Gas to be detected	Oxygen
Detection method	Diffusion type or remote detection method
Detection principle	Galvanic cell
Detection range	0~25.0 vol% (1 digit: 0.1 vol%)
Concentration value display	LCD digital display (3 digit 7 segment/3 color backlight: green, orange and red) *1
Length of remote cable	3 m, 5 m, 10 m, 20 m
Kind of alarm	Gas alarm: 2 step alarm (fault alarm pattern/cancel with reset switch) Fault alarm: System abnormal, sensor abnormal (non latching (auto-reset))
Alarm setpoint value	1st: 19.0vol% 2nd: 18.0vol%
Alarm history record	10 records from the latest (least concentration and generated date)
External output	4~20 mADC (non-insulated, load resistance 300 Ω or less) or 0~1 VDC (non-insulated) *2
Alarm contact	Dry contact 1a or 1b each, Contact capacity 125 VAC 1 A or 30 VDC 1 A (resistance load)
Range of operating temperature and relative humidity	-10~+40°C (no sudden change), below 90% RH (non-condensing)
Power supply	100 VAC ±10% 50/60 Hz or 24 VDC ±10% or 2 size AA alkaline battery
Power consumption	AC specification: Max. 5 VA DC specification: Max. 3 W
Continuous operating time (dry battery specification)	approx. 1 year (25°C, without Alarm, backlight off)
External dimensions	Main body: approx. 80 (W) × 120 (H) ×35.5 (D) mm Remote sensor: approx. 40 (W) × 96 (H) × 35.5 (D) mm (projection portions excluded)
Weight	AC specification: approx. 200 g DC specification: approx. 180 g Dry battery specification: approx. 230 g Remote sensor: approx. 55 g (cable excluded)

● Sensor built-in type and remote sensor type, selectable

EC-600

Main body

Remote sensor [option]

Model	EC-600
Gas to be detected	Carbon monoxide
Detection method	Diffusion type or remote detection method
Detection principle	Electrochemical
Detection range	0~150 ppm (1 digit: 1 ppm)
Concentration value display	LCD digital display (3 digit 7 segment/3 color backlight: green, orange and red) *1
Length of remote cable	3 m, 5 m, 10 m, 20 m
Kind of alarm	Gas alarm: 2 step alarm (fault alarm pattern/cancel with reset switch) Fault alarm: System abnormal, sensor abnormal (non latching (auto-reset))
Alarm setpoint value	1st: 50ppm 2nd: 100ppm
Alarm history record	10 records from the latest (highest concentration and generated date)
External output	4~20 mADC (non-insulated, load resistance 300 Ω or less) or 0~1 VDC (non-insulated)*2
Alarm contact	Dry contact 1a or 1b each, Contact capacity 125 VAC 1 A or 30 VDC 1 A (resistance load)
Range of operating temperature and relative humidity	0~40°C (no sudden change), below 90% RH (non-condensing)
Power supply	100 VAC ±10% 50/60 Hz or 24 VDC ±10% or 2 size AA alkaline battery
Power consumption	AC specification: Max. 5 VA DC specification: Max. 3 W
Continuous operating time (dry battery specification)	approx. 1 year (25°C, without alarm, backlight off)
External dimensions	Main body: approx. 80 (W) × 120 (H) ×35.5 (D) mm Remote sensor: approx. 40 (W) × 96 (H) × 35.5 (D) mm (projection portions excluded)
Weight	AC specifications: approx. 200 g DC specifications: approx. 180 g Dry battery specification: approx. 230 g Remote sensor: approx. 55 g (cable is excluded)

*1 Backlight is usually off for dry battery specification. (a part of operation for dry battery specification is different from that of AC and DC specifications)
*2 0-1VDC only for dry battery specification

Photoelectron Spectrophotometer

AC-5

Features

- Work function and ionization potential can be measured in approx. 5 minutes in the atmosphere.
- A big sample can be measured (max. 180 mm × 180 mm).
- Continuous measurement possible (max. 25 samples at 1 time).
- A new type detector adopted
  (the measurement of the electron count in 1 second has increased to twice compared to our old detector).
- Range of energy scanning: 3.4 ~ 6.2 eV.
- Max. light intensity: 500 nW or more (at 5.9 eV).

Specification

Model	AC-5
Measuring principle	Low-energy electron count
Range of energy scanning	3.4~6.2eV (364~200nm)
Repeatability (standard deviation)	Work function 0.02 eV (sample: gold plate) Slope 1.0 Y/eV (averaged slope at 20 ~ 30 Y/eV)
Measuring time	Normal time required to measure the work-function: approx. 5 minutes (5 sec an energy measurement)
Maximum count	4,000cps
UV lamp	D_2 lamp
Min. light intensity	1.0 nW or less (at 5.9 eV)
Max. light intensity	500 nW or more (at 5.9 eV)
Ultraviolet spot size	2~4 mm square
Spectroscope	Grating type monochromator
Sample	approx. 180 mm × 180 mm Max. thickness 1.0 mm ±0.2 mm
Sample stand	For approx. 195 mm × 195 mm Max. thickness 1 mm
Range of operating temperature and relative humidity	15~35°C, dew point -30°C or higher, below 60% RH
Power supply	100~240VAC 50/60Hz 5A (max)
Power consumption	approx. 240 W (personal computer excluded)
External dimensions	AC-5 LC (light source part): approx. 470 (W) × 500 (D) × 300 (H) mm AC-5 DC (metering part): approx. 600 (W) × 500 (D) × 380 (H) mm (neither rubber feet nor projection portions are included)
Weight	AC-5 LC (light source part): approx. 35 kg AC-5 DC (metering part): approx. 50 kg

* To operate this equipment, a display and manual operating device (personal computer equipment) is required separately.

Option for photoelectron spectrophotometer Fermi level measuring instrument

FAC-2

Features

- Fermi level of the semiconductor sample that was not able to be measured with the photoelectron spectrophotometer can be measured in an atmosphere.
- It is suitable to measure the time elapsing changes in metallic surface, etc. immediately after deposition, because the necessary time to measure is short.
- Set up of the sample is easy, as the precise adjustment of the distance between electrode and sample is unnecessary.

Specification

Measuring method	Kelvin method
Configuration of Mesuring section	ϕ 10mm
Energy range of measurement	3.4~6.2 eV (when calibrated with a standard sample of the work function 5 eV)
Measuring time	10 seconds or less
Repeated reproducibility	±0.02 eV or less
Range of operating temperature	10~35℃
Range of operating relative humidity	60% RH or less
Power supply	100VAC 50/60Hz
External dimensions	approx. 235 (W) × 330 (H) × 408 (D) mm (standard size. H and D vary depending on the microscope position.)
Weight	approx. 12 kg

Photoelectron Spectrophotometer

AC-3

Features

- A comparatively big sample (max. 30 mm square) and powder can be measured because measurement is implemented in the atmosphere.
- Information on the surface up to the depth to the nanometer order can be measured.
- Work function and ionization potential can be measured in approx. 5 minutes.
- Range of energy scanning: 4.0 ~ 7.0 eV.
- Max. light intensity: 100 nW or more (at 5.9 eV).
- Handling is easy as the vacuum is not used.

Specification

Model	AC-3
Measuring principle	Low-energy electron count
Electron detector	Open counter
Range of energy scanning	4.0~7.0eV (310~177nm)
UV lamp	Heavy hydrogen lamp with lamphouse
Spectroscope	Nitrogen substitution grating type monochromator
Repeatability	Work function 0.02 eV (standard deviation)
Measuring time	Normal time required to measure work function: approx. 5 minutes (10 sec an energy measurement)
Ultraviolet spot size	2×5mm
Max. light intensity	100 nW or more (at 5.9 eV)
Sample	30 × 30 mm (max.), thickness 10 mm (max.), 1 point measurement
Software	AC-3 for Windows (work function meter)
Range of operating temperature and relative humidity	15~35℃, 20~60%RH
Power supply	AC100V 50/60Hz 5A (max)
Utility	Compressed air: Pressure 0.5 ~ 0.7 MPa, flow rate 5 L/min Nitrogen: Pressure 0.5 ~ 0.6 MPa, flow rate 2 L/min (measuring), 5 L/min (purging)
External dimensions	approx. 740 (W) × 1080 (H)× 680 (D) mm (caster included)
Weight	approx. 120 kg

* To operate this equipment, a display and manual operating device (personal computer equipment) is required separately.

Portable X-ray Diffractometer with a Fluorescent X-ray Analyzer

DF-01

Features

- 2 kinds of analyses of diffraction X rays and X-ray fluorescence can be implemented at the same point, and then more accurate data can be obtained from 2 different measurement data.
- Nondestructive and noncontact portable analyzer.
  Analysis method of nondestructive and noncontact.
  The relic and the cultural asset, etc. which are restricted to move and carry out can be "analysed in situ".
- Measuring object of large-scale and the strange appearance can be measured as it is.
  There are little restrictions in the nominal size and the shape of the measuring object. It is possible to measure it as it is without fracture, cutting out and/or dividing even if the measuring object is large and/or strange appearance.

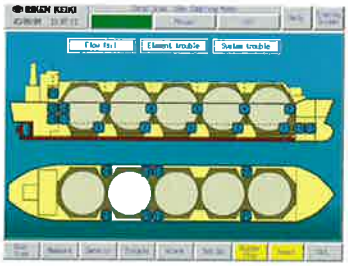
Specification

Model	DF-01
Detection element	$_{13}$Al—$_{92}$U
Specimen geometry	Unrestricted (do not collide with the device)
Atmosphere	Atmosphere and He
Measurement size	over ϕ 2.5 mm (differ according to the angle)
Measuring range of angle 2 θ	0~120°
The least travel	0.002°
Collimator	ϕ 2mm×75mm
X-ray tube target	Cr
Rated output of X-ray tube	28W
Rated voltage of X-ray tube	35kV
Rated current of X-ray tube	0.8mA
X-ray tube cooling system	Forced-air cooling
Detector type	Si-PIN photodiode
Power supply	100~240VAC 50/60Hz 5A (max)
External dimensions	Metering section: approx. 542 (W) × 342 (D) × 203 (H) mm (for 2 θ = 0°) Control part: approx. 427 (W) × 295 (D) × 180 (H) mm
Weight	Metering part: approx. 12 kg Control part: approx. 16 kg

* To operate this equipment, a display and manual operating device (personal computer equipment) is required separately.

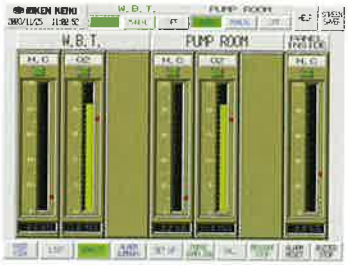
Marine Gas Detection System

● Scanning type gas detection system
Pump room/water ballast tank/inter barrier space
Other holding



Area screen

List screen



Bar meter screen

Alarm screen

- Touch panel easy to see
- Gas detecting part <--> Display part separated type considering the installing location
- Piping inboard shortening possible
- Built-in ballast water mis-aspiration prevention device (for oil tanker)

● Gas detection alarm system for pump room

Operation unit

Display unit

Model MS PR-2.0 (HC)
Model MS PR-2.1 (HC/O_2)
Model MS PR-2.2 (HC/H_2S)
Model MS PR-2.3 (HC/O_2/H_2S)

- Covering SOLAS 2000
  Oil tanker pump room dedicated gas detecting alarm system
- 4 to 6 point switching measurement type
- Corresponding to O_2 and H_2S measurement besides HC gas

Danger of Gas

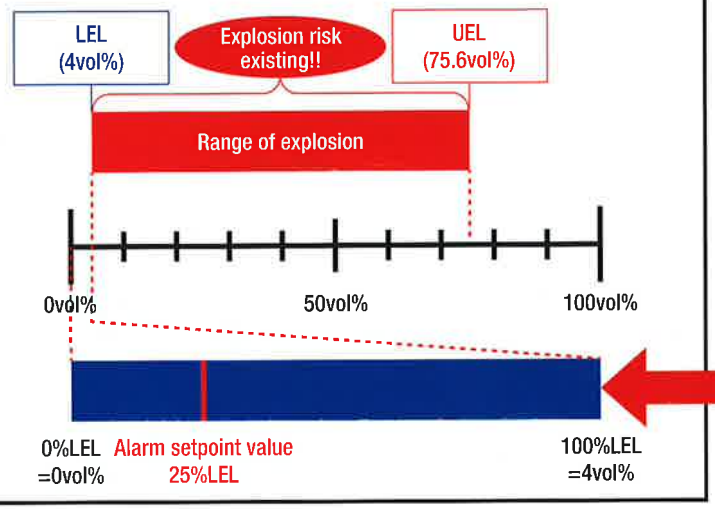
What is the Combustible Gas ...?

According to Safety Regulations for General High Pressure Gas (JAPAN), the combustible gas is;

- The lower limit of the explosion limit of it (it means the explosion limit when it is mixed with air. It is the same as follows.) is 10-percent or less.
- The difference between upper limit and lower limit of explosion limit of it is 20 percent or larger.

The combustible gas is a generic name of the gas with the possibility of causing combustion. There is a possibility of causing an explosion if the density range of the mixture of combustible gas and Oxygen (air) is in a certain range and ignition source exists. This density range is called the range of explosion, and the lowest concentration over the range of explosion is called Lower Explosive Limit (LEL) and the highest concentration are called Upper Explosive Limit (UEL).

One Example of Lower Explosive Limit (LEL) and Upper Explosive Limit (UEL) of Hydrogen (H_2)



Regarding the Alarm Setpoint Value of the Combustible Gas

It is too late to annunciate the danger after the concentration of the combustible gas reaches Lower Explosive Limit (LEL)!!

The concentration control to inform the existence of the combustible gas before it reaches LEL is necessary.

Regarding the concentration control of less than the Lower Explosive Limit, the alarm setpoint value of the combustible gas is decided as follows in Exemplified Standards concerning Safety Regulations for General High Pressure Gas.

- The value of 1/4 or less of the Lower Explosive Limit

What is the Toxic Gas ...?

According to Safety Regulations for General High Pressure Gas (JAPAN), the toxic gas is,

- Threshold limit value is the one of 200/1,000,000 or less (= permissible level is 200 ppm or less)

Moreover, the alarm setpoint value of the toxic gas, according to Exemplified Standards concerning Safety Regulations for General High Pressure Gas, is

- The value below the permissible level value (twice value of the permissible level concentration value for the one which is difficult to prepare the calibration gas)

● Definition of permissible level

It is a concentration judged for the adverse effect on health not to be seen by almost all workers if the concentration of the toxic substance in air is below this value even if the worker is exposed to the toxic substance on the labor site.

RIKEN KEIKI adopts the threshold limit value of ACGIH (The United States industry hygiene expert meeting: American Conference of Governmental Industrial Hygienists) though the threshold limit value is recommended by ACGIH and Japan Association of Industrial Health.

● Kind of threshold limit value

- TWA (time weighted average): Time-weighted average value of that health problems might not be caused even if exposed repeatedly in the usual work of eight hours per day, 40 hours during the week.
- STEL (short term exposure limit): Limit value of short time exposure 4 times or less a day within 15 minutes and interval of 1h or more, by which no health problems might be caused.
- C (ceiling value): Upper bound that must not be exceeded.

What are Oxygen Deficiency and the Hydrogen Sulfide Poisoning?

Oxygen Deficiency and the hydrogen sulfide poisoning are provided from Ordinance on Prevention of Oxygen Deficiency, etc. as follows.

- Oxygen Deficiency ..... The symptom that occurs because of inhalation of air in the state whose concentration of the atmospheric oxygen is less than 18% is observed.
- Hydrogen sulfide poisoning .... The symptom that occurs because of inhalation of air in the state whose concentration of the hydrogen sulfide exceeds 10/1,000,000 (10 ppm) is observed.

A usual alarm setpoint value is set to 18% according to Ordinance on Prevention of Oxygen Deficiency, etc (JAPAN).

Symptom of Oxygen Deficiency

Oxygen concentration (%)	Symptom
20.93	Oxygen concentration of atmosphere.
18	It is necessary to prepare the respiratory protective device such as continuous ventilation, the oxygen concentration measurements in the work environment, and the safety belts though it is a safety threshold.
16 ~ 12	Increase of pulse and ventilatory frequency, mental concentration decrease, wrong simple calculation, poor precision muscle work, muscular depression, headache, the tinnitus aurium, the evil intention, and nausea appear.
14 ~ 9	A judgment decrease, a state of exaltation, an unstable mental status, frequent sigh, abnormal tiredness, the state of drunkenness, headache, nausea, vomits, no memory at that time, pain in the wound not felt, escape power of whole body, temperature elevation, cyanosis, haze consideration, danger of the crash death from stairs and a ladder and drowning.
10 ~ 6	Nausea, vomitus, loose freedom of the action, cannot move nor shout even if danger is felt, prostration, sensory hallucination, cyanosis, loss of consciousness, fainting, central nervous system disorder, generalized convulsion, crisis of death.
6 or less	Several-time gasping respirations and syncope, fainting, bradypnea and stop, spasm, cardioplegic arrest, death.

Symptom of Hydrogen Sulfide Poisoning

Hydrogen sulfide concentration (ppm)	Symptom
0.025	Limitation of sense of smell.
0.2	Everyone can perceive the odour.
3 ~ 5	Odour of strength of revolted medium degree.
10	Mucous membrane stimulation thresholds of eyes.
20 ~ 30	Do not feel the strength in a concentration any more by the experience of the odour. Minimum boundary where lungs are stimulated.
100 ~ 300	It comes to be felt that the unpleasant odour decreased rather in 2 to 15 minute due to sense of smell neuroparalysis. Diaphragma flame (gas eyes), itching of eye, soreness, feeling that sand catches one's eye, dazzling, hyperemia and tumescence, turbidity of diaphragma, cornea fracture and sluff, distortion of view or bleariness, enhancement of soreness by light. Dead from suffocation due to bronchitis, pulmonitis and pulmonary oedema with 8 to 48 hrs. continuum exposure. Scorching soreness of mucous membrane of the air passages. Limitation that doesn't arrive at a serious symptom with an exposure of 1 hr. or less.
350 ~ 600	Danger of the life with an exposure of 30 minutes to 1 hr.
700 ~ 1000	Respiratory paralysis, loss of consciousness, fainting, respiratory stoppage, and death at once after appearance of short time interval breath.
5,000	Instantaneous death.

Reference : New anoxia danger work chief person text (October 26, 2007 3rd print issued)

List of Combustible Gas to be Detected※

Gas name	Chemical formula	Flash point (℃)	Ignition temperature (℃)	Explosion limit (vol%)		Specific gravity
				Lower limit	Upper limit	
Acetylene	C_2H_2	gas	305	1.5	100	0.9 (gas)
Acetone	C_3H_6O	-20	539	2.15	14.3 100℃	0.8
Isobutane	C_4H_{10}	gas	460	1.8	9.8	0.6
Ethanol	C_2H_6O	12	400	3.3	19	0.8
Ethane	C_2H_6	gas	515	3.0	15.5	1.0 (gas)
Ethylene	C_2H_4	gas	440	2.7	36.0	1.0 (gas)
Ortho-xylene	C_8H_{10}	30	470	1.0	7.6	0.9
Ethyl acetate	$C_4H_8O_2$	-4	470	2.1	12.8	0.9
Cyclohexane	C_6H_{12}	-17	245	1.3	8.3	0.8
Cyclopentane	C_5H_{10}	-37	320	1.4	—	—
Dimethyl ether	C_2H_6O	gas	240	3.0	32	—
Hydrogen	H_2	gas	560	4.0	75	0.07 (gas)
Styrene	C_8H_8	30	490	1.1	8.0	0.9
Tetrahydrofuran	C_4H_8O	-14	230	1.8	12.4	0.9
Toluene	C_7H_8	4	530	1.2	7.8	0.9
1,3-butadiene	C_4H_5	gas	420	1.1	16.3	0.6
Propane	C_3H_8	gas	450	2.0	10.9	1.6 (gas)
Propylene	C_3H_6	gas	455	2.0	11.1	—
n-hexane	C_6H_{14}	-22	223	1.2	7.5	0.7
n-heptane	C_7H_{16}	-7	204	1.1	6.7	0.7
Benzene	C_6H_6	-11	498	1.2	8.6	0.9
Methyl methacrylate	$C_5H_8O_2$	10	430	1.7	12.5	0.9
Methanol	CH_4O	9	440	5.5	36	0.8
Methane	CH_4	gas	600	5.0	15.0	0.6
Methyl isobutyl ketone	$C_6H_{12}O$	16	475	1.2 90℃	8 90℃	0.8

※ The value of each item is different according to the literature. The explosion limit in this list of gas to be detected is described based on the house standard. The flash point and the ignition temperature is according to [Technological indicator of Labor health and safety General Institute: JNIOSH-TR-No.44 (2012) Factory explosion-proof facility guide for user] and the specific gravity is according to [Danger and harmful handbook of chemical substance, June 20, 1991, 1st ed 1st print Issued]

List of Toxic Gas to be Detected

Gas name	Chemical formula	ACGIH recommendation value			Japan Association of Industrial Health recommendation value	RIKEN KEIKI standard	
		Threshold limit value (TLV)※1			Threshold limit value※1	Detection range※2	Alarm setpoint value※2
		TWA	STEL	C			
Arsine	AsH_3	5ppb	—	—	10ppb	0～15ppb	5ppb
Phosphine	PH_3	0.3ppm	1ppm	—	0.3ppm	0～1ppm	0.3ppm
Diborane	B_2H_6	0.1ppm	—	—	0.01ppm	0～0.3ppm	0.1ppm
Silane	SiH_4	5ppm	—	—	100ppm	0～15ppm	5ppm
Disilane	Si_2H_6	—	—	—	—	0～15ppm	5ppm
Germane	GeH_4	0.2ppm	—	—	—	0～0.8ppm	0.2ppm
Hydrogen selenide	H_2Se	0.05ppm	—	—	0.05ppm	0～0.2ppm	0.05ppm
Nitrogen trifluoride	NF_3	10ppm	—	—	—	0～30ppm	10ppm
Boron tribromide	BBr_3	—	—	1ppm	—	HBr 0～6ppm	HBr 2ppm
Arsenic trichloride	$AsCL_3$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Arsenic pentachloride	$AsCL_5$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Boron trichloride	BCL_3	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Germanium tetrachloride	$GeCL_4$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Molybdenum pentachloride	$MoCL_5$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Phosphorus trichloride	PCL_3	0.2ppm	0.5ppm	—	0.2ppm	HCL 0～6ppm	HCL 2ppm
Phosphorus pentachloride	PCL_5	0.1ppm	—	—	0.1ppm	HCL 0～6ppm	HCL 2ppm
Phosphorus oxychloride	$POCL_3$	0.1ppm	—	—	—	HCL 0～6ppm	HCL 2ppm
Antimony pentachloride	$SbCL_5$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Silicon tetrachloride	$SiCL_4$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Dichlorosilane	SiH_2CL_2	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Trichlorosilane	$SiHCL_3$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Tin tetrachloride	$SnCL_4$	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Tungsten hexachloride	WCL_6	—	—	—	—	HCL 0～6ppm	HCL 2ppm
Tungsten hexafluoride	WF_6	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Arsenic trifluoride	AsF_3	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Arsenic pentafluoride	AsF_5	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Boron trifluoride	BF_3	—	—	1ppm	0.3ppm	HF 0.4ppm～3ppm	HF 0.5ppm
Molybdenum hexafluoride	MoF_6	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Phosphorus pentafluoride	PF_5	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Sulfur tetrafluoride	SF_4	—	—	0.1ppm	—	HF 0.4ppm～3ppm	HF 0.5ppm
Silicon Tetrafluoride	SiF_4	—	—	—	—	HF 0.4ppm～3ppm	HF 0.5ppm
Hydrogen chloride	HCL	—	—	2ppm	5ppm	0～6ppm	2ppm
Hydrogen fluoride	HF	0.5ppm	—	2ppm	3ppm	HF 0.4ppm～3ppm	HF 0.5ppm
Hydrogen bromide	HBr	—	—	2ppm	—	0～6ppm	2ppm
Hydrogen iodide	HI	—	—	—	—	0～5ppm	2ppm
Chlorine	CL_2	0.5ppm	1ppm	—	0.5ppm	0～1.5ppm	0.5ppm
Fluorine	F_2	1ppm	2ppm	—	—	0～3ppm	1ppm
Bromide	Br_2	0.1ppm	0.2ppm	—	0.1ppm	0～1ppm	0.2ppm
Chlorine trifluoride	CLF_3	—	—	0.1ppm	—	0～0.6ppm	0.1ppm
Ozone	O_3	0.1ppm	—	—	0.1ppm	0～0.6ppm	0.1ppm
Nitrogen monoxide	NO	25ppm	—	—	—	0～100ppm	25ppm
Nitrogen dioxide	NO_2	0.2ppm	—	—	pending	0～9ppm	3ppm
Sulfur dioxide	SO_2	—	0.25ppm	—	pending	0～6ppm	2ppm／4ppm
Hydrogen sulfide	H_2S	1ppm	5ppm	—	5ppm	0～3ppm	1ppm
Carbon monoxide	CO	25ppm	—	—	50ppm	0～75ppm	25ppm
Ammonia	NH_3	25ppm	35ppm	—	25ppm	0～75ppm	25ppm
Monomethylamine (MMtA)	CH_5N	5ppm	15ppm	—	10ppm	0～15ppm	5ppm
Dimethylamine (DMA)	C_2H_7N	5ppm	15ppm	—	10ppm	0.2～15ppm	5ppm
Trimethylamine (TMA)	C_3H_9N	5ppm	15ppm	—	—	0～15ppm	5ppm
Diethylamine (DEA)	$C_4H_{11}N$	5ppm	15ppm	—	10ppm	0.2～15ppm	5ppm
Hydrogen cyanide	HCN	—	—	4.7ppm	5ppm	0.3～15ppm	5ppm
Hydrogen peroxide	H_2O_2	1ppm	—	—	—	0～3ppm	1ppm／2ppm

※1 Refer to [2013 TLVs R and BEIs R] for the threshold limit value recommended by ACGIH (American Coference of Governmental Industrial Hygienist).
Refer to [Industrial hygiene magazine Journal of Occupational Health Vol 55 No. 5 Issue September, 2013] for the threshold limit value recommended by Japan Association of Industrial Health.
RIKEN KEIKI adopts the threshold limit value of ACGIH.

※2 For the hydrolyzing gas, the range of detection and the alarm setpoint value of the gas generated after the gas is hydrolyzed are described.
TWA (time weighted average): Time-weighted average value of that health problems might not be caused even if exposed repeatedly in the usual work of 8 hours per day, 40 hours during the week.
STEL (short term exposure limit): Limit value of short time exposure 4 times or less a day within 15 minutes and interval of 1h or more, by which no health problems might be caused.
C (ceiling value): Upper bound that must not be exceeded.

Related Laws and Regulations (JAPAN)

In the work environments where combustible gases, toxic gases and other hazardous gases are used, it is mandatory to install gas detector to measure them in order to secure safety. This section provides excerpt of the laws and regulations relating to gas detector.

High Pressure Gas Safety Act (act no. 204 of June 7, 1951)

Latest Amendments: Act No. 72 of June 18, 2014

Chapter I General Provisions

Article 1 (purpose)

The purpose of this Act is to regulate the production, storage, sale, transportation and other matters related to the handling of high pressure gases, their consumption as well as the manufacture and handling of their containers and to encourage voluntary activities by private businesses and the High Pressure Gas Safety Institute of Japan for the safety of high pressure gases with the aim of securing public safety by preventing accidents and disasters caused by high pressure gases.

Article 2 (definitions)

The term "high pressure gas" as used in this Act means any gas that falls under any of the following items:

(i) Compressed gas, the pressure (meaning gauge; the same shall apply hereinafter) of which is not less than 1 megapascal at its normal operating temperature and which is currently not less than 1 megapascal, or compressed gas, the pressure of which is not less than 1 megapascal at a temperature of 35 degrees Celsius (except compressed acetylene gas in both cases);

(ii) Compressed acetylene gas, the pressure of which is not less than 0.2 megapascal at its normal operating temperature and which is currently not less than 0.2 megapascal, or compressed acetylene gas, the pressure of which is not less than 0.2 megapascal at a temperature of 15 degrees Celsius;

(iii) Liquefied gas, the pressure of which is not less than 0.2 megapascal at its normal operating temperature and which is currently not less than 0.2 megapascal, or liquefied gas, the temperature of which is 35 degrees Celsius or less in the case that the pressure is 0.2 megapascal; or

(iv) In addition to what is listed in the preceding item, those liquefied gases, the pressure of which exceeds zero Pascal at a temperature of 35 degrees Celsius, and which, inclusive of liquefied hydrogen cyanide and liquefied methyl-bromide, are specified by a Cabinet Order.

Cabinet Order of High Pressure Gas Safety Act (cabinet order no. 20 of February 19, 1997)

Latest Amendments: Cabinet Order No. 328 of October 27, 2004

The Cabinet establishes this Order in accordance with the provisions of the High Pressure Gas Safety Act (act no. 204 of 1951) and for implementation thereof.

Article 7 (type of high pressure gas specified in cabinet order)

The types of gases, among those high pressure gases of Paragraph 1 of Article 24-2 of the Act, specifically specified in a Cabinet Order as requiring special care for the prevention of accidents in their consumption shall be the following gases in compressed and liquefied form:

(i) silane
(ii) phosphine
(iii) arsine
(iv) diborane
(v) hydrogen selenide
(vi) monogermane
(vii) disilene

Safety Regulations for General High Pressure Gas (ministry of international trade and industry ordinance no. 53 of May 25, 1966)

Latest Amendments: Ministry of Economy, Trade and Industry Ordinance No. 58 of November 20, 2014

Chapter I General Provisions

Article 1 (scope)

This is to set forth, based on the High Pressure Gas Safety Act (act no. 204 of 1951, hereinafter referred to as the "Act"), the regulations on the safety (excluding the safety on the production of high pressure gases pertaining to the specific production businesses specified in the Safety Regulations for Industrial Complex, etc. (ministry of international trade and industry ordinance no. 88 of 1986)) on the high pressure gases (excluding high pressure gasses subject to the provisions of Regulations for Refrigeration Safety (ministry of international trade and industry ordinance no. 51 of 1966) and Safety Regulations for Liquefied Petroleum Gas (ministry of international trade and industry ordinance no. 52 of 1966): the same shall apply hereinafter).

Article 2 (definitions)

For the purpose of these regulations, the terms listed in the following items shall be defined as follows:

(i) "combustible gases" shall mean: acrylonitrile, acrolein, acetylene, acetaldehyde, arsine, ammonia, carbon monoxide, ethane, ethylamine, ethyl benzene, ethylene, ethyl chloride, vinyl chloride, chloromethyl, ethylene oxide, propylene oxide, hydrogen cyanide, cyclopropane, disilene, diborane, dimethylamine, hydrogen, hydrogen selenide, trimethylamine, carbon disulfide, butadiene, butane, butylene, propane, propylene, bromomethyl, benzene, phosphine, methane, monogermane, silane, monomethylamine, methyl ether, hydrogen sulfide and other gases falling under either of the following a. or b.
   a. The lower explosion limit (meaning the explosion limit when mixed with air: the same shall apply hereinafter) being 10% or less
   b. The difference between the upper limit and lower explosion limit being 20% or more

(ii) "toxic gases" shall mean: acrylonitrile, acrolein, sulfurous acid gas, arsine, ammonia, carbon monoxide, chlorine, chloromethyl, chloroprene, arsenic pentafluoride, phosphorus pentafluoride, ethylene oxide, nitrogen trifluoride, boron trifluoride, phosphorus trifluoride, hydrogen cyanide, diethylamine, disilene, sulfur tetrafluoride, silicon tetrafluoride, diborane, hydrogen selenide, trimethylamine, carbon disulfide, fluorine, bromomethyl, benzene, phosgene, phosphine, monogermane, silane, monomethylamine, hydrogen sulfide and other gases with threshold limit value being 200 ppm or less.

(iii) "special high pressure gases" shall mean: arsine, disilene, diborane, hydrogen selenide, phosphine, monogermane and silane.

(iv) "inert gases" shall mean: helium, neon, argon, krypton, xenon, radon, nitrogen, carbon dioxide or fluorocarbon (excluding combustible type).

Chapter II Permission, etc. concerning Production or Storage of High Pressure Gas

Section 1 Permission, etc. concerning Production of High Pressure Gas

Article 6 (technical standards concerning stationary production equipment)

Technical standards specified by an Ordinance of METI as referred to in Article 8, item (1) of the Act for the production facilities made up of stationary production equipment (excluding cold evaporator, compressed natural gas station, liquefied natural gas station and compressed hydrogen station) shall be as follows, provided, however, that this shall not apply in case of taking any safety measure which is approved by the Minister of Economy, Trade and Industry as having an equivalent effect, and refrigerating equipment for cooling of production equipment may be subject to the technical standards specified by the Regulations for Refrigeration Safety.

(xxvi) Electrical equipment concerning high pressure gas equipment for combustible gases (excluding ammonia and bromomethyl) shall be of a structure having explosion-proof capabilities suitable for its installation place and the type of the gas.

(xxxi) Production facilities of combustible gases or toxic gases specified by the Minister of Economy, Trade and Industry shall be installed with equipment to detect leak of such gases and trigger an alarm at places where gases leaked from such production facilities may accumulate.

(xxxvi) Piping concerning gas equipment for special high-pressure gas, arsenic pentafluoride, etc., sulfurous acid gas, ammonia, chlorine, chloromethyl, ethylene oxide, hydrogen cyanide, phosgene or hydrogen sulfide shall, wherever necessary, of double tube construction depending on the type, properties and pressure of these gases as well as on the nearby situation of the piping (including the concentrated condition of type 1 safety properties and type 2 safety properties in the vicinity of the business where the piping is installed), and necessary measures shall be taken to detect the leakage of the gas from such double tube, provided, however, that this shall not apply if the piping is prevented from being damaged by installing in a sheath or other protective structure and measures are taken to prevent any leaked gas from spreading to the vicinity.

Chapter VIII Notification concerning Consumption of High Pressure Gas

Article 55 (technical standards concerning consumers of specific high pressure gas)

Technical standards specified by an Ordinance of METI as referred to in Paragraph 1 of Article 24-3 of the Act shall be as follows.

(xxiv) Piping concerning consumption equipment for special high-pressure gas, liquefied ammonia or liquefied chloride shall, wherever necessary, of double tube construction depending on the type, properties and pressure of these gases as well as on the nearby situation of the piping (including the concentrated condition of type 1 safety properties and type 2 safety properties in the vicinity of the business where the piping is installed), and necessary measures shall be taken to detect the leakage of the gas from such double tube, provided, however, that this shall not apply if the piping is prevented from being damaged by installing in a sheath or other protective structure and measures are taken to prevent any leaked gas from spreading to the vicinity.

(xxvi) Consumption facilities shall be installed with equipment to detect leak of such gases and trigger an alarm at places where gases leaked from such production facilities may accumulate.

Exemplified Standards concerning Safety Regulations for General High Pressure Gas

(enacted on March 26, 2001, amended on December 26, 2012)

23. Gas leakage detection and alarm equipment and place of installation

Relevant provisions

> Article 6 paragraph 1 item (xxxi), Article 7 paragraph 1 item (i), Article 7-3 paragraph 1 item (vii), paragraph 2 item (xvi), Article 12 paragraph 1 item (i), Article 22, Article 55 paragraph 1 item (xxvi)

Equipment to detect and trigger an alarm of any leakage of combustible gases and toxic gases (acrylonitrile, sulfurous acid gas, arsine, ammonia, carbon monoxide, chlorine, ethylene oxide, disilene, diborane, hydrogen selenide, carbon disulfide, benzene, phosphine, monogermane, silane and hydrogen sulfide) at production facilities, storage places and consumption facilities shall be in accordance with the following standards.

1. Function

Gas leakage detection and alarm equipment (hereinafter referred to as "Detection alarm

Related Laws and Regulations (JAPAN)

equipment" in 23 of these Standards) shall be capable of detecting leakage of combustible gases or oxygen or toxic gases, indicating its concentration as well as triggering an alarm and shall have the following capabilities.

1.1 Detection alarm equipment shall be of catalytic combustion method, membrane type galvanic cell method, semi-conductor method or any other method to automatically trigger an alarm at the preset gas concentration (hereinafter referred to as "Alarm setpoint") by detecting the change of detection element by an electrical mechanism.

1.2 Alarm setpoint shall be a quarter or less of a lower explosive limit for combustible gases, 25% for oxygen and acceptable concentration (twice the value of acceptable concentration for ammonia, chlorine and other toxic gases similar thereto with difficulty to prepare the calibration gas; the same shall apply to 1.6) or less for toxic gases, provided, however, that it shall be 0.1% or less for the Detection alarm equipment to be installed pursuant to 3.1 (6) c. In this case, Alarm setpoint shall be able to be set at any value.

1.3 The gas alarm accuracy of Detection alarm equipment shall be ±25% or less for combustible gases, ±5% or less for oxygen and ±30% or less for toxic gases of the Alarm setpoint.

1.4 The delay time for the Detection alarm equipment to trigger an alarm shall be inspected by applying the alarm delay test under the provision 6.7.2 of JIS M7626 (1994) correspondingly. This inspection shall be conducted by introducing the gas 1.6 times of the concentration of the Alarm setpoint and the delay then shall be within 30 seconds, provided, however, that it shall be within one minute for specific gases which delay more than that for the structure of the Detection alarm equipment or for theoretical reasons (ammonia, carbon monoxide or any other gases equivalent thereto).

1.5 Alarm accuracy shall not deteriorate even when there are ±10% fluctuations of power voltage, etc.

1.6 The scale of indicator shall, within each scale range, clearly indicate 0 to lower explosive limit (for those with the Alarm setpoint being low concentration, proper value of the lower explosive limit or less can be set in consideration of such Alarm setpoint), 0 to 50% for oxygen and 0 to three times the value of acceptable concentration for toxic gases.

1.7 Once an alarm is triggered, the alarm shall, in principle, continue even upon the change of gas concentration in the atmosphere and shall stop only by its inspection or measures to be taken.

1.8 Detection alarm equipment shall be regularly maintained in accordance with maintenance particulars described in instruction manuals or specifications. The results of maintenance shall also be recorded and retained for three years or more.

1.9 Calibration of the reading of gas leakage detection alarm equipment for special high-pressure gas shall be carried out at least once every six months.

1.10 Detection alarm equipment shall be checked at least once a month for triggering of an alarm upon the alarm circuit inspection and at least once a year for the proper operation by the detection and alarm inspection.

2. Construction

The construction of Detection alarm equipment shall be as follows.

2.1 It shall have sufficient strength (element and transmission circuit being particularly durable) and shall be easy to handle and maintain (particularly for the replacement of element, etc.)

2.2 The parts which come into contact with gases shall be made of corrosion-resistant materials or materials with sufficient anticorrosion treatment and other parts shall be finished with good coating or plating.

2.3 For explosion proof property, it shall have passed the test under Article 44 of Industrial Safety and Health Act (act no. 57 of 1972).

2.4 In the case of receiving alarms from two or more probes, receiving circuit shall be able to trigger an alarm if it is under the condition to activate the Detection alarm equipment and such point shall be identifiable even when the other triggers an alarm and activate the circuit.

2.5 Receiving circuit shall be made easily identifiable of it being activated.

2.6 Alarm shall trigger an alarm simultaneously with turning on or blinking of a lamp.

3. Installation place

Detection alarm equipment shall be installed as follows.

3.1 Installation place and quantity of probes of Detection alarm equipment in the production facilities (excluding piping: the same shall apply hereinafter in 3.1) shall be in accordance with the following items:

(1) In the circumference of a place where there are indoor-installed compressor, pump, reaction equipment, storage tank and other high-pressure gas equipment with high potential for gas leakage (excluding those specified in (3)) and where leaked gas is likely to accumulate: One or more per 10 meter circumference of these equipment group;

(2) If those high-pressure gas equipment as referred to in (1) are installed outdoor and are close to other high-pressure equipment, walls or other structures, or are installed inside a pit or the like, a place where leaked gas is likely to accumulate: One or more per 20 meter circumference of these equipment group;

(3) A place where leaked gas is likely to be accumulated in the circumference of production facilities including fire source such as a heating furnace: The number calculated by the ratio of one or more per 20 meter circumference of the place;

(4) Inside an instrument room (excluding the case where measure(note) is taken to prevent penetration of leaked gas): One or more;

(5) In the circumference of a group of filling ports of toxic gases: One or more;

(note) In principle, the measure to prevent penetration of leaked gas shall mean either of the following:

a. To retain the pressure inside the instrument room necessary for preventing penetration of gases from outside; or

b. To raise the entrance floor to at least 2.5 meters over the ground for the instrument room only for gases heavier than air.

(6) Notwithstanding the foregoing (1) to (5), the following standards shall apply to specific compressed hydrogen stations of Article 7-3, Paragraph 2:

a. One or more inside a steel casing or inside a fireproof room in which compressor is installed, provided, however, that for such fireproof room of which inside wall dimension exceeds 10 meters, the quantity shall be one or more for every 10 meters in such length;

b. One or more inside the dispenser case;

c. One each or more of Detection alarm equipment having one or more probes near the connection part such as the coupling between the filling hose and the container fixed onto a vehicle (see Fig.1);

d. One or more on the upper piping module of accumulator (see Fig.2);

e. One or more at a place where hydrogen is accumulated near the device to generate hydrogen such as a reformer.

3.2 Installation place and quantity of probes for Detection alarm equipment in a repository or consumption facilities (excluding piping; the same shall apply hereinafter in 3.2) shall be in accordance with the following items:

(1) In the circumference of a place where there are indoor-installed decompression equipment, storage equipment, consumption equipment (excluding part of burners, etc. which are equipped with an interlocking mechanism of pilot burner method and not likely to cause gas leakage) and other equipment with high potential for gas leakage and where leaked gas is likely to accumulate: One or more per 10 meters of the circumference of these equipment group;

(2) If those equipment as referred to in (1) are installed outdoor and are close to other equipment, walls or other structures, or are installed inside a pit or the like, a place where leaked gas is likely to accumulate: One or more per 20 meter circumference of these equipment group;

(3) If containers for special high-pressure gas, etc. are stored at a container depot: One or more in the circumference of a place of the container group where leaked gas is likely to accumulate;

(4) Inside a cylinder cabinet: One or more.

3.3 The height for the probe to be installed for the facilities of 3.1 or 3.2 shall be determined in accordance with conditions such as specific gravity of the gas, environment, height of gas equipment and so on.

3.4 A place where alarm is triggered and lamp is turned on or blinks shall be where parties concerned are stationed and is suitable for taking various countermeasures upon an alarm.

3.5 In cases where forced exhaust equipment is operated around the clock in production or consumption facilities, the provisions of 3.1 and (1), (2), (3) of 3.2 shall not apply and a probe shall be installed for every inlet of forced exhaust equipment.

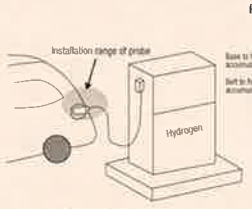


Fig 1 Example of Installation near the Connection like a Coupling

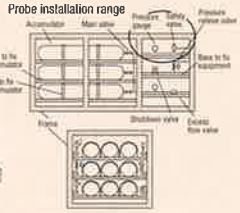


Fig 2 Example of Installation at Piping Module of Accumulators, etc.

27. Double tube for toxic gas piping

Relevant provisions
Article 6 paragraph 1 item (xxxvi), Article 12 paragraph 1 item (i), Article 22, Article 55 paragraph 1 item (xxiv)

With regard to double tube construction for gas equipment piping of special high-pressure gas, arsenic pentafluoride, etc., sulfurous acid gas, ammonia, chlorine, chloromethyl, ethylene oxide, hydrogen cyanide, phosgene and hydrogen sulfide, the following items shall apply:

1. Outer tube of the double tube construction shall have the standard inside diameter of 1.2 times or more of the outside diameter of the inner tube and material, wall thickness, etc. shall conform to the specifications under 7. Breakdown test and airtightness test, 8. Strength of high-pressure gas equipment and conduit, and 9. Standards of materials used for gas equipment, etc.

2. Any of the following measures shall be taken between the inside tube and outside tube of the double tube to detect leakage of gases:

2.1 To install a probe of gas leakage detection and alarm equipment between the inside tube and outside tube of the double tube;

2.2 To install a device to detect and alarm the rise of pressure between the inside tube and outside tube of the double tube;

2.3 To run inert gas such as nitrogen all the time between the inside tube and outside tube of the double tube, and to install a probe of gas leakage detection alarm equipment on its outlet; or

2.4 To suction between the inside tube and outside tube of the double tube all the time by exhaust equipment, etc. and to install a probe of gas leakage detection alarm equipment on its outlet.

Industrial Safety and Health Act (act no. 57 of June 8, 1972)

Latest Amendments: Act No. 82 of June 25, 2014

Chapter I General Provisions

Article 1 (purpose)

The purpose of this Act is to secure, in conjunction with the Labor Standards Act (act no. 49 of 1947), the safety and health of workers in workplaces, as well as to facilitate the establishment of comfortable working environment, by promoting comprehensive and systematic countermeasures concerning the prevention of industrial accidents, such as taking measures for the establishment of standards for hazard prevention, clarifying the safety and health management responsibility and the promotion of voluntary activities with a view to preventing industrial accidents

Chapter IV Measures for Preventing the Dangers or Health Impairment of Workers

Article 20 (measures to be taken by employers, etc.)

The employer shall take necessary measures for preventing the following dangers:

Related Laws and Regulations (JAPAN)

(i) Dangers due to machines, instruments and other equipment (hereinafter referred to as "machines, etc.")
(ii) Dangers due to substances of an explosive nature, substances of a combustible nature and substances of an combustible nature
(iii) Dangers due to electricity, heat and other energy

Chapter V Regulations concerning Machines, etc. and Harmful Substances
Section 1 Regulations concerning Machines

Article 42 (restrictions on transfer, etc.)
Among machines, etc., other than specified machines, etc., which are listed in Appended Table 2, or require dangerous or harmful operations, or are used in a dangerous place, or used for preventing danger or health impairment, those defined by Cabinet Order shall not be transferred, leased or installed unless they conform to the construction code provided for by the Minister of Health, Labour and Welfare or are equipped with safety apparatus designated by the Minister of Health, Labour and Welfare.

Article 44-2 (type examination)
Of the machines, etc. as referred to in Article 42, one who has manufactured or imported a machine which is listed in Appended Table 4 and designated by the Cabinet Order shall have such manufactured or imported machine undergo the type examination to be conducted by the party registered by the Minister of Health, Labour and Welfare (hereinafter referred to as the "registered type examination agency") as prescribed by the Ordinance of the Ministry of Health, Labour and Welfare. However this provision shall not apply to the machines, etc., which have been imported, and which have undergone the examination set forth in the next paragraph.

Ordinance on Industrial Safety and Health (ministry of labour ordinance no. 32 of September 30, 1972)
Latest Amendments: Ministry of Health, Labour and Welfare Ordinance No. 132 of December 1, 2014

Part II Safety Standards

Chapter VI Prevention of Dangers in Excavating Work, etc.

Section 2 Construction Work of Tunnels, etc.

Subsection 1 Investigation, etc.

Article 382-2 (measurement, etc. of the concentration of combustible Gas)
The employer shall, in the case of a construction work of tunnels, etc., the combustible gases are liable to be generated, designate a person charged with the measurement of the concentration of the combustible gases in order to prevent an explosion or fire and have the said person measure and record the concentration of the combustible gas at the places where the said combustible gases are liable to be generated or stagnate, every day before commencing the work for the day, after an earthquake of medium shock or heavier or when having found any abnormalities related to the said combustible gases.

Article 382-3 (installation, etc. of automatic alarms)
The employer shall, when it is found as a result of the measurement set forth in the preceding Article that the combustible gases exist and is liable to cause an explosion or fire, install automatic alarms at necessary places for an early detection of abnormal rise in the concentration of the combustible gases. In this case, the said automatic alarms shall have system, which is able to quickly alert workers who are working around the area of the detector heads of the automatic alarms to the abnormal rises in the concentration of the said combustible gas.
2. The employer shall, as regards the automatic alarm device set forth in the preceding paragraph, check the following matters before commencing the work for the day, and immediately repair when having found any abnormalities:
(i) Abnormalities in the measuring gauges
(ii) Abnormalities in detector heads
(iii) Function of the alarms

Subsection 1-3 Prevention of Explosions, Fires, etc.

Article 389-2 (measures in the case of automatic alarms sound)
The employer shall establish measures in advance that the workers concerned should take to prevent an explosion or fire due to combustible gas when the automatic alarms set forth in Article 382-3 sound, and make the said measures known to the said workers.

Part III Health Standards

Chapter I Harmful Working Environment

Article 583 (standards of concentration of carbon dioxide gas in a pit)
The employer shall ensure that the concentration of carbonic dioxide gas in the air is kept at 1.5% or less in workshop in pits. However, this shall not apply to lifesaving or danger prevention work using air respirators, oxygen respirators or hose masks.

Article 589 (workplace to be measured for work environment)
The workshops in pits prescribed by the Ordinance of the Ministry of Health, Labour and Welfare set forth in item (iv) of Article 21 of the Order shall be as follows:
(i) Workshops in pits where carbon dioxide gas stagnates or is liable to stagnate;
(ii) Workplace in a pit where temperature exceeds or is likely to exceed 28°C;
(iii) Workshops in pits provided with ventilation facilities.

Article 592 (measurement, etc., of concentration of carbon dioxide gas in a pit)
The employer shall, as regards a workshop in pit set forth in item (i) of Article 589, measure concentration of carbon dioxide gas, periodically once every period within a month.
2. The provisions of paragraph (2) of Article 590 shall apply mutatis mutandis to the case that measurements pursuant to the provision of the preceding paragraph have been carried out.

Ordinance on Prevention of Anoxia, etc. (ministry of labour ordinance no. 42 of September 30, 1972)
Latest Amendments: Ministry of Health, Labour and Welfare Ordinance No. 175 of December 19, 2003

In accordance with the provisions of Industrial Safety and Health Act (act no. 57 of 1972) and for the purpose of implementing the Act, ordinance on prevention of anoxia, etc. shall be set forth as follows:

Chapter I General Provisions

Article 1 (duties of the employer)
The employer shall make efforts to establish working methods, maintain a proper working environment and take measures necessary for preventing anoxia, etc.

Article 2 (definitions)
In this ordinance, the meanings of the terms are as defined respectively in the following items:
(i) Oxygen deficiency: States under which the oxygen concentration in the air is less than 18%.
(ii) Oxygen deficiency, etc.: The state defined in the preceding item or the state in which the concentration of hydrogen sulfide in the air is 10ppm or more.
(iii) Anoxia: The symptom observed in one who has inhaled oxygen-deficient air.
(iv) Hydrogen sulfide poisoning: The symptom observed in one who has inhaled the air in which the concentration of hydrogen sulfide is 10 ppm or more.
(v) Anoxia, etc.: Anoxia or hydrogen sulfide poisoning.
(vi) Hazardous work of oxygen deficiency: Those jobs to be carried out in places with the hazard of oxygen deficiency (hereinafter referred to as "oxygen-deficient place") designated in Attached Table 6 of the Enforcement Qrder (hereinafter referred to as "Cabinet Order") of the Industrial Safety and Health Law (cabinet ordinance no. 318 of 1972).
(vii) Class-1 hazardous work of oxygen deficiency: The oxygen deficiency-hazard work other than class-2 hazardous work of oxygen deficiency out of the oxygen-deficiency-hazard works.
(viii) Class-2 hazardous work of oxygen deficiency work: The work to be carried out in the oxygen-deficiency-hazard place designated in item 3-3, item 9 or item 12 of Attached Table 6 of the Cabinet Order (to be restricted to the places designated by the Minister of Health, Labour and Welfare as the places with the hazard of anoxia and hydrogen sulfide poisoning for the places designated in the said items) from among the oxygen-deficiency-hazard places.

Chapter II General Preventive Measures

Article 3 (working environment measurement, etc.)
For the workplace designated in item 9 of Article 21 of Cabinet Order, the employer shall measure the concentration of the oxygen in the air before having the workers start the day's work, providing that the concentrations of both the oxygen and hydrogen sulfide shall be measured for workplaces where class-2 hazardous work of oxygen deficiency is to be carried out.
2. When the employer has made the measurements of the oxygen concentrations in the air provided for by the preceding paragraph, he shall make a record of the items given below, every time the said measurements have been made, and shall keep the recorded results of the said measurements in custody for a period of three years.
(i) Date and time of the measurements
(ii) Method of measurement
(iii) Places at which the said measurements were carried out
(iv) Conditions of measurements
(v) Results of the measurements
(vi) Name of the measurer
(vii) Outline of the measures taken for prevention of anoxia based on the results of the measurements

Article 4 (measuring instruments)
When the employer has workers engage in hazardous work of oxygen-deficiency, he shall provide the instruments necessary for measurement of oxygen concentration in the air stipulated in Paragraph 1 of the preceding Article, or shall take measures for enabling the workers to easily make use of said instruments.

Article 5 (ventilation)
The employer whose workers engage in hazardous work of oxygen deficiency shall keep the concentration of oxygen in the air at least at 18% or more in the workplace (the concentration of the oxygen shall be 18% or more, and the concentration of the hydrogen sulfide, less than 10 ppm in the case of class-2 hazardous work of oxygen deficiency) by installing an appropriate ventilating system except in cases where a ventilating system cannot be installed in order to prevent explosion or oxidization, etc., and where it is extremely difficult to install a ventilating system due to the nature of the work to be carried out.
2. The employer shall not be allowed to use pure oxygen while the workplace is ventilated conforming to the provision of the preceding paragraph.

Other Relevant Laws and Regulations

In addition to the foregoing laws and regulations, there are following relevant laws and regulations:

- Working Environment Measurement Act
- Fire Service Act
- Ship Safety Act
- Act on Maintenance of Sanitation in Buildings (building maintenance act)
- Act on Securing of Safety and Optimization of Transaction of Liquefied Petroleum Gas (liquefied petroleum gas act)
- Gas Business Act
- Act on Hot Springss

Explosion-proof Construction

Explosion-proof electrical equipment are currently classified based on two types of standards.
One is Constructional Requirements for Electrical Equipment for Explosive Atmospheres of the Ministry of Labour Notification No. 16 of 1969 and another is its partial amendment, Recommended Practices for Explosion-Protected Electrical Installations in General Industries as referred to in the Ministry of Health, Labour and Welfare, Labour Standards Bureau Chief Notification No. 2 of August 24, 2010 issued by Labour Standards Bureau (JAPAN).

【Constructional Requirements for Electrical Equipment for Explosive Atmospheres】

Types of Explosion-proof Construction of Electrical Equipment for Explosive Atmospheres and their Corresponding Symbols

Kind of type of gas-explosion protection	Symbol
Intrinsic safety	ia or ib
Flameproof enclosures	d
Pressurized enclosures	f
Increased safety	e
Oil-immersion	o
Type of protection 'n'	nA, nC, nR or nL
Encapsulation	ma or mb
Special	s

Explosion Class Classification of Combustible Gases or Vapors

Explosion class	Limit of flame propagation (mm)
1	Over 0.6
2	Over 0.4 and less than 0.6
3 (a,b,c,n) ※1	Equal to or less than 0.4

※1 3a, 3b, 3c and 3n in the explosion class denote hydrogen and water gas, carbon disulfide, acetylene and all gases and vapors, respectively.

Ignition Point Classification of Combustible Gases or Vapors

Ignition point	Ignition point (°C)	Permissible temperature of electrical equipment (°C)
G1	Over 450	360
G2	Over 300 and less than 450	240
G3	Over 200 and less than 300	160
G4	Over 135 and less than 200	110
G5	Over 100 and less than 135	80

Ignition points of representative explosive gas classes under the Constructional Requirements for Electrical Equipment for Explosive Atmospheres

Temperature class / Explosion-proof class	G1	G2	G3	G4	G5
1	Acetone Ammonia Carbon monoxide Ethane Acetic acid Ethyl acetate Toluene Propane Benzene Methanol Methane	Ethanol Isopentyl acetate Butane	Gasoline Hexane	Acetaldehyde	
2		Ethylene Ethylene oxide			
3	Water gas Hydrogen	Acetylene			

Display example

d3aG4

- d: Flameproof enclosures
- 3a: Limit of flame propagation of combustible gas (hydrogen and water gas) less than 0.4 mm
- G4: Ignition temperature over 135°C and less than 200°C

【Recommended Practices for Explosion-Protected Electrical Installations in General Industries】

Types of Explosion-proof Construction of Electrical Equipment for Explosive Atmospheres and their Corresponding Symbols※2

Kind of type of gas-explosion protection	Symbol
Intrinsic safety	ia or ib
Flameproof enclosures	d
Pressurized enclosures	px or py
Increased safety	e
Oil-immersion	o
Type of protection 'n'	nA, nC, nR or nL
Encapsulation	ma or mb
Special	s

※2 To indicate the explosion-proof construction under the Recommended Practices for Explosion-Protected Electrical Installations in General Industries, "Ex" needs to be added in front of each explosion-proof class symbol.

Classification of Explosion-proof Electrical Equipment Corresponding to the Maximum Experimental Safe Gap※3

Electrical equipment group of flameproof enclosure	Maximum experimental safe gap (mm)
ⅡA	Equal to or more than 0.9
ⅡB	Over 0.5 and less than 0.9
ⅡC	Equal to or less than 0.5

Classification of Explosion-proof Electrical Equipment Corresponding to the Minimum Ignition Current※3

Electrical equipment group of intrinsic safety	Minimum ignition current ratio (methane = 1)
ⅡA	Over 0.8
ⅡB	Equal to or more than 0.45 and equal to or less than 0.8
ⅡC	Less than 0.45

※3 Electrical equipment groups are classified into IIA, IIB and IIC but classification may differ depending on the type of explosion-proof construction.

Classification of Combustible Gases or Vapors Corresponding to the Temperature Class of Electrical Equipment

Maximum surface temperature of electrical equipment (°C)	Temperature class	Ignition temperatures of combustible gases or vapors (°C)
Less than 450	T1	Over 450
Equal to or less than 300	T2	Over 300 and less than 450
Equal to or less than 200	T3	Over 200 and less than 300
Equal to or less than 135	T4	Over 135 and less than 200
Equal to or less than 100	T5	Over 100 and less than 135
Equal to or less than 85	T6	Over 85 and less than 100

Temperature Classes of Representative Explosive Gases under the Recommended Practices for Explosion-Protected Electrical Installations in General Industries

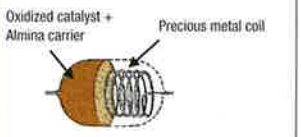
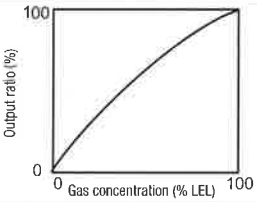
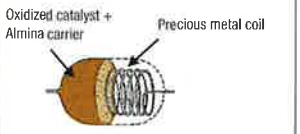
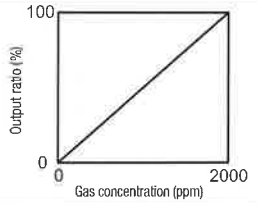
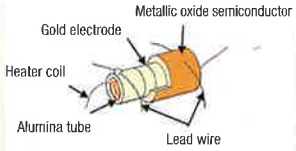
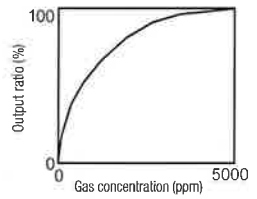
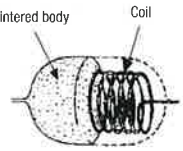
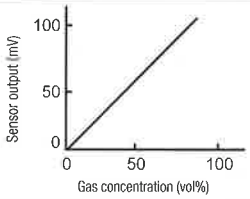
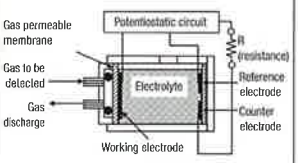
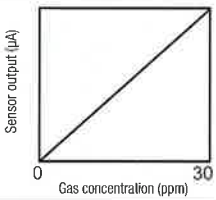
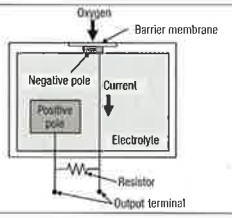
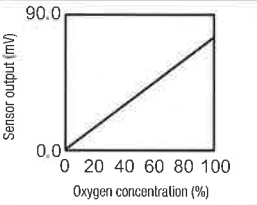
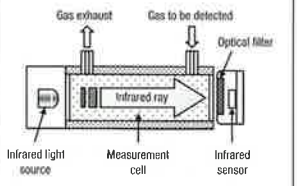
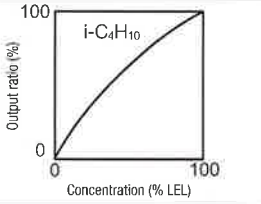
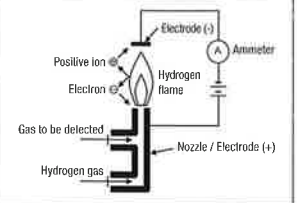
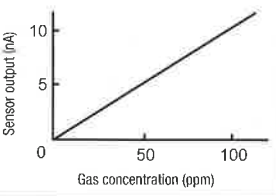
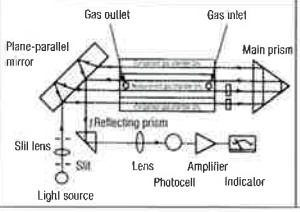
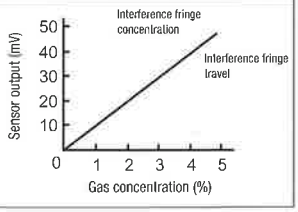
Temperature class / Explosion-proof class	T1	T2	T3	T4	T5	T6
ⅡA	Acetone Ammonia Isobutane Ethane Acetic acid Ethyl acetate Toluene Benzene Methane	Isopentyl acetate Acetic anhydride Butane Propane Methanol	Hexane	Acetaldehyde		
ⅡB	Carbon monoxide	Ethanol Ethylene Ethylene oxide				
ⅡC	Water gas Hydrogen	Acetylene				Carbon disulfide

Display example

ExdIICT5

- Ex: Symbol to indicate the explosion-proof construction under the Recommended Practices for Explosion-Protected Electrical Installations in General Industries
- d: Flameproof enclosures
- IIC: Maximum experimental safe gap less than 0.5 mm
- T5: Temperature of combustible gases or vapors over 100°C and less than 135 °C

List of Detection Principles (Advantage, Construction, etc. of Various Principles)

	Principle and advantage	Construction	Output characteristics
Catalytic Combustion HW	This method uses calorific power generated by combustible gases burning on oxidation catalyst (resistance variation of precious metal coil). ● The sensor output is almost proportional (linear) to the concentration of gas up to the lower explosive limit. ● There is almost no effect from the temperature and humidity of usage environment. ● Good response with speedy reaction and excellent in accuracy and reproducibility.		
New Ceramic NC	This method uses calorific power generated by combustible gases burning on the originally developed super-atomization oxidative catalyst (new ceramics). ● A single sensor can detect a wide range of concentrations from ppm to % LEL. ● There is almost no effect from the temperature and humidity of usage environment. ● Compared to the conventional catalytic combustion method sensor, it has excellent poisoning resistance, less sensitivity deterioration and prolonged stability.		
Semiconductor SG	This method uses resistance variations that occur when metallic oxide semiconductor cotacts gases. ● It has high sensor output in the low concentration range and has high sensitivity. ● It can detect not only combustible gases but also various gases including toxic gas. ● While controlling the sensitivity for miscellaneous gases, methane or isobutene can be detected selectively. ● Compared to other methods, this method has large tolerance under the harsh environmental conditions.		
Thermal Conductivity TE	This method uses the difference in thermal conduction unique to gases when they contact heated element. ● Up to 100 vol% gas concentration, the output is almost proportional (linear) to the concentration. ● Without chemical reaction such as a combustion reaction, no deterioration or poisoning of catalyst ensures long and stable use. ● With compensation element, it is almost free from the effect of the ambient environment. ● Noncombustible gases such as high-concentration argon, nitrogen and carbon dioxide can be detected.		
Electrochemical ES	Gas is subject to electrolysis on electrodes kept at constant potential and the current generated then is detected as gas concentration. ● Toxic gas can be detected with high sensitivity (e.g. arsine 0 to 0.2 ppm). ● By choosing bias voltage, gas to be detected can be detected selectively. ● Linear output enables accurate measurement of low-concentration gases.		
Galvanic cell OS	The current generated upon the electrolysis of oxygen on electrodes is detected as oxygen concentration. ● Product can be made smaller and lighter. ● No external power supply is needed for sensor operation. ● Output up to 100 vol% is proportional to oxygen concentration. ● Temperature compensation by a thermistor built in a sensor makes the temperature dependence of reading virtually nonexistent.		
Non-dispersive Infrared DE	This method uses the absorbed amount by gas of infrared rays radiated from the light source in the sensor. ● It provides accurate and stable measurement. ● Less sensitivity deterioration ensures stable measurement results for a long time. ● It has less influence from coexisting gas, water vapor and the like and is excellent in selectivity. ● As oxygen concentration has no effect, measurement is possible even in inert gas or N2.		
Flame ionization FID	This method uses the changes in current value by ionization of carbon hydride and other gases in hydrogen flame. ● It features quick response and high sensitivity. ● Output is almost proportional to the number of carbon in carbon hydride and will not be affected by inorganic carbon compound at all. ● Output shows high linearity within the measurement range of concentration.		
Optical interferometric FI	This method uses the nature of light being refracted by gas. ● Without using any chemical reaction, it has no deterioration in sensitivity and is excellent in prolonged stability. ● Continuous measurement of gas concentration can be conducted with accuracy for various processes. ● Measurement is possible in the order from 1000 ppm to 100 vol%.		

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