Technical Reference & Application Guide

Gas Detection Equipment

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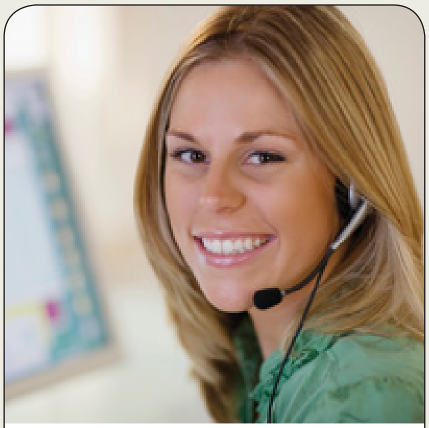

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Contents

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What is Gas?

The name *gas* is derived from the word *chaos*. Gas molecules move randomly and tend to expand indefinitely, filling any available volume. Gas molecules will mix rapidly into any atmosphere in which they are released.

There are different types of gases present in everyday life. Even the air we breathe is made up of several different gases including Nitrogen, Oxygen, and Carbon Dioxide.

Air Composition

Name	Symbol	Percent by Volume
Nitrogen	N_2	78.084%
Oxygen	O_2	20.9476%
Argon	Ar	0.934%
Carbon Dioxide	CO_2	0.0314%
Neon	Ne	0.001818%
Methane	CH_4	0.0002%
Helium	He	0.000524%
Krypton	Kr	0.000114%
Hydrogen	H_2	0.00005%
Xeron	Xe	0.0000087%

The table above gives the sea-level composition of air (in percent by volume at a temperature of 59°F (15°C) and a pressure of 101325 Pa).

Propane and Natural Gas (Methane) are used in many restaurants, commercial kitchens, and homes for heating and cooking.

Carbon Monoxide, Carbon Dioxide, and Nitrogen Oxides are produced by vehicle engines with fuel and oxygen combustion.

Gas Hazards

Some gases have a color, some have a smell, and others could have both features associated with them. For example, H_2S, Hydrogen Sulfide has an odor of rotten eggs. Alternatively, many gases cannot be seen or smelled, making them difficult to detect without the use of a monitor. Also, gases vary in weight and could be lighter, heavier, or about the same density as air. Even though you may not see it, smell it, or touch it, it doesn´t mean the gases are not there.

Gas monitoring applications are typically classified into three main types:

FLAMMABLE	TOXIC	ASPHYXIANT
		
RISK OF FIRE AND/OR EXPLOSION	**RISK OF POISONING**	**RISK OF SUFFOCATION**
A flammable gas is one that will burn when mixed with oxygen and ignited.	Toxic gases pose a threat to human health and can be deadly at elevated concentrations.	Oxygen can be consumed or displaced by another gas.

Gas Hazards

FLAMMABLE

RISK OF FIRE AND/OR EXPLOSION:

Methane
Butane
Propane

TOXIC

RISK OF POISONING:

Carbon Monoxide
Carbon Dioxide
Chlorine

ASPHYXIANT

RISK OF SUFFOCATION:

Oxygen deficiency

Flammable Hazards

Required for Combustion:

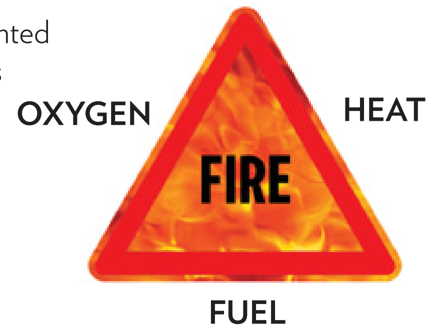
- Source of Ignition
- Oxygen
- Fuel

Fire Triangle

Combustion is a chemical reaction where oxygen is rapidly combined with a fuel (usually hydrocarbon compounds) accompanied by the evolution of light and heat. The hydrocarbon compound can be solid, liquid, vapor, or gas.

The process of combustion can be represented by the fire triangle. Three factors are always needed to cause combustion:

1. A source of ignition
2. Oxygen
3. Fuel in the form of a solid, liquid, vapor, or gas



Ignition Temperature

Flammable gases can be ignited at certain temperatures even without an external ignition source. The temperature for self-sustained combustion, independent of a flame or spark, is called the ignition temperature. If using a gas monitor in a hazardous area, the surface temperature must not exceed the ignition temperature of the gas. Apparatus designed for hazardous areas are marked with a T rating or a maximum surface temperature.

Flash Point (F.P. °C)

The flash point of a flammable substance is the lowest temperature at which the surface of the substance emits sufficient vapor to be ignited by a small flame.

Flash point and the ignition temperatures can be different. Do not confuse the two.

Gas / Vapor	Flash Point °C	Ignition Temp. °C
Methane	<-20	595
Kerosene	38	210
Bitumen	270	310

To convert a Celsius temperature into degrees Fahrenheit:
°F = (9/5 x °C)+32

Vapor Density

Vapor density is a measure of the density of a gas or vapor relative to air.

The vapor density helps to determine sensor placement.

The density of a gas / vapor is compared with air when air = 1.0

If the vapor density is 4.0 the gas will rise.

If the vapor density is 1.0 the gas will fall.

Gas / Vapor	Vapor density
Methane	0.55
Carbon Monoxide	0.97
Hydrogen Sulfide	1.19
Petrol Vapor	3.0 approx

Image Courtesy of Honeywell Analytics

Flammable Limit

Each gas or vapor has a specific concentration band that will produce the combustible mixture. The upper level limit on this band is called the Upper Explosive Limit (or the UEL) and a lower level is called the Lower Explosive Limit (LEL).

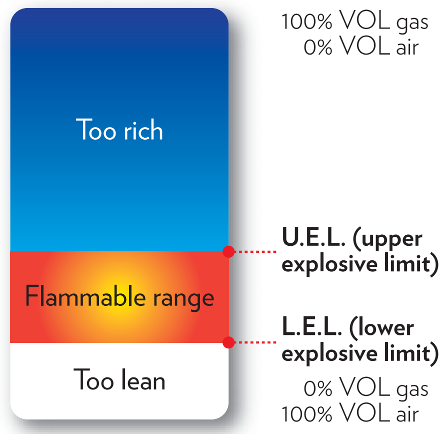


Image Courtesy of Honeywell Analytics

Concentration levels below the LEL will not produce an explosion because there is insufficient gas and the mixture is considered too "lean." At levels above the UEL, the mixture has insufficient oxygen and is considered too "rich." The flammable range for each gas or mixture of gases falls between the limits of the LEL and UEL. Gas concentrations outside these limits are not capable of combustion. The Flammable Gases Data starting on page 6, indicates the limiting values for some of the better-known combustible gases and compounds. The data presents limits for gases and vapors at normal pressure and temperature conditions. An increase in atmospheric pressure or temperature will decrease the LEL of a gas or vapor.

Normal operating conditions in a typical industrial plant should have very low background levels of gas present or none at all. For this scenario, detection and early warning systems will only be required to detect levels from 0% of gas up to the lower explosive limit. Shutdown procedures and site clearance should be initiated prior to gas concentrations reaching 50% LEL to ensure an adequate safety margin is provided.

Gas concentrations in excess of the UEL can occur in enclosed or unventilated areas. Gases confined in these areas can be diluted to a hazardous level when opening doors or hatches.

Methane

Butane

Propane

Benzene

Ethanol

Flammable Gases Data

FLAMMABLE GASES DATA

Common Name	Formula	Relative Vapor Density	Flash Point °C	Flammable Limits: Lower Flammable Limit % v/v	Flammable Limits: Upper Flammable Limit % v/v	Flammable Limits: Lower Flammable Limit mg/L	Flammable Limits: Upper Flammable Limit mg/L	I.T. °C
Cresols (mixed isomers)	CH3C5H4OH	3.73	81	1.10		50		555
Crotonaldehyde	CH3CH=CHCHO	2.41	13	2.10	16.00	82	470	280
Cumene	C6H5CH(CH3)2	4.13	31	0.80	6.50	40	328	424
Cyclobutane	CH2(CH2)2CH2	1.93		1.80		42		
Cycloheptane	CH2(CH2)5CH2	3.39	<10	1.10	6.70	44	275	
Cyclohexane	CH2(CH2)4CH2	2.90	-18	1.20	8.30	40	290	259
Cyclohexanol	CH2(CH2)4CHOH	3.45	61	1.20	11.10	50	460	300
Cyclohexanone	CH2(CH2)4CO	3.38	43	1.00	9.40	42	386	419
Cyclohexene	CH2(CH2)3CH=CH	2.83	-17	1.20		41		244
Cyclohexylamine	CH2(CH2)4CHNH2	3.42	32	1.60	9.40	63	372	293
Cyclopentane	CH2(CH2)3CH2	2.40	-37	1.40		41		320
Cyclopentene	CH=CHCH2CH2CH	2.30	<-22	1.48		41		309
Cyclopropane	CH2CH2CH2	1.45		2.40	10.40	42	183	498
Cyclopropyl methyl ketone	CH3COCHCH2CH2	2.90	15	1.70		58		452
p-Cymene	CH3CH6H4CH(CH3)2	4.62	47	0.70	6.50	39	366	436
Decahydro-naphthalene trans	CH2(CH2)3CHCH(CH2)3CH2	4.76	54	0.70	4.90	40	284	288
Decane (mixed isomers)	C10H22	4.90	46	0.70	5.60	41	433	201
Dibutyl ether	(CH3(CH2)3)2O	4.48	25	0.90	8.50	48	460	198
Dichlorobenzenes (isomer not stated)	C6H4Cl 2	5.07	86	2.20	9.20	134	564	648
Dichlorodiethyl-silane	(C2H5)SiCl2		24	3.40		223		
1,1-Dichloroethane	CH3CHCl2	3.42	-10	5.60	16.00	230	660	440
1,2-Dichloroethane	CH2ClCH2Cl	3.42	13	6.20	16.00	255	654	438
Dichloroethylene	ClCH=CHCl	3.55	-10	9.70	12.80	391	516	440
1,2-Dichloro-propane	CH3CHClCH2Cl	3.90	15	3.40	14.50	160	682	557
Dicyclopentadiene	C10H12	4.55	36	0.80		43		455
Diethylamine	(C2H5)2NH	2.53	-23	1.70	10.00	50	306	312
Diethylcarbonate	(CH3CH2O)2CO	4.07	24	1.40	11.70	69	570	450
Diethyl ether	(CH3CH5)2O	2.55	-45	1.70	36.00	60	1 118	160
1,1-Difluoro-ethylene	CH2=CF2	2.21		3.90	25.10	102	665	380
Diisobutylamine	((CH3)2CHCH2)2NH	4.45	26	0.80	3.60	42	190	256
Diisobutyl carbinol	((CH3)2CHCH2)2CHOH	4.97	75	0.70	6.10	42	370	290
Diisopentyl ether	(CH3)2CH(CH2)2O(CH2)2CH(CH3)2	5.45	44	1.27		104		185
Diisopropylamine	((CH3)2CH)2NH	3.48	-20	1.20	8.30	49	260	285
Diisopropyl ether	((CH3)2CH)2O	3.52	-28	1.00	21.00	45	900	405
Dimethylamine	(CH3)2NH	1.55	-18 gas	2.80	14.40	53	272	400
Dimethoxymethane	CH2(OCH)3)2	2.60	-21	3.00	16.90	93	535	247
3-(Dimethylamino)propiononitrile	(CH3)2NHCH2CH2CN	3.38	50	1.57		62		317
Dimethyl ether	(CH3)2O	1.59	-42 gas	2.70	32.00	51	610	240
N,N-Dimethylformamide	HCON(CH3)2	2.51	58	1.80	16.00	55	500	440
3,4-Dimethyl hexane	CH3CH2CH(CH3)CH(CH3)CH2CH3	3.87	2	0.80	8.50	38	310	305
N,N-Dimethyl hydrazine	(CH3)2NNH2	2.07	-18	2.40	20	60	490	240
1,4-Dioxane	OCH2CH2OCH2CH2	3.03	11	1.90	22.50	74	813	379
1,3-Dioxolane	OCH2CH2OCH2	2.55	-5	2.30	30.50	70	935	245
Dipropylamine	(CH3CH2CH2)2NH	3.48	4	1.60	9.10	66	376	280
Ethane	CH3CH3	1.04	2.50		15.50	31	194	515
Ethanethiol	CH3CH2SH	2.11	<-20	2.80	18.00	73	466	295
Ethanol	CH3CH2OH	1.59	12	3.10	19.00	59	359	363
2-Ethoxyethanol	CH3CH2OCH2CH2OH	3.10	40	1.80	15.70	68	593	235
2-Ethoxyethyl acetate	CH3COOCH2CH2OCH2CH3	4.72	47	1.20	12.70	65	642	380
Ethyl acetate	CH3COOCH2CH3	3.04	-4	2.20	11.00	81	406	460
Ethyl acetoacetate	CH3COCH2COOCH2CH3	4.50	65	1.00	9.50	54	519	350
Ethyl acrylate	CH2=CHCOOCH2CH3	3.45	9	1.40	14.00	59	588	350
Ethylamine	C2H5NH2	1.50	<-20	2.68	14.00	49	260	425
Ethylbenzene	CH2CH3C6H5	3.66	23	1.00	7.80	44	340	431
Ethyl butyrate	CH3CH2CH2COOC2H5	4.00	21	1.40		66		435
Ethylcyclobutane	CH3CH2CHCH2CH2CH2		<-16	1.20	7.70	42	272	212
Ethylcyclohexane	CH3CH2CH(CH2)4CH2	3.87	<24	0.90	6.60	42	310	238
Ethylcyclopentane	CH3CH2CH(CH2)3CH2	3.40	<5	1.05	6.80	42	280	262
Ethylene	CH2=CH2	0.97		2.30	36.00	26	423	425

FLAMMABLE GASES DATA

Common Name	Formula	Relative Vapor Density	Flash Point °C	Flammable Limits: Lower Flammable Limit % v/v	Upper Flammable Limit % v/v	Lower Flammable Limit mg/L	Upper Flammable Limit mg/L	I.T. °C
Ethylenediamine	NH2CH2CH2NH2	2.07	34	2.70	16.50	64	396	403
Ethylene oxide	CH2CH2O	1.52	<-18	2.60	100.00	47	1 848	435
Ethyl formate	HCOOCH2CH3	2.65	-20	2.70	16.50	87	497	440
Ethyl isobutyrate	(CH3)2CHCOOC2H5	4.00	10	1.60		75		438
Ethyl methacrylate	CH2=CCH3COOCH2CH3	3.90	(20)	1.50		70		
Ethyl methyl ether	CH3OCH2CH3	2.10		2.00	10.10	50	255	190
Ethyl nitrite	CH3CH2ONO	2.60	-35	3.00	50.00	94	1 555	95
Formaldehyde	HCHO	1.03		7.00	73.00	88	920	424
Formic acid	HCOOH	1.60	42	10.00	57.00	190	1 049	520
2-Furaldehyde	OCH=CHCH=CHCHO	3.30	60	2.10	19.30	85	768	316
Furan	CH=CHCH=CHO	2.30	<-20	2.30	14.30	66	408	390
Furfuryl alcohol	OC(CH2OH)CHCHCH	3.38	61	1.80	16.30	70	670	370
1,2,3-Trimethyl-benzene	CHCHCHC(CH3)C(CH3)C(CH3)	4.15	51	0.80	7.00			470
Heptane (mixed isomers)	C7H16	3.46	-4	1.10	6.70	46	281	215
Hexane (mixed isomers)	CH3(CH2)4CH3	2.97	-21	1.00	8.40	35	290	233
1-Hexanol	C6H13OH	3.50	63	1.20		51		293
Hexan-2-one	CH3CO(CH2)3CH3	3.46	23	1.20	8.00	50	336	533
Hydrogen	H2	0.07		4.00	77.00	3.4	63	560
Hydrogen cyanide	HCN	0.90	<-20	5.40	46.00	60	520	538
Hydrogen sulfide	H2S	1.19		4.00	45.50	57	650	270
4-Hydroxy-4-methyl-penta-2-one	CH3COCH2C(CH3)2OH	4.00	58	1.80	6.90	88	336	680
Kerosene			38	0.70	5.0			210
1,3,5-Trimethylbenzene	CHC(CH3)CHC(CH3)CHC(CH3)	4.15	44	0.80	7.30	40	365	499
Methacryloyl chloride	CH2CCH3COCl	3.60	17	2.50		108		510
Methane (firedamp)	CH4	0.55		4.40	17.00	29	113	537
Methanol	CH3OH	1.11	11	5.50	38.00	73	484	386
Methanethiol	CH3SH	1.60		4.10	21.00	80	420	340
2-Methoxyethanol	CH3OCH2CH2OH	2.63	39	2.40	20.60	76	650	285
Methyl acetate	CH3COOCH3	2.56	-10	3.20	16.00	99	475	502
Methyl acetoacetate	CH3COOCH2COCH3	4.00	62	1.30	14.20	62	685	280
Methyl acrylate	CH2=CHCOOCH3	3.00	-3	2.40	25.00	85	903	415
Methylamine	CH3NH2	1.00	-18 gas	4.20	20.70	55	270	430
2-Methylbutane	(CH3)2C HCH2CH3	2.50	<-51	1.30	8.00	38	242	420
2-Methylbutan-2-ol	CH3CH2C(OH)(CH3)2	3.03	16	1.40	10.20	50	374	392
3-Methylbutan-1-ol	(CH3)2CH(CH2)2OH	3.03	42	1.30	10.50	47	385	339
2-Methylbut-2-ene	(CH3)2C=CHCH3	2.40	-53	1.30	6.60	37	189	290
Methyl chloro-formate	CH3OOCC	3.30	10	7.50	26	293	1 020	475
Methylcyclohexane	CH3CH(CH2)4CH2	3.38	-4	1.16	6.70	47	275	258
Methylcyclo-pentadienes (isomer not stated)	C6H6	2.76	<-18	1.30	7.60	43	249	432
Methylcyclopentane	CH3CH(CH2)3CH2	2.90	<-10	1.00	8.40	35	296	258
Methylenecyclo-butane	C(=CH2)CH2CH2CH2	2.35	<0	1.25	8.60	35	239	352
2-Methyl-1-buten-3-yne	HC=CC(CH3)CH2	2.28	-54	1.40		38		272
Methyl formate	HCOOCH3	2.07	-20	5.00	23.00	125	580	450
2-Methylfuran	OC(CH3)CHCHCH	2.83	<-16	1.40	9.70	47	325	318
Methylisocyanate	CH3NCO	1.98	-7	5.30	26.00	123	605	517
Methyl methacrylate	CH3=CCH3COOCH3	3.45	10	1.70	12.50	71	520	430
4-Methylpentan-2-ol	(CH3)2CHCH2CHOHCH3	3.50	37	1.14	5.50	47	235	334
4-Methylpentan-2-one	(CH3)2CHCH2COCH3	3.45	16	1.20	8.00	50	336	475
2-Methylpent-2-enal	CH3CH2CHC(CH3)COH	3.78	30	1.46		58		206
4-Methylpent-3-en-2-one	(CH3)2(CCHCOCH)3	3.78	24	1.60	7.20	64	289	306
2-Methylpropan-1-ol	(CH3)2CHCH2OH	2.55	28	1.70	9.80	52	305	408
2-Methylprop-1-ene	(CH3)2C=CH2	1.93	gas	1.60	10	37	235	483
2-Methylpyridine	NCH(CH3)CHCHCHCH	3.21	27	1.20		45		533
3-Methylpyridine	NCHCH(CH3)CHCHCH	3.21	43	1.40	8.10	53	308	537
4-Methylpyridine	NCHCHCH(CH3)CHCH	3.21	43	1.10	7.80	42	296	534
α-Methyl styrene	C6H5C(CH3)=CH2	4.08	40	0.90	6.60	44	330	445
Methyl tert-pentyl ether	(CH3)2C(OCH3)CH2CH3	3.50	<-14	1.50		62		345
2-Methylthiophene	SC(CH3)CHCHCH	3.40	-1	1.30	6.50	52	261	433
Morpholine	OCH2CH2NHCH2CH2	3.00	31	1.80	15.20	65	550	230

Flammable Gases Data

Flammable Hazards

Flammable Gases Data

FLAMMABLE GASES DATA

Common Name	Formula	Relative Vapor Density	Flash Point °C	Flammable Limits: Lower Flammable Limit % v/v	Upper Flammable Limit % v/v	Lower Flammable Limit mg/L	Upper Flammable Limit mg/L	I.T. °C
Ethylenediamine	NH2CH2CH2NH2	2.07	34	2.70	16.50	64	396	403
Ethylene oxide	CH2CH2O	1.52	<-18	2.60	100.00	47	1 848	435
Ethyl formate	HCOOCH2CH3	2.65	-20	2.70	16.50	87	497	440
Ethyl isobutyrate	(CH3)2CHCOOC2H5	4.00	10	1.60		75		438
Ethyl methacrylate	CH2=CCH3COOCH2CH3	3.90	(20)	1.50		70		
Ethyl methyl ether	CH3OCH2CH3	2.10		2.00	10.10	50	255	190
Ethyl nitrite	CH3CH2ONO	2.60	-35	3.00	50.00	94	1 555	95
Formaldehyde	HCHO	1.03		7.00	73.00	88	920	424
Formic acid	HCOOH	1.60	42	10.00	57.00	190	1 049	520
2-Furaldehyde	OCH=CHCH=CHCHO	3.30	60	2.10	19.30	85	768	316
Furan	CH=CHCH=CHO	2.30	<-20	2.30	14.30	66	408	390
Furfuryl alcohol	OC(CH2OH)CHCHCH	3.38	61	1.80	16.30	70	670	370
1,2,3-Trimethyl-benzene	CHCHCHC(CH3)C(CH3)C(CH3)	4.15	51	0.80	7.00			470
Heptane (mixed isomers)	C7H16	3.46	-4	1.10	6.70	46	281	215
Hexane (mixed isomers)	CH3(CH2)4CH3	2.97	-21	1.00	8.40	35	290	233
1-Hexanol	C6H13OH	3.50	63	1.20		51		293
Hexan-2-one	CH3CO(CH2)3CH3	3.46	23	1.20	8.00	50	336	533
Hydrogen	H2	0.07		4.00	77.00	3.4	63	560
Hydrogen cyanide	HCN	0.90	<-20	5.40	46.00	60	520	538
Hydrogen sulfide	H2S	1.19		4.00	45.50	57	650	270
4-Hydroxy-4-methyl-penta-2-one	CH3COCH2C(CH3)2OH	4.00	58	1.80	6.90	88	336	680
Kerosene			38	0.70	5.0			210
1,3,5-Trimethylbenzene	CHC(CH3)CHC(CH3)CHC(CH3)	4.15	44	0.80	7.30	40	365	499
Methacryloyl chloride	CH2CCH3COCl	3.60	17	2.50		108		510
Methane (firedamp)	CH4	0.55		4.40	17.00	29	113	537
Methanol	CH3OH	1.11	11	5.50	38.00	73	484	386
Methanethiol	CH3SH	1.60		4.10	21.00	80	420	340
2-Methoxyethanol	CH3OCH2CH2OH	2.63	39	2.40	20.60	76	650	285
Methyl acetate	CH3COOCH3	2.56	-10	3.20	16.00	99	475	502
Methyl acetoacetate	CH3COOCH2COCH3	4.00	62	1.30	14.20	62	685	280
Methyl acrylate	CH2=CHCOOCH3	3.00	-3	2.40	25.00	85	903	415
Methylamine	CH3NH2	1.00	-18 gas	4.20	20.70	55	270	430
2-Methylbutane	(CH3)2C HCH2CH3	2.50	<-51	1.30	8.00	38	242	420
2-Methylbutan-2-ol	CH3CH2C(OH)(CH3)2	3.03	16	1.40	10.20	50	374	392
3-Methylbutan-1-ol	(CH3)2CH(CH2)2OH	3.03	42	1.30	10.50	47	385	339
2-Methylbut-2-ene	(CH3)2C=CHCH3	2.40	-53	1.30	6.60	37	189	290
Methyl chloro-formate	CH3OOCC	3.30	10	7.50	26	293	1 020	475
Methylcyclohexane	CH3CH(CH2)4CH2	3.38	-4	1.16	6.70	47	275	258
Methylcyclo-pentadienes (isomer not stated)	C6H6	2.76	<-18	1.30	7.60	43	249	432
Methylcyclopentane	CH3CH(CH2)3CH2	2.90	<-10	1.00	8.40	35	296	258
Methylenecyclo-butane	C(=CH2)CH2CH2CH2	2.35	<0	1.25	8.60	35	239	352
2-Methyl-1-buten-3-yne	HC=CC(CH3)CH2	2.28	-54	1.40		38		272
Methyl formate	HCOOCH3	2.07	-20	5.00	23.00	125	580	450
2-Methylfuran	OC(CH3)CHCHCH	2.83	<-16	1.40	9.70	47	325	318
Methylisocyanate	CH3NCO	1.98	-7	5.30	26.00	123	605	517
Methyl methacrylate	CH3=CCH3COOCH3	3.45	10	1.70	12.50	71	520	430
4-Methylpentan-2-ol	(CH3)2CHCH2CHOHCH3	3.50	37	1.14	5.50	47	235	334
4-Methylpentan-2-one	(CH3)2CHCH2COCH3	3.45	16	1.20	8.00	50	336	475
2-Methylpent-2-enal	CH3CH2CHC(CH3)COH	3.78	30	1.46		58		206
4-Methylpent-3-en-2-one	(CH3)2(CCHCOCH)3	3.78	24	1.60	7.20	64	289	306
2-Methylpropan-1-ol	(CH3)2CHCH2OH	2.55	28	1.70	9.80	52	305	408
2-Methylprop-1-ene	(CH3)2C=CH2	1.93	gas	1.60	10	37	235	483
2-Methylpyridine	NCH(CH3)CHCHCHCH	3.21	27	1.20		45		533
3-Methylpyridine	NCHCH(CH3)CHCHCH	3.21	43	1.40	8.10	53	308	537
4-Methylpyridine	NCHCHCH(CH3)CHCH	3.21	43	1.10	7.80	42	296	534
α-Methyl styrene	C6H5C(CH3)=CH2	4.08	40	0.90	6.60	44	330	445
Methyl tert-pentyl ether	(CH3)2C(OCH3)CH2CH3	3.50	<-14	1.50		62		345
2-Methylthiophene	SC(CH3)CHCHCH	3.40	-1	1.30	6.50	52	261	433
Morpholine	OCH2CH2NHCH2CH2	3.00	31	1.80	15.20	65	550	230

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FLAMMABLE GASES DATA

Common Name	Formula	Relative Vapor Density	Flash Point °C	Flammable Limits: Lower Flammable Limit % v/v	Upper Flammable Limit % v/v	Lower Flammable Limit mg/L	Upper Flammable Limit mg/L	I.T. °C
Naphtha		2.50	<-18	0.90	6.00			290
Naphthalene	C10H8	4.42	77	0.90	5.90	48	317	528
Nitrobenzene	CH3CH2NO2	4.25	88	1.70	40.00	87	2 067	480
Nitroethane	C2H5NO2	2.58	27	3.40		107		410
Nitromethane	CH3NO2	2.11	36	7.30	63.00	187	1 613	415
1-Nitropropane	CH3CH2CH2NO2	3.10	36	2.20		82		420
Nonane	CH3(CH2)7CH2	4.43	30	0.70	5.60	37	301	205
Octane	CH3(CH2)3CH3	3.93	13	0.80	6.50	38	311	206
1-Octanol	CH3(CH2)6CH2OH	4.50	81	0.90	7.40	49	385	270
Penta-1,3-diene	CH2=CH-CH=CH-CH3	2.34	<-31	1.20	9.40	35	261	361
Pentanes (mixed isomers)	C5H12	2.48	-40	1.40	7.80	42	236	258
Pentane-2,4-dione	CH3COCH2COCH3	3.50	34	1.70		71		340
Pentan-1-ol	CH3(CH2)3CH2OH	3.03	38	1.06	10.50	38	385	298
Pentan-3-one	(CH3CH2)2CO	3.00	12	1.60		58		445
Pentyl acetate	CH3COO-(CH2)4-CH3	4.48	25	1.00	7.10	55	387	360
Petroleum		2.8	<-20	1.20	8.0			560
Phenol	C6H5OH	3.24	75	1.30	9.50	50	370	595
Propane	CH3CH2CH3	1.56	-104 gas	1.70	10.90	31	200	470
Propan-1-ol	CH3CH2CH2OH	2.07	22	2.20	17.50	55	353	405
Propan-2-ol	(CH3)2CHOH	2.07	12	2.00	12.70	50	320	425
Propene	CH2=CHCH3	1.50		2.00	11.00	35	194	455
Propionic acid	CH3CH2COOH	2.55	52	2.10	12.00	64	370	435
Propionic aldehyde	C2H5CHO	2.00	<-26	2.00		47		188
Propyl acetate	CH3COOCH2CH2CH3	3.60	10	1.70	8.00	70	343	430
Isopropyl acetate	CH3COOCH(CH3)2	3.51	4	1.80	8.10	75	340	467
Propylamine	CH3(CH2)2NH2	2.04	-37	2.00	10.40	49	258	318
Isopropylamine	(CH3)2CHNH2	2.03	<-24	2.30	8.60	55	208	340
Isopropylchloro-acetate	ClCH2COOCH(CH3)2	4.71	42	1.60		89		426
2-Isopropyl-5-methylhex-2-enal	(CH3)2CH-C(CHO)CHCH2CH(CH3)2	5.31	41	3.05		192		188
Isopropyl nitrate	(CH3)2CHONO2		11	2.00	100.00	75	3 738	175
Propyne	CH3C=CH	1.38		1.70	16.80	28	280	
Prop-2-yn-1-ol	HC=CCH2OH	1.89	33	2.40		55		346
Pyridine	C5H5N	2.73	17	1.70	12.00	58	398	550
Styrene	C6H5CH=CH2	3.60	30	1.10	8.00	48	350	490
Tetrafluoroethylene	CF2=CF2	10.00			59.00	420	2 245	255
2,2,3,3-Tetrafluoro-propylacrylate	CH2=CHCOOCH2CF2CF2H	6.41	45	2.40		182		357
2,2,3,3-Tetrafluoro-propyl methacrylate	CH2=C(CH2)COOCH2CF2CF2H	6.90	46	1.90		155		389
Tetrahydrofuran	CH2(CH2)2CH2O	2.49	-20	1.50	12.40	46	370	224
Tetrahydrofurfuryl alcohol	OCH2CH2CH2CHCH2OH	3.52	70	1.50	9.70	64	416	280
Tetrahydro-thiophene	CH2(CH2)2CH2S	3.04	13	1.10	12.30	42	450	200
N,N,N', N'-Tetra-methylmethane-diamine	(CH3)2NCH2N(CH3)2	3.50	<-13	1.61		67		180
Thiophene	CH=CHCH=CHS	2.90	-9	1.50	12.50	50	420	395
Toluene	C6H5CH3	3.20	4	1.10	7.60	42	300	535
Triethylamine	(CH3CH2)3N	3.50	-7	1.20	8.00	51	339	
1,1,1-Trifluoro-ethane	CF3CH3	2.90		6.80	17.60	234	605	714
2,2,2-Trifluoro-ethanol	CF3CH2OH	3.45	30	8.40	28.80	350	1 195	463
Trifluoroethylene	CF2=CFH	2.83		15.30	27.00	502	904	319
3,3,3-Trifluoro-prop-1-ene	CF3CH=CH2	3.31		4.70		184		490
Trimethylamine	(CH3)3N	2.04		2.00	12.00	50	297	190
2,2,4-Trimethyl-pentane	(CH3)2CHCH2C(CH3)3	3.90	-12	1.00	6.00	47	284	411
2,4,6-Trimethyl-1,3,5-trioxane	OCH(CH3)OCH(CH3)OCH(CH3)	4.56	27	1.30		72		235
1,3,5-Trioxane	OCH2OCH2OCH2	3.11	45	3.20	29.00	121	1 096	410
Turpentine	149		35	0.80				254
Isovaleraldehyde	(CH3)2CHCH2CHO	2.97	-12	1.70		60		207
Vinyl acetate	CH3COOCH=CH2	3.00	-8	2.60	13.40	93	478	425
Vinyl cyclohexenes (isomer not stated)	CH2CHC6H9	3.72	15	0.80		35		257
Vinylidene chloride	CH2=CCl2	3.40	-18	7.30	16.00	294	645	440
2-Vinylpyridine	NC(CH2=CH)CHCHCHCH	3.62	35	1.20		51		482
4-Vinylpyridine	NCHCHC(CH2=CH)CHCH	3.62	43	1.10		47		501
Xylenes	C6H4(CH3)2	3.66	30	1.00	7.60	44	335	464

Toxic Gas Hazards

Carbon Monoxide

Ammonia

Hydrogen Sulfide

Chlorine

Nitrogen Dioxide

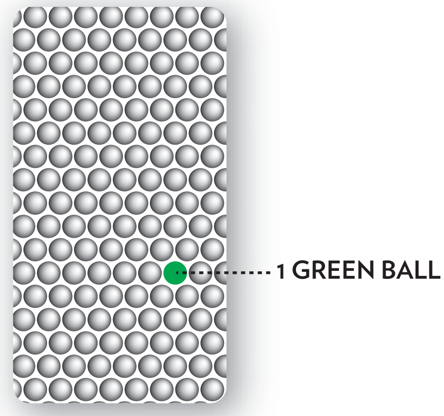
Toxic Gas Hazards

Some gases are poisonous and can cause illness or even death at very low concentrations. Carbon Monoxide can be fatal at low concentrations if exposed for a long period of time. Some gases are both combustible and toxic such as Ammonia and Hydrogen Sulfide (H_2S).

Toxic gases may have strong smells like Ammonia or the distinctive "rotten eggs" smell of Hydrogen Sulfide (H_2S).

Toxic gas concentrations are usually measured by parts per million (ppm) or parts per billion (ppb).

If a room were filled with 1 million balls and one ball were green, the green ball would represent 1 ppm.



100% VOL = 1,000,000 ppm
1% VOL = 10,000 ppm

EXAMPLE
100% LEL Ammonia = 15% VOL
50% LEL Ammonia = 7.5% VOL
50% LEL Ammonia = 75,000 ppm

Image Courtesy of Honeywell Analytics

The main concern with toxic gases and vapors is the effect on the health and safety of employees, the possible contamination of manufactured end-products, and the subsequent disruption of normal working activities. Toxic substances in the workplace include both organic and inorganic compounds. Cleaning agents, pesticides, paint, carpeting, upholstery, and adhesives may emit volatile organic compounds (VOCs), including formaldehyde, into the workplace. The toxic hazards may be inhaled, ingested, or absorbed through the skin. Research indicates some VOCs can cause chronic and acute health effects at high concentrations. Low to moderate levels may cause acute reactions.

It is important to measure the concentration as well as the total time of exposure, since adverse effects can often result from long-term exposure. Some substances can interact and produce a greater negative effect when combined than individually.

Toxic Exposure Limits

Toxic gases can create an immediate and/or long-term risk to personnel and the environment. Gaseous toxic substances are dangerous because they are often invisible and/or odorless. People may be exposed to toxic substances by inhalation, absorbed through the skin, or swallowed.

OCCUPATIONAL EXPOSURE LIMITS COMPARISON

AICGH	OSHA	NIOSH	EH40	Meaning
Threshold Limit Values (TLVs)	Permissible Exposure Limits (PELs)	Recommended Exposure Levels (RELs)	Workplace Exposure Limits (WELs)	Limit definition
TLV-TWA	TWA	TWA	TW A	Long term exposure limit (8hr-TWA reference period)
TLV-STEL	STEL	STEL	STEL	Short term exposure limit (15-minute exposure period)
TLV-C	Ceiling	Ceiling	–	The concentration that should not be exceeded during any part of the working exposure
Excursion Limit	Excursion Limit	–	–	Limit if no STEL stated
–	BEIs	BEIs	–	Biological Exposure Indices

Image Courtesy of Honeywell Analytics

Occupational exposure limits have been defined for levels at which there is no indication of risk to the health of workers and employees exposed by inhalation day after day. The limits protect workers from health effects, but do not address safety issues such as explosive risk. In the USA there are three main organizations contributing to the development of occupational exposure limits, which include The American Conference of Governmental Industrial Hygienists (ACGIH), The Occupational Safety and Health Administration (OSHA), and The National Institute for Occupational Safety and Health (NIOSH).

The ACGIH publishes Threshold Limit Values (TLVs) as exposure guidelines. These guidelines are not legally enforceable, but are updated regularly and represent good professional practice. The list of TLVs includes more than 700 chemical substances and physical agents.

The ACGIH defines different TLV-Types as:

Threshold Limit Value – Time-Weighted Average (TLV-TWA):
The time-weighted average concentration for a normal 8-hour workday and a 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

Threshold Limit Value – Short-Term Exposure Limit (TLV-STEL):
Defined as a 15 minute time-weighted average exposure which should not be exceeded at any time during a work day even if the 8 hour TWA is within the TLV. The Short Term Exposure Limit (STEL) should not be repeated more than 4 times a day and there should be 60 minutes between successive exposures at the STEL concentration.

Threshold Limit Value - Ceiling (TLV-C):
The concentration that should not be exceeded during any part of the working exposure.

Toxic Gas Hazards

Threshold Limit Values (TLV):

Time-Weighted Average (TLV-TWA)

Short-Term Exposure Limit (TLV-STEL)

Ceiling (TLV-C)

Toxic Exposure Limits

The Occupational Safety and Health Administration (OSHA) of the U.S. Department of Labor defines regulatory limits and publishes Permissible Exposure Limits (PEL). PELs are enforceable regulatory limits on the amount or concentration of a substance in the air.

The National Institute for Occupational Safety and Health (NIOSH) recommends exposure levels that protect workers but are not legally enforced. NIOSH also recommends Biological Exposure Indices (BEI).

The table below illustrates the effects of concentration levels and exposure time for Carbon Monoxide (CO). CO is the most abundant toxic gas and is colorless and ordorless.

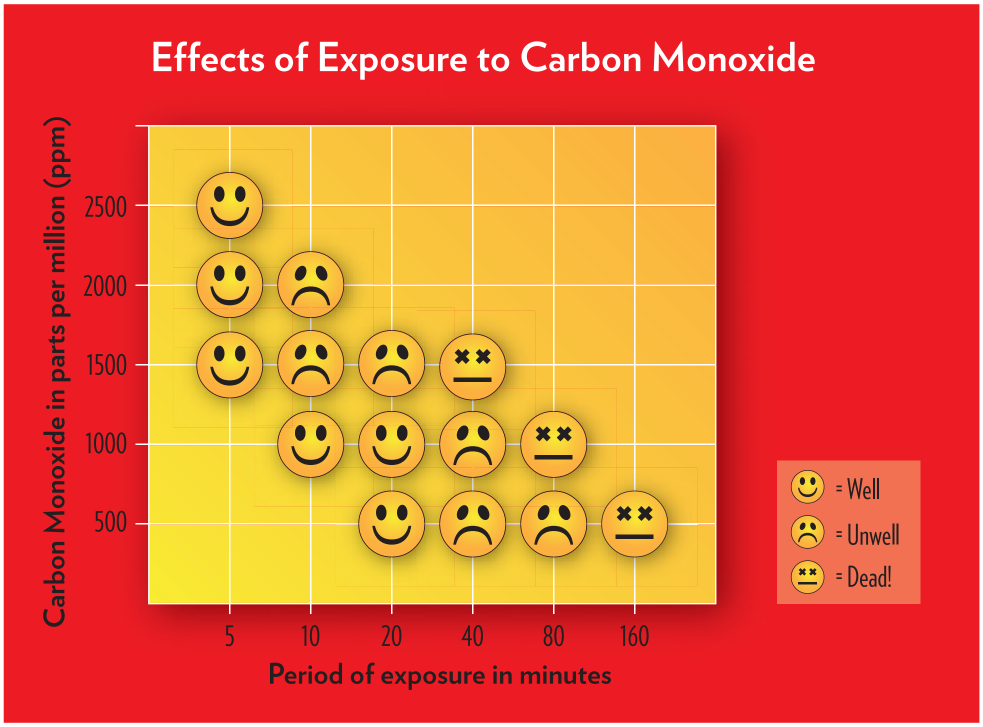


Image Courtesy of Honeywell Analytics

Toxic Gas Data

		EH40 Workplace Exposure Limit (WEL)				OSHA Permissible Exposure Limits (PEL)		ACGIH Threshold Limit Value (TLV)
		Long-term exposure limit (8-hour reference period)		Short-term exposure limit (15-minute reference period)		Long-term exposure limit (8-hour TWA reference period)		8-hour TWA workday and a 40-hour workweek
Common Name	**Formula**	**ppm**	**mg.m-3**	**ppm**	**mg.m-3**	**ppm**	**mg.m-3**	**ppm**
Ammonia	NH3	25	18	35	25	50	35	25
Arsine	AsH3	0.05	0.16		0.05	0.2	0.05	
Boron Trichloride	BCl3							
Boron Trifluoride	BF3					1 (ceiling)	3 (ceiling)	1 (ceiling)
Bromine	Br2	0.1	0.66	0.3	2	0.1	0.7	0.1
Carbon Monoxide	CO	30	35	200	232	50	55	25
Chlorine	Cl2	0.5	1.5	1	2.9	1 (ceiling)	3 (ceiling)	0.5
Chlorine Dioxide	ClO2	0.1	0.28	0.3	0.84	0.1	0.3	0.1
1,4 Cyclohexane diisocyanate								
Diborane	B2H6					0.1	0.1	0.1
Dichlorosilane	H2Cl2Si							
Dimethyl Amine (DMA)	C2H7N	2	3.8	6	11	10	18	5
Dimethyl Hydrazine	C2H8N2							0.01
Disilane	Si2H6							
Ethylene Oxide	C2H4O	5	9.2			1		1
Fluorine	F2	1		1		0.1	0.2	1
Germane	GeH4	0.2	0.62	0.6	1.9			0.2
Hexamethylene Diisocyanate	C8H12N2O2							0.005
Hydrazine	N2H4	0.02	0.03	0.1	0.13	1	1.3	0.01
Hydrogen	H2							Asphyxiant
Hydrogen Bromide	HBr			3	10	3	10	2 (ceiling)
Hydrogen Chloride	HCl	1	2	5	8	5 (ceiling)	7 (ceiling)	2 (ceiling)
Hydrogen Cyanide	HCN			10	11	10	11	4.7 (ceiling)
Hydrogen Fluoride	HF	1.8	1.5	3	2.5	3	3 (ceiling)	
Hydrogen Iodide	HI							
Hydrogen Peroxide	H2O2	1	1.4	2	2.8	1	1.4	1
Hydrogen Selenide	H2Se					0.05	0.2	0.05
Hydrogen Sulfide	H2S	5	7	10	14	20 (ceiling)		10
Hydrogenated Methylene Bisphenyl Isocyanate (HMDI)								
Isocyanatoethylmethacrylate (IEM)								
Isophorone Diisocyanate (IPDI)	C12H18N2O2							0.005
Methyl Fluoride (R41)	CH3F							
Methylene Bisphenyl Isocyanate	C15H10N2O2							0.005
Methylene Bisphenyl Isocyanate (MDI-2)	C15H10N2O2							0.005
Methylene Dianiline (MDA)	C13H14N2	0.01	0.08					0.1
Monomethyl Hydrazine (MMH)	CH6N2							0.01
Naphthalene Diisocyanate (NDI)	C12H6N2O2							0.005
Nitric Acid	HNO3	2	5.2	4	10	2	5	2
Nitric Oxide	NO					25	30	25
Nitrogen Dioxide	NO2					5 (ceiling)	9 (ceiling)	3
Nitrogen Trifluoride	NF3					10	29	10
n-Butyl Amine (N-BA)	C4H11N					5 (ceiling)	15 (ceiling)	5 (ceiling)
Ozone	O3			0.2	0.4	0.1	0.2	100 ppb
Phosgene	COCl2	0.02	0.08	0.06	0.25	0.1	0.4	100 ppb
Phosphine	PH3			0.3	0.42	0.3	0.4	300 ppb
Propylene Oxide	C3H6O	5	12			100	240	2
p-Phenylene Diamine (PPD)	C6H8N2		0.1				0.1	0.1 mg/mm3
p-Phenylene Diisocyanate (PPDI)	C8H4N2O2							
Silane	SiH4	0.5	0.67	1	1.3			5
Stibine	SbH3					0.1	0.5	0.1
Sulfur Dioxide	SO2					5	13	2
Sulfuric Acid	H2SO4						1	0.05
Tertiary Butyl Arsine (TBA)								0.01mg/m3 for arsenic
Tertiary Butyl Phosphine (TBP)	C4H11P							
Tetraethylorthosilicate (TEOS)	C8H20O4Si							
Tetrakis (Dimethylamino) Titanium (TDMAT)	C8H24N4Ti							5 as DMA
Tetramethylxylene Diisocyanate (TMXDI)	C14H16N2O2							
Toluene Diamine (TDA)	C7H10N2	50	191	150	574			lowest feasible (NIOSH)
Toluene Diisocyanate (TDI)	C9H6N2O2			0.02 (ceiling)	0.14 (ceiling)			0.005
Triethyl Amine (TEA)	C6H15N	2	8	4	17			5
Trimethylhexamethylene Diisocyanate (TMDI)	C11H18N2O2							
Unsymetrical Dimethyl Hydrazine (UDMH)	C2H8N2							0.01
Xylene Diisocyanate (XDI)								

Asphyxiant Hazards

Oxygen depletion can be caused by:

- Displacement
- Combustion
- Oxidation
- Chemical reaction

Oxygen Depletion

People normally breathe air that is 20.9% VOL Oxygen (O_2) under normal atmospheric conditions. When the concentration of Oxygen decreases below 19.5% VOL, the air is considered oxygen deficient, and Oxygen concentrations below 16% VOL are considered unsafe for humans. Oxygen deficiency can cause impaired judgement and increased respiration leading to fainting, unconsciousness, and even death.

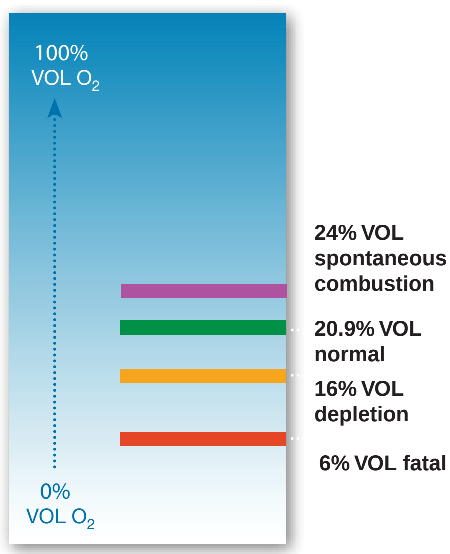
Air Composition

Name	Symbol	Percent by Volume
Nitrogen	N_2	78.084%
Oxygen	O_2	20.9476%
Argon	Ar	0.934%
Carbon Dioxide	CO_2	0.0314%
Neon	Ne	0.001818%
Methane	CH_4	0.0002%
Helium	He	0.000524%
Krypton	Kr	0.000114%
Hydrogen	H_2	0.00005%
Xeron	Xe	0.0000087%

A variety of causes can lead to Oxygen deficiency such as leaking materials from storage tanks or natural gas lines. Leaks that develop in purging or processing with an inert gas such as Helium, Argon, or Nitrogen, can result in Oxygen depletion. Decomposing organic matter produces Methane, Carbon Monoxide, Carbon Dioxide, and Hydrogen Sulfide that consume or displace Oxygen. Rust and other forms of oxidation also consume Oxygen.

Oxygen Enrichment

Oxygen enrichment can also increase risk and cause adverse effects to human health. There is an increased risk of fire and explosion in applications where O_2 concentrations are elevated. Clothing can spontaneously combust at O_2 levels of 24%. Oxygen enriched atmospheres such as welding areas, glass and ceramic manufacturing, oxygen generation facilities, medical air, chemical processes, and clean water treatment facilities must constantly monitor the environment and sensors must be certified for use in O_2 enriched atmospheres.



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Applications

Toxic, combustible, and Oxygen monitoring is becoming more popular across many industries due to a strong focus on employee safety and governmental regulations. Monitors provide early leak detection which can save lives and reduce operating costs. The use and manufacture of dangerous substances in industrial processes is increasing and accidental gas leaks create a potential hazard to the industrial plant, its employees, and people living nearby.

Parking Garages

Parking garages and car tunnels need to be monitored for toxic gases from exhaust fumes. Modern garages and tunnels use this monitoring to control the ventilation fans. Tunnels may also need to be monitored for the buildup of natural gas.

Typical Applications:

- **Car tunnels**
- **Underground and enclosed garages**
- **Access tunnels**
- **Ventilation control**

Typical Gases:

Flammable: Methane (natural gas), LPG, LNG, Petroleum Vapor
Toxic: Carbon Monoxide, Nitrogen Dioxide

Boiler Rooms

The configuration and size of the boiler room depends on the size of the building. Small buildings may have a single boiler, whereas larger buildings may have several boilers.

Typical Applications:

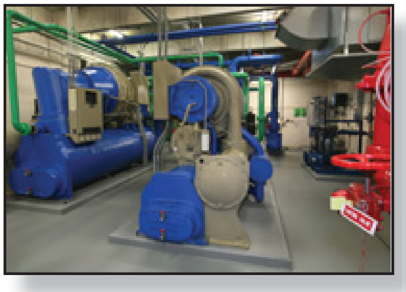
- **Flammable gas leaks from the incoming gas main**
- **Leaks from the boiler and surrounding gas piping**
- **Carbon Monoxide from badly maintained boilers**

Typical Gases:

Flammable: Methane
Toxic: Carbon Monoxide, NOx

Mechanical Rooms

The refrigerants used in mechanical rooms are potentially dangerous if leaks occur.



Typical Applications:

- **Leaks from refrigeration systems**
- **Leaks from chillers**

Typical Gases:

Toxic: R-11, 12, 22, 123, 125, 134a, 222, 245, 404a, 407c, 410a, 507a, 508b, R717 (Ammonia)

Gas Monitoring Applications

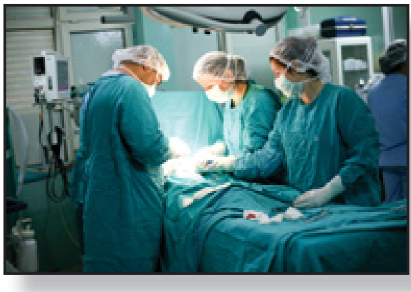
The use of early warning devices, such as gas detectors, are a key part of the safety plan for reducing the risks to personnel and facilities. Early detection provides more time to take remedial or protective action. Gas detectors can be used as part of a total integrated monitoring and safety system for an office, industrial plant, and manufacturing facilities.

Gas Monitoring Applications

- Hospitals
- Wastewater Treatment Plants
- Oil and Gas

Hospitals

Hospitals may use many different flammable and toxic substances, particularly in their laboratories. Many hospitals have on-site utility supplies and back-up power stations.



Typical Applications:
- **Laboratories**
- **Refrigeration plants**
- **Boiler rooms**

Typical Gases:
Flammable: Methane, Hydrogen
Toxic: Carbon Monoxide, Chlorine, Ammonia, Ethylene Oxide and Oxygen deficiency

Wastewater Treatment Plants

Sewage naturally gives off both Methane and Hydrogen Sulfide (H_2S). The human nose can detect H_2S at less than 0.1 ppm due to the "rotten egg" smell.

Typical Applications:
- **Digesters**
- **Plant sumps**
- **H2S scrubbers**
- **Pumps**

Typical Gases:
Flammable: Methane, Solvent vapors
Toxic: Hydrogen Sulfide, Carbon Dioxide, Chlorine, Sulfur Dioxide, Ozone

Oil and Gas

The large amount of highly flammable Hydrocarbon gases involved with onshore and offshore exploration and production of oil and gas are a serious explosive risk. Transportation, storage, and refining of oil and gas are also high risk. In addition, toxic gases such as Hydrogen Sulfide are often present.

Typical Applications:
- **Exploration drilling rigs**
- **Production platforms**
- **Onshore oil and gas terminals**
- **Refineries**

Typical Gases:
Flammable: Hydrocarbon gases
Toxic: Hydrogen Sulfide, Carbon Monoxide

Gas Monitoring Applications

- Semiconductor Manufacturing
- Chemical Plants
- Power Stations

Semiconductor Manufacturing

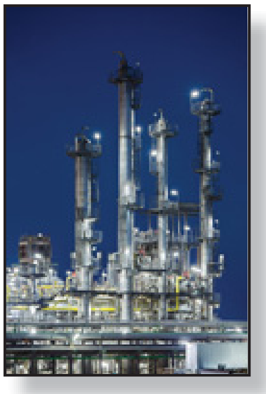
Manufacturing semiconductor materials uses highly toxic substances and flammable gas. Phosphorus, Arsenic, Boron and Gallium are commonly used as doping agents. Hydrogen is used both as a reactant and a reducing atmosphere carrier gas. Etching and cleaning gases include NF_3 and other perfluorocompounds.

Typical Applications:
- **Wafer reactor**
- **Wafer dryers**
- **Gas cabinets**
- **Chemical vapor deposition**

Typical Gases:
Flammable: Hydrogen, Isopropyl Alcohol, Methane
Toxic: HCl, AsH_3, BCl_3, PH_3, CO, HF, O_3, H_2Cl_2Si, TEOS, C_4F_6, C_5F_8, GeH_4, NH_3, NO_2, and O_2 Deficiency.
Pyrophoric: Silane
(Spontaneous combustible in air without the need to extend ignition.)

Chemical Plants

Chemical plants are some of the largest users of gas detection equipment. The manufacturing processes use both flammable and toxic gases. Some toxic hazards are created as a by-product.



Typical Applications:
- **Raw material storage**
- **Process areas**
- **Laboratories**
- **Pump rows**
- **Compressor stations**
- **Loading/unloading areas**

Typical Gases:
Flammable: General Hydrocarbons
Toxic: Hydrogen Sulfide, Hydrogen Fluoride, and Ammonia

Power Stations

Power stations traditionally use coal as the main fuel. Most are being converted to natural gas in Europe and the US.

Typical Applications:
- **Around the boiler pipe work and burners**
- **In and around turbine packages**
- **In coal silos and conveyor belts in older coal/oil fired stations**

Typical Gases:
Flammable: Natural Gas, Hydrogen
Toxic: Carbon Monoxide, SOx, NOx, and Oxygen Deficiency

Installation and Maintenance

Periodic servicing, maintenance, and calibration are a vital part of ensuring that fixed and portable gas detection equipment operates correctly. Gas detection equipment does not have specific legislation or clear guidelines that specify service frequency. Relevant documents simply state that inspection and maintenance should be carried out frequently by competent, trained personnel and in line with the manufacturers recommendations.

Installation

Detectors should be mounted where the gas is most likely to be present or near potential leak points. Locations requiring the most protection in an industrial plant would be around gas boilers, chillers, compressors, pressurized storage tanks, cylinders, or pipelines. Areas where leaks are most likely to occur are pipe joints, valves, gauges, flanges, T-joints, filling or draining connections, and more.

Considerations to help determine detector location:

- For gases that are lighter than air (e.g. Methane and Ammonia), detectors should be mounted at a high level. The use of a collecting cone is recommended.
- For gases heavier than air (e.g. Butane and Sulfur Dioxide), detectors should be mounted at a low level.
- Select a location where personnel can view the display and can be easily accessed for service and calibration.
- Natural or forced air currents may change the behavior of the target gas. Consider mounting in ventilation ducts if appropriate.
- Detectors and cables should be protected against mechanical damage and damage caused by natural events such as flooding. Use weather protection assembly if mounting the unit outdoors.
- Use a detector sunshade if locating a detector in a hot climate or in direct sun.
- Be sure to consider the process conditions. Butane and Sulfur Dioxide, are normally heavier than air, but if released from a process line that is at an elevated temperature and/or under pressure, the gas may rise rather than fall.
- Detectors should be positioned away from high pressure parts to allow gas clouds to form. Otherwise any leak of gas is likely to pass by in a high speed jet and not be detected.
- The unit should be installed, located, and operated in accordance with all applicable codes. Never mount in corners of the room because of poor air flow.
- The sensor technology selected must not be adversely affected by other substances in the environment, such as cleaning agents, paint fumes, and other contaminants.
- Do not expose the sensor to liquid or dust contamination. Use spray deflectors when installing outdoors, or in wash-down areas.
- Ensure the detector is mounted on structures that are sturdy and not susceptible to vibration and shock.
- If using a sample draw detector, make sure to properly exhaust the unit to a safe area or outside atmosphere.

Maintenance

Properly commissioning a system ensures that it is fully functioning as designed and accurately detecting gas hazards. It is recommended that employees who use personal gas detection equipment, or work in areas that have fixed systems installed, are formally trained on the use and routine maintenance of the equipment. Service training departments should be able to offer certified training courses designed to suit all levels of ability from basic gas detection principles to advanced custom designed technical courses.

Calibration frequency and servicing are dependent on the specific application. It is important to establish a suitable service period for the equipment.

KCOC Series

KCOP Series

TP1-M

BA/420CO Series

KCO Series

CO DETECTOR SELECTION CHART

	KCOC Series	Model TP1-M	KCOP Series	KCO Series	BA/420CO Series
Power	20-28 VAC/ 12-30 VDC	10-28 VDC	23-30 VAC/VDC	24 VAC/VDC	14-27 VDC
Range	0-200 ppm	0-500 ppm	0-200 ppm	0-200 ppm	0-100 ppm 0-300 ppm
Accuracy	±2% full scale	5% of range	±2.5% full scale	±5%	±5 ppm
Output	0-10V or 4-20 mA	4-20 mA	4-20 mA or SPDT relay	4-20 mA or SPDT relay	4-20 mA
Relay Output	Optional	NA	Two SPDT	Two SPDT	NA
Alarm Setpoint	20 ppm	25 ppm and 200 ppm	10/20 ppm, 25/50 ppm, 50/100 ppm	50/100 ppm	NA
Visual Indication	LED alarm status	LED power status	LED power, alarm and sensor status	LED power, alarm status	NA
Display	Optional	NA	NA	NA	Optional
Audible Alarm	Optional	NA	NA	NA	NA
Operating Temperature	32° to 122° F	-4° to 104° F	14° to 140° F	-4° to 185° F	14° to 104° F
Operating Humidity	0-99% RH	15-90% RH	5-99% RH	5-95% RH	15-90% RH
Enclosure	ABS, UL94V-0	Stainless steel screen	Metal	Metal	ABS Polymer
Mounting	Wall or Duct	Wall, single-gang box	Wall	Wall	Wall
Dimensions	4.6"H x 2.9"W x 1.0"D	4.6"H x 2.8"W x 3.0"D	5.4"H x 4.9"W x 3.1"D (hinge cover)	6.3"H x 6.1"W x 3.0"D (hinge cover)	3.8" Diameter x 2.1"D
Weight	Wall: 4 oz Duct: 8 oz	1.3 oz	Hinge: 3.5 lb Screw: 4.0 lb	3.0 lb	0.25 lb
Approvals	NA	CSA	NA	NA	NA
Warranty	18 months	1 year	18 months	18 months	2 years

Carbon Monoxide

Carbon Monoxide (CO) is an odorless, invisible toxic gas that is slightly lighter than air. CO is a common by-product of incomplete combustion. It is produced when fossil fuel appliances burn (furnace, boiler, coal fire, wood burning stove, range oven, water heater or space heater) without sufficient air. Internal combustion engines in vehicles produce CO as a result of incomplete combustion. This can result in harmful concentrations in enclosed areas such as parking structures, loading docks, fire and police stations, warehouses, transportation terminals, and automotive maintenance shops.

Carbon Monoxide is a toxic gas that can cause permanent neurological damage and can be fatal. The OSHA long-term exposure limit (8-hour TWA reference period) for CO is 50 ppm.

The LEED Indoor Environmental Quality Credit 3.2 limits the maximim indoor CO concentration of 9 ppm. In addition, the indoor concentration cannot be more than 2 ppm over outdoor concentrations. A summary of the Primary Standards is included in ASHRAE 62-2001.

Carbon Monoxide detectors should be mounted 3 to 5 feet above the floor.

Carbon Dioxide

CO_2 is measured in **parts per million** (ppm)

Typical outdoor ambient CO_2 concentrations: **350 – 450 ppm**

Acceptable IAQ CO_2 concentrations: **600 – 800 ppm**

Tolerable IAQ CO_2 concentrations: **1000 ppm**

Interpretation of ASHRAE (www.ashrae.org) Standard 62.1 "Ventilation for Acceptable Indoor Air Quality" implies CO2 levels should not exceed 700 ppm above outdoor ambient levels of 400 ppm.

Source: Vaisala Application Note, Nov. 2009

Carbon Dioxide is colorless and at low concentrations, the gas is odorless. At higher concentrations it has a sharp, acidic odor. When inhaled at concentrations much higher than usual atmospheric levels, it can produce a sour taste in the mouth and a stinging sensation in the nose and throat.

Wall Mount   Wall Mount with Display   Duct Mount

KCOC Series

CO2 DETECTOR SELECTION CHART

	KCO2 Series	KCD Series	Model T5007
Power	20-28 VAC/12-30 VDC	20-28 VAC/12-30 VDC	18-30 VAC/18-42 VDC
Range	0-2000 ppm	0-2000 ppm	0-2000 ppm
Accuracy	±3% of reading or ±40 ppm	±3% of reading or ±40 ppm	±75 ppm
Output	0-10V or 4-20 mA	0-10V or 4-20 mA	0-10V
Relay Output	Optional	NA	NA
Alarm Setpoint	1000 ppm	1000 ppm	Factory set at 1000 ppm and 1500 ppm
Visual Indication	LED alarm status	LED alarm status	LED alarm status
Display	Optional	NA	NA
Audible Alarm	Optional	NA	NA
Operating Temperature	32° to 122° F	32° to 122° F	-4° to 158° F
Operating Humidity	0-99% RH	0-95% RH	0-95% RH
Enclosure	ABS, UL94V-0	ABS, UL94V-0	Plastic
Mounting	Wall or Duct	Wall or Duct	Wall
Dimensions	4.6"H x 2.9"W x 1.0"D	4.6"H x 2.9"W x 1.0"D	7.5"L x 4.3"W x 2.1"D
Weight	Wall: 4 oz Duct: 8 oz	Wall: 4 oz Duct: 8 oz	8 oz
Approvals	NA	NA	CE, RoHS
Warranty	18 months	18 months	18 months

Wall Mount   Duct Mount

KCD Series

Model T5007

Model 5001/8041 Series

C7232 Series

CO2 DETECTOR SELECTION CHART				
	Model 5001/8041	**Model CD-A**	**C7232 Series**	**GM Series**
Power	18-30 VAC/18-42 VDC	20-30 VAC/18-30 VDC	24 VAC	24 VAC/VDC
Range	0-2000 ppm	0-2000 ppm	0-2000 ppm	0-2000 ppm
Accuracy	5001: ±100 ppm 8041: ±40 ppm	±5% of reading or ±75 ppm	±5% of reading or ±50 ppm	±2% of reading or ±30 ppm
Output	0-10V	0-10V and SPDT relay	0-10V, 2-10V, 0-20 mA, or 4-20 mA and SPDT relay	0-10V, 0-20 mA, or 4-20 mA
Relay Output	NA	SPDT, 2A resistive @ 24 VAC	SPDT, 1A resistive	Optional
Alarm Setpoint	NA	1000 ppm Field adustable 700-1300 ppm	800 ppm	1000 ppm
Visual Indication	NA	NA	NA	NA
Display	NA	Optional	Optional	Optional
Audible Alarm	NA	NA	NA	NA
Operating Temperature	32° to 122° F	32° to 122° F	-4° to 158° F	23° to 113° F
Operating Humidity	0-95% RH	0-90% RH	0-95% RH	0-85% RH
Enclosure	Plastic, UL94V-0	Plastic	Plastic	Plastic
Mounting	Wall or Duct	Wall or Duct (pilot tube)	Wall or Duct	Wall or Duct
Dimensions	5001: 4.8″H x 3.3″W x 1.0″D 8041: 3.0″H x 3.0″W x 1.6″D	5.25″H x 3.50″W x 1.38″D	5.1″H x 3.2″W x 1.8″D	4.7″H x 4.7″W x 1.3″D
Weight	Wall (5001): 4 oz Duct (8041): 8 oz	12 oz	1.6 lb	Model Dependent
Approvals	CE, RoHS	NA	CE, UL	CE
Warranty	2 years	18 months	1 year	2 years

Model CD-A

GMW21/GMD20 Series

Carbon Dioxide

Carbon Dioxide acts as an asphyxiant and an irritant. Amounts above 5,000 ppm are considered very unhealthy, and those above about 50,000 ppm (equal to 5% by volume) are considered dangerous.

Good demand-based ventilation indoor air quality can be achieved by monitoring the levels of CO_2. Humans expel CO_2 when they exhale. In rooms, offices, or other areas where a large group of people congregate, the CO_2 levels will increase. The correlation between occupancy and CO_2 levels make CO_2 measurement the most economical method to monitor both air quality and human presence with one sensor.

An elevated level of CO_2 is an indication of inadequate ventilation. High levels of CO_2 indoors can cause occupants to become drowsy and perform at lower productivity levels. Controlling indoor ventilation systems by monitoring CO_2 levels will increase productivity and save energy by minimizing the use of unconditioned outside air.

Indoor Air Quality

Human beings spend approximately 90% of their time indoors. Studies indicate that Indoor Air Quality (IAQ) is directly linked to human well-being and productivity.

A high CO_2 level is a sign of poor ventilation and often an indication of other unpleasant odors in the air. As many as 30% of buildings have poor IAQ. The most economical way to determine the ventilation demand is to measure Carbon Dioxide, which increases in relation to number of humans present.

By controlling demand-based ventilation according to the CO_2 level rather than the assumed amount of people occupying the space, the indoor air can be kept fresh without over-ventilating and wasting energy.

T8100 Series

KTS Series

IAQ DETECTOR SELECTION CHART

	T8100 Series	KTS Series	IAQPOINT Series
Power	18-30 VAC	20-28 VAC/12-30 VDC	20-30 VAC/18-30 VDC
Range	CO2: 400-2000 ppm Humidity: 0-99% Temperature: 32° to 122°F	CO: 0-200 ppm CO2: 0-2000 ppm Humidity: 0-100% VOC: 0-1000 ppm ethanol	CO2: 0-2000 ppm or 0-10,000 ppm Humidity: 0-99% Temperature: -4° to 122°F
Accuracy	CO2: ±3% of reading or ±40 ppm between 0-1000 ppm Humidity: ±2% RH, 10-90% Temperature: ±1.8°F, 59° to 95°F	CO: ±2.5% full scale CO2: ±3% or ±40 ppm Humidity: ±5% RH, 20-80% VOC: ±10% ethanol	CO2: ±3% between 0-2000 ppm Humidity: ±3% RH, 0-99% Temperature: ±0.9°F @ 77°F
Output	0-5V, 0-10V or 4-20 mA	0-10V or 4-20 mA	BACnet, LON, or Modbus Communication
Relay Output	NA	SPDT, 2A resistive	NA
Communication	NA	NA	BACnet, LON, or Modbus
Alarm Setpoint	NA	CO: 20 ppm CO2: 1000 ppm	Programmable
Visual Indication	NA	LED alarm status	LED calibration status
Display	Optional	Optional	Two-line LCD
Operating Temperature	32° to 122°F	32° to 122°F	32° to 100°F
Operating Humidity	0-95% RH	0-99% RH	0-95% RH
Enclosure	Plastic, UL94V-5VA	ABS, UL94V-0	ABS plastic
Mounting	Wall	Wall or Duct	Wall or Duct
Dimensions	4.6"H x 3.2"W x 1.1"D	4.3"H x 2.9"W x 1.0"D	4.6"L x3.2"W x 1.3"D
Weight	Wall: 0.44 lb	Wall: 4 oz Duct: 8 oz	Wall: 0.44 lb Duct: 0.66 lb
Approvals	CE, RoHS	NA	CE, CSA
Warranty	1 year	18 months	1 year

IAQPOINT Series

BA / BS3 Series

IAQ DETECTOR SELECTION CHART

	IAQPT Series	BA/BS3 Series
Power	20-30 VAC/18-30 VDC	9-24 VDC
Range	CO2: 0-2000 ppm or 0-10,000 ppm Humidity: 0-99% Temperature: -4° to 122°F	0-100% contaminant level of over 30 different contaminants
Accuracy	CO2: ±3% between 0-2000 ppm Humidity: ±3% RH, 0-99% Temperature: ±0.9°F @ 77°F	NA
Output	4-20 mA selectable for CI2, RH, or temperature	0-5V or 0-10V
Relay Output	NA	NA
Communication	NA	NA
Alarm Setpoint	NA	NA
Visual Indication	LED calibration status	3 Color status LED (optional)
Display	Optional	4 Digit LCD (optional)
Operating Temperature	32° to 100°F	32° to 122°F
Operating Humidity	0-95% RH	0-95% RH
Enclosure	ABS plastic	Plastic
Mounting	Wall or Duct	Wall
Dimensions	4.6"L x3.2"W x 1.3"D	Wall: 5.5"H x 3.5"W x 1.0"D
Weight	Wall: 0.44 lb Duct: 0.66 lb	0.45 lb
Approvals	CE, CSA	RoHS
Warranty	1 year	2 years

Indoor Air Quality

In addition to monitoring CO_2, indoor air quality sensors also measure the temperature and humidity which contributes to the comfort of the occupant.

NIOSH considers that indoor air concentrations of Carbon Dioxide that exceed 1,000 ppm are a marker suggesting inadequate ventilation.

ASHRAE recommends that Carbon Dioxide levels not exceed 700 ppm above outdoor ambient levels.

OSHA limits Carbon Dioxide concentration in the workplace to 5,000 ppm for prolonged periods, and 35,000 ppm for 15 minutes.

Toxic and Combustible

A combustible gas is any gas that will burn. Mixtures of combustible gases combined with air, when ignited, produce an explosion. As a result, using a combustible gas sensor to ensure that the percentage of gas in the air can never get high enough for the mixture to burn is essential for facility safety.

When gas is detected by the sensor, it is critical to replace the gas/air mixture with fresh air. If this happens, it is important to shut down all equipment and evacuate all personnel from the area to ensure safety. Gas sensors or gas detectors can check for Methane (natural gas), Propane, Butane, Ethane, Pentane, Hexane, Heptane, Acetylene, LNG, LPG, Hydrogen and other combustible gases. The combination of these sensors with demand-based ventilation systems is imperative for guaranteeing facility and occupant safety.

Model OS-1

GDS Series

PCA Series

TOXIC & COMBUSTIBLE DETECTOR SELECTION CHART

	Model OS-1	PCA Series	GDS Series	GDD Series
Power	24 VAC/VDC	100-240 VAC or four AA batteries	17-27 VAC/ 24-38 VDC	17-27 VAC/ 24-38 VDC
Type	Oxygen Sensor	Hand-Held Combustion Analyzer	Toxic and Combustible Detector	Toxic and Combustible Detector with Remote Sensor
Range	O2: 0-25%	O2: 0-20.9% CO: 0-4000 ppm NO: 0-3000 ppm NO2: 0-500 ppm SO2: 0-5000 ppm Temperature 32° to 255°F	O2: 0-25% CO: 0-250 ppm NO2: 0-10 ppm H2S: 0-50 ppm CH4, C3H8, H2: 0-100% LEL	O2: 0-25% CO: 0-250 ppm NO2: 0-10 ppm H2S: 0-50 ppm CH4, C3H8, H2: 0-100% LEL
Accuracy	±1% of reading	O2: ±0.3% on flue gas CO: CO, SO2: ±5% of reading NO, NO2: ±5% of reading or ±5 ppm 32° to 212°F	±3% full scale @ 25°C	±3% full scale @ 25°C
Output	4-20 mA, 0-5 VDC, 0-10 VDC Relay	NA	4-20 mA and dual relay	4-20 mA and dual relay
Relay Output	SPDT 24 VAC/VDC @ 0.5A	NA	DPDT, 5A resistive	DPDT, 5A resistive
Communication	NA	NA	NA	NA
Alarm Setpoint	19.5%	NA	Programmable	Programmable
Visual Indication	NA	NA	LED power, alarm/ fault status	LED power, alarm/ fault status
Display	NA	Alpha-numeric LCD	Alpha-numeric LCD	Alpha-numeric LCD
Operating Temperature	40° to 104°F	Ambient Air: -4° to 999°F Stack Temperature: -4° to 2192°F	-4° to 122°F	-4° to 122°F
Operating Humidity	10-95% RH	0-95% RH	0-95% RH	0-95% RH
Enclosure	Plastic, UL94V-5VA	Plastic	Polycarbonate	Polycarbonate
Mounting	Wall	Hand-Held	Wall or Duct	Wall
Dimensions	5.1"H x 5.1"W x 33.0"D	9.0"H x 3.0"W x 2.5"D	8.1"H x 5.9"W x 2.7"D	8.1"H x 5.9"W x 2.7"D
Weight	1 lb	1.4 lb	0.86 lb	Base: 0.86 lb Remote Sensor: 1.4 oz
Approvals	NA	CE	UL, CSA	UL, CSA
Warranty	1 year	18 months	1 year	1 year

GDD Series

VASQN8X Series

Model VA301EM

TOXIC & COMBUSTIBLE DETECTOR SELECTION CHART

	GDN Series	Model VA301EM	VASQN8X Series	Model VA301C
Power	17-27 VAC/ 24-38 VDC	20-27 VAC/29-38 VDC	24 VAC	17-27 VAC/ 24-38 VDC
Type	Network Compatible Toxic and Combus-tible Detector	Four Zone Toxic and Combustible Detector with Remote Sensors	Dual Zone Sample Draw Gas Detector	Gas Detection Controller
Range	O2: 0-25% CO: 0-250 ppm NO2: 0-10 ppm H2S: 0-50 ppm CH4, C3H8, H2: 0-100% LEL	O2: 0-25% CO: 0-250 ppm NO2: 0-10 ppm H2S: 0-50 ppm SO2: 0-10 ppm CL2: 0-15 ppm Combustibles: 0-100% LEL	O2: 0-25% CO: 0-250 ppm NO2: 0-10 ppm CO2: 0-2000 ppm Combustibles: 0-100% LEL	Monitors up to 96 inputs/outputs. Works in tandem with other remote sensors
Accuracy	±3% full scale @ 25°C	±3% full scale @ 25°C	±3% full scale @ 25°C	Input dependent
Output	BACnet or Modbus Communication	Four 4-20 mA, Modbus Communication and four relays	Four relays	Four relays
Relay Output	DPDT, 5A resistive	DPDT, 5A resistive	DPDT, 5A resistive	DPDT, 5A resistive
Communica-tion	BACnet or Modbus	Modbus	NA	Three 32 Modbus zones
Alarm Setpoint	Programmable	Programmable	Programmable	Programmable
Visual Indication	LED power, alarm/ fault status	LED power, alarm/ fault status	LED power, alarm/ fault status	LED power, alarm/ fault status
Display	Alpha-numeric LCD	Alpha-numeric LCD	Alpha-numeric LCD	Alpha-numeric LCD
Operating Temperature	-4° to 122°F	32° to 100°F	32° to 104°F	-4° to 122°F
Operating Humidity	0-95% RH	0-95% RH	0-95% RH	0-95% RH
Enclosure	Polycarbonate	Polycarbonate, NEMA 4X	Polycarbonate, NEMA 4X	Polycarbonate, NEMA 4X
Mounting	Wall or Duct	Wall	Wall	Wall
Dimensions	8.1"H x 5.9"W x 2.7"D	8.0"H x 11.0"W x 2.8"D	19.0"H x 11.8"W x 4.5"D	8"H x 11"W x 2.8"D
Weight	0.86 lb	2.3 lb	26.5 lb	3.5 lb
Approvals	UL, CSA	NA	NA	NA
Warranty	1 year	1 year	1 year	1 year

Toxic and Combustible

A toxic gas is any gas that, when inhaled, will produce some adverse effect on the person breathing. Toxic gases in large concentrations can produce unconsciousness or death by displacing the oxygen in breathable air. Many toxic gases, even in very low concentrations, over a long time period can cause cancer or permanently damage the lungs. Toxic gas sensors ensure that no personnel are injured or killed by toxic leak accidents.

Many times toxic gas detectors are found in parking garages, loading docks, boiler rooms, factories, and many more places where toxic gases are present. Use these types of sensors to check for H_2S, SO_2, CO, CO_2, CL_2, NO_2, and other toxic gases.

Refrigerant Monitors

Refrigerant gases are those used in climate control in commercial and business facilities such as warehouses, stores, and office buildings. The refrigerants used in commercial heating, ventilating and air conditioning (HVAC) or regular air conditioning (AC) units include hydrofluorocarbons (HCFCs), chlorofluorocarbon (CFCs) and perfluorocarbon (PFCs).

As refrigerant costs continue to rise and government regulations become increasingly restrictive, employing an effective refrigerant leak detection system is more important than ever. The following are important steps to follow for the installation of a refrigerant monitor.

Make sure you:

- Locate the monitor and/or sample point as close as possible to potential leak points
- Select a location where personnel will see the readout panel so it can easily be accessed for service and calibration
- Check wiring codes: they should be installed in accordance with all applicable codes
- Properly exhaust the instrument to a safe area or to outside atmosphere
- If ventilation exists in a chiller room, smoke tubes can help determine the most appropriate gas monitoring location

Model RLD-5

Model AGM-SZ

Model HGM-SZ

REFRIGERANT GAS MONITOR SELECTION CHART

	Model RLD-5	Model RLD-134A	Model HGM-SZ	Model AGM-SZ
Power	24 VAC/VDC ±10%	24 VAC/VDC	100 to 240 VAC, 50/60 Hz	100 to 240 VAC, 50/60 Hz
Type	Refrigerant Leak Detector	Refrigerant Leak Detector	Single Zone Monitor	Single Zone Ammonia Monitor
Range	R-11, R-12, R-22, R-113, R-502: 0-1000 ppm	R-134a: 0-1000 ppm	R-11, R-12, R-22, R-113, R-114, R-123, R-124, R-125, R-134a, R-227, R-236FA, R-401a, R-402a, R-402b, R404a, R-407a, R-407c, R-408a, R-409a, R-410a, R-500, R-502, R-503, R-507, R-508b, H-1211, H-1301. H-2404, N-1230: 0-1000 ppm	R-717: 25-10,000 ppm
Accuracy	±5%	±5%	±1 ppm ±10% reading	±10 ppm from 25 to 100 ppm or ±10% reading from 100 to 10,000 ppm
Output	4-20 mA, 0-5 VDC, 0-10 VDC, 1-6 VDC Relay	4-20 mA, 0-5 VDC, 0-10 VDC, 1-6 VDC Relay	Three alarm relays, One fault relay, 240 VAC, 5A, and 4-20 mA	Three alarm relays, One fault relay, 240 VAC, 5A, and 4-20 mA
Relay Output	SPDT 24 VAC/VDC @ 0.5A	SPDT 24 VAC/VDC @ 0.5A	SPDT 24 VAC/VDC @ 0.5A	SPDT 24 VAC/VDC @ 0.5A
Communication	NA	NA	NA	NA
Alarm Setpoint	500 ppm: 0-1000 ppm	500 ppm: 0-1000 ppm	Dependant on Gas	Dependant on Gas
Visual Indication	Warm-up, ready, warning, alarm LEDs	Warm-up, ready, warning, alarm LEDs	LED alarm/fault status	LED power, alarm/fault status
Display	NA	NA	NA	LED
Operating Temperature	32° to 158°F	32° to 158°F	32° to 122°F	32° to 122°F
Operating Humidity	10-95% RH	10-95% RH	5-90% RH	5-90% RH
Enclosure	Plastic	Plastic	Metal	Metal
Mounting	Wall	Wall	Wall	Wall
Dimensions	8″H x 4.5″W x 2″D	8″H x 4.5″W x 2″D	7.7″H x 3.6″D x 13.7″L	Base: 7.4″H x 15″L x 3.3″D
Weight	1.45 lb	1.45 lb	7 lb	7 lb
Approvals	NA	NA	UL (61010-1), CSA, CE	UL (61010A-1), CSA, CE
Warranty	1 year	1 year	2 years	2 years

Model VA301EM

IR-F9 Series

Model HGM-MZ

REFRIGERANT GAS MONITOR SELECTION CHART

	IR-F9 Series	Model VA301EM	VASQN8X Series	Model HGM-MZ
Power	24 VDC	20-27 VAC/29-38 VDC	120 VAC, 2A	100 to 240 VAC, 50/60 Hz, 21W
Type	Stand-Alone Infrared Detector	Detector	Multi-point Sample Draw Monitor	Multi-zone Monitor
Range	R-22, R-134A, R-404A, R-407A, R-410A, R-422D, R507A: 0-1000 ppm	R-11, R-12, R-22, R-123, R-125, R-134a, R401a: 0-1000 ppm	R-11, R-12, R-22, R-123, R-125, R-134A	R-11, R-12, R-21, R-22, R-23, R-113, R-114, R-123, R-124, R-125, R-134a, R-227, R-236FA, R-245FA, R-401a, R-402a, R-402b, R404a, R-407a, R-407c, R-408a, R-409a, R-410a, R-422a, R-422d, R-500, R-502, R-503, R-507, R-508b, H-1211, H-1301, H-2402, N-1230, FA188, FC72, HFP
Accuracy	±25 ppm @ 25°C ±3% of full scale	±10 ppm @ 50 ppm; ±40 ppm @ 500 ppm	±3%	±1 ppm ±10% reading
Output	4-20 mA	Four DPDT relays, Three 24 VDC @ 250 mA, Four 4-20 mA, 1000Ω @ 24 VDC, RS-485 Modbus	Three DPDT relays, Three alarms	Three SPDT relays, One fault relay, 250 VAC, 3A, Dual 4-20 mA
Relay Output	Optional	DPDT	DPDT	SPDT, 3A resistive
Communication	Modbus, Optional	Modbus	NA	RS-232C port, RS-485 serial interface, Modbus
Alarm Setpoint	Dependant on Gas	Dependant on Gas	Dependant on Gas	Dependant on Gas
Visual Indication	LED power	G - Normal, R -Alarm, ABC, Y - Fault, A - Tx	LED, Green: Normal, Red: Alarm, Yellow: failure location	NA
Display	NA	LCD	NA	NA
Operating Temperature	-40° to 140°F	32° to 100°F	32° to 122°F	32° to 122°F
Operating Humidity	0-100% RH	0-95% RH	0-95% RH	5-90% RH
Enclosure	ABS Polycarbonate Reinforced fiberglass, polyster, NEMA 4	ABS Polycarbonate, NEMA 4X	Plastic	Metal
Mounting	Wall	Wall	Wall	Wall
Dimensions	9.59"H x 7.71"W x 4.52"D	7.99"H x 11.2"W x 2.76"D	19"H x 11.75"W x 4.5"D	12.2"L x 13.7"H x 5.0"D
Weight	4.4 lb	2.25 lb	26.5 lb	15 lb
Approvals	NA	NA	NA	UL (61010-1), CSA, CE
Warranty	1 year	1 year	1 year	2 years

Refrigerant Monitors

Avoid:

- Mounting the unit to a structure subject to vibrations and shock, such as piping and piping supports
- Locating the units near an excessive heat source or in wet or damp locations
- Mounting the unit to where it will be exposed to direct sun light
- Installing the monitor in areas where condensation may form which may clog or block the sampling line, preventing it from receiving fresh gas samples

Ammonia (NH_3) is one of the most highly produced chemicals in the world and is used in many industrial refrigeration systems. It is considered to be environmentally friendly because it does not deplete the ozone layer or contribute to global warming as other refrigerants do. However, Ammonia is toxic to humans at low concentrations and must be monitored in case of an accidental release.

Natural Ammonia levels in the atmosphere are in the low ppb range. Ammonia is a severe irritant to the human respiratory tract and short-term exposure over 15 minutes needs to be limited to 25-35 ppm. Concentration levels at or above 300 ppm are considered immediate danger to life and health.

Accessories

- Calibration Kits
- Verficiation Kits
- Gas Cylinders

ACCESSORIES	
PRODUCT	**DESCRIPTION**
3015-3430	R-22 Gas verification kit
3015-3437	R-134a Gas verification kit
3015-3438	R-123 Gas verification kit
UCK-1	Universal calibration kit for non-corrosive gases (N_2, CO_2, CH_4, H_2, O_2, CO, and refrigerants)
UCK-2	Universal calibration kit for corrosive gases (NO_2, H_2S, SO_2, and NH_3)
UCK-3	Universal calibration kit for non-corrosive or corrosive gases
1309K0002	GDS, GDN, GDD calibration kit (58-1036)
1309K0004	GDS, GDN, GDD calibration kit (17-346)
GAS-N2	Nitrogen (N_2), 17L
GAS-CO2-2000	2000 ppm Carbon Dioxide (CO_2) in Nitrogen (N_2), 17L
GAS-CO2-1000	1000 ppm Carbon Dioxide (CO_2) in Nitrogen (N_2), 17L
GAS-CO2-800	800 ppm Carbon Dioxide (CO_2) in Nitrogen (N_2), 17L
GAS-CO-200	200 ppm Carbon Monoxide (CO) in air, 17L
GAS-CO-100	100 ppm Carbon Monoxide (CO) in air, 17L
GAS-CO-50	50 ppm Carbon Monoxide (CO) in air, 17L
GAS-CO-25	25 ppm Carbon Monoxide (CO) in air, 17L
GAS-NO2-5	5 ppm Nitrogen Dioxide (NO_2) in air, 58L
GAS-CH4-2.5	2.5% Methane (CH_4) in air, 17L
GAS-H2-2	2.0% Hydrogen (H_2) in air, 17L
GAS-H2S-25	25 ppm Hydrogen Sulfide (H_2S) in air, 58L
GAS-SO2-5	5 ppm Sulfur Dioxide (SO_2) in air, 58L
GAS-O2-18	18% Oxygen (O_2) in Nitrogen (N_2), 17L
GAS-NH3-50	50 ppm Ammonia (NH_3) in Nitrogen (N_2), 58L
GAS-R123-100	100 ppm R-123 in air, 17L
GAS-R11-500	500 ppm R-11 in air, 17L
GAS-R12-500	500 ppm R-12 in air, 17L
GAS-R134A-500	500 ppm R-134a in air, 17L
GAS-R22-500	500 ppm R-22 in air, 17L

UCK-1

Refrigerant Verification Kit

Gas Calibration Kit

GAS APPLICATION CHART

GAS	FORMULA	APPLICATIONS	ORIGIN OF HAZARD	LOCATION
Hydrogen Sulfide **Toxic**	H_2S	Manholes, pumping stations, filtration, wastewater treatment & power plants, agriculture, chemical, construction, electric & gas utilities, fire service, food & beverage processing, hazmat, iron, steel, oil & gas production, marine shipyard, mining, petrochemical, paper & pulp, pharmaceutical/research labs & public works	Leak from process equipment	1 foot above floor
Carbon Monoxide **Toxic**	CO	Parking garage, ambulance bay, fire & police stations, loading docks, vehicle tunnels, automatic maintenance garages, emergency generator, transport terminal-baggage, commercial kitchen, golf cart maintenance, battery charging area, car wash, indoor stadium/arena, warehouse, agriculture, chemical, construction, electrical & gas utilities, manufacturing, food & beverage processing, boiler room, hospital, hazmat, iron, steel, gas & oil production, marine shipyard, mining, petrochemical, paper & pulp, power & wastewater treatment plants, welding	Product of incomplete combustion engines present in exhaust systems in varying degrees	3-5 feet above floor
Nitrogen Dioxide **Toxic**	NO_2	Parking garage, ambulance bay, fire & police stations, loading docks, vehicle tunnels, automatic maintenance garages, transport terminal-baggage, emergency generator, agriculture, chemical, construction, iron & steel production, mining, public works, welding, golf cart maintenance, battery charging area, hospital, car wash, warehouse	By-product of diesel fuel engine combustion present in exhaust systems	1 foot below ceiling
Chlorine **Toxic**	CL_2	Swimming pools, wastewater treatment plants, hospital, chemical, paper & pulp, pharmaceutical/research labs	Leaks from Chlorine containers and Chlorinators	1 foot above floor
Hydrogen **Combustible**	H_2	Battery charging area, golf cart maintenance, phone company-battery backup, chemical, hazmat, power plants, maintenance garage, fire & police stations, hydrogen tanks	Leak from batteries or furnaces	1 foot below ceiling
Methane **Combustible**	CH_4	Boiler room, wastewater treatment plants, commercial kitchen, golf cart maintenance, battery charging area, indoor stadium/arena, semiconductor manufacturing, hospital, parking garage, agriculture, aviation, chemical, construction, electrical & gas utilities, fire service, food & beverage processing, hazmat, iron & steel production, manufacturing, marine shipyard, mining, oil & gas production, petrochemical, paper & pulp, pharmaceutical/research labs, power plants, public works, welding	Leaks from sludge digesters and dryers	1 foot below ceiling
Propane **Combustible**	C_3H_8	Golf cart maintenance, forklifts, commercial & residential heating, transport terminal-baggage, hospital, loading docks, commercial kitchen, car wash, parking garage, agriculture, aviation, chemical, construction, indoor stadium/arena, warehouse, electric & gas utilities, fire service, food & beverage processing, hazmat, manufacturing, marine shipyard, mining, oil, gas, steel & iron production, petrochemical, paper & pulp, pharmaceutical/research labs, power plants, public works, wastewater treatment plants, welding	Gas storage area	1 foot above floor
Oxygen **Combustible**	O_2	Blood bank, pumping stations, refrigeration & air conditioning systems, biological specimen storage, cryogenic containers, oxygen depletion-MRI room, agriculture, aviation, chemical, construction, electric & gas utilities, fire service, food & beverage processing, hazmat, iron, steel, oil & gas production, marine shipyard, mining, petrochemical, paper & pulp, pharmaceutical/research labs, power plants, public works, wastewater treatment plants, welding, fire & police stations, golf cart maintenance, battery charging area, maintenance garage	Dispersion of oxygen in the air by nitrogen leaking from liquid open flask dewars or pressurized cryogenic liquid containers	3-5 feet above floor
Carbon Dioxide **Indoor Air Quality**	CO_2	Schools, meeting rooms, agriculture, aviation, fire service, food & beverage processing, marine shipyard, mining, wastewater treatment plants	People exhale CO_2	3-5 feet above floor
Refrigerants: R-11, 12, 12B1, 22, 123a, 125, 134A, 222, 245, 404A, 407C, 410A, 507A, 508B		Compressor and machine rooms, refrigeration systems	Leaks from chillers	1 foot above floor
Ammonia: R717 **Toxic & Combustible**	NH_3	Refrigerated warehouse, indoor stadium/arena, breweries, agriculture, food & beverage processing, hazmat, oil & gas production, petrochemical, pharmaceutical/research labs, wastewater treatment plants, chemical, hospital	Leak from mechanical freezers spill or leak during ammonia transferring process	1 foot below ceiling
Chlorine Dioxide **Toxic**	ClO_2	Paper & pulp, air decontamination, wastewater treatment plants	By-product of paper production	1 foot from floor
Hydrogen Chloride **Toxic**	HCl	Chemical, food & beverage processing, hazmat, manufacturing, pharmaceutical/research labs, welding, semiconductor manufacturing	Production of hydrochloric acid; reagent industrial chemical use Silicon Purification	1 foot below ceiling
Hydrogen Cyanide **Toxic**	HCN	Fire service, food & beverage processing, hazmat, iron & steel production, mining	Precursor to sodium cyanide and potassium cyanide used in mining	3-5 feet above floor
Nitric Oxide **Toxic**	NO	Agriculture, chemical, construction, iron & steel production, mining, public works, semiconductor manufacturing, welding	Used for the synthesis of nitric acid from ammonia	1 foot below ceiling
Ozone **Toxic**	O_3	Electric utilities, public works, wastewater treatment plants, hospital, welding, semiconductor manufacturing	Used in preparation of commercially useful organic compounds; used as disinfectant	3-5 feet above floor
Phosphine **Toxic**	PH_3	Agriculture, food & beverage processing, hazmat, semiconductor manufacturing	Dopant in semiconductor industry; used as fumigant in agriculture	1 foot below ceiling
Sulfur Dioxide **Toxic**	SO_2	Chemical, electric utilities, hazmat, iron & steel production, paper & pulp, pharmaceutical/research labs, power plants, public works, wastewater treatment plants, welding	Used as a refrigerant and reducing agent	1 foot from floor
Volatile Organic Compounds (VOCs) **Toxic & Combustible**		Chemical, construction, aviation, food & beverage processing, hazmat, iron & steel production, manufacturing, petrochemical, oil & gas production, paper & pulp, pharmaceutical/research labs, wastewater treatment plants	Organic chemicals having significant vapor pressures and can affect environment and human health; building materials such as paint, adhesives, wall boards, and ceiling tiles emit formaldehyde-one common VOC	3-5 feet above floor

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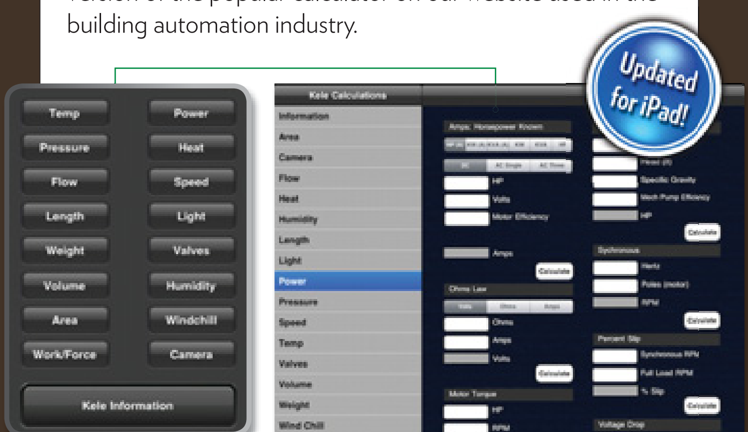

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