Decision tree for gas detection and/or ventilation

Asphyxiating gasses (Ex.: Nitrogen, Argon): <19,5 % O_2

Toxic gasses (Ex.: Sulfurdioxide, Ammonia): TWA (8h limit) & STEL (15min limit)
Flammable gasses (Ex.: Hydrogen, Acetylene): 10% LEL
High-oxygen environment (Ex.: Oxygen): >23,5% O_2

Based on calculations from:

NBN EN IEC 60079-10-1:2021
NBN EN IEC 60079-10-1:2008

Decision tree

Global situation (in the whole room)

Calculate the ventilation capacity needed to reduce the hazardous gas concentration below the safe limit (V_{min})

Is the available ventilation capacity sufficient?

Yes: No action needed
No: Increase ventilation, or place global gas detection, or require personal gas detection when entering the room

Local situation (near the release)

Calculate the hazardous volume (V_z)

Is the hazardus volume smaller than the safe limit?

Yes: No action needed
No: Install local gas detection

Minimum requirements ventilation

- Calculated minimum capacity
- Flow detection (direct measurement in ventilation channels) with alarm for action
- Alarming in room and at room entries, if relevant also a centralized alarm in control room

Minimum requirements gas detection

- Positioning according to density (relative to air, Life Safety Zone)

- Alarming in room and at room entries, if relevant also a centralized alarm in control room
- For continuous sources: automatic shut-off

Decision Tree for Gas Detection: Asphyxiating Gases

Business Unit		Building nr.	
Department		Room nr.	
Requester		Date	
ADV-number			

Fill in | Is calculated | Background info available

Important: This decision tool does not negate the need for a (process) risk assessment for the use of hazardous gases!

Room Information

Dimensions			
Length	l	0	m
Width	w	0	m
Height	h	0	m
Total room volume	V_r	0	m³
Forced ventilation			m³/u

Asphyxiating Gas Information

Gas selection		Argon (Ar)		
Molar mass	M	40	kg/kmol	
Heat capacity	c_p	520	J/kg,K	
Gas density (Room Temp.)	ρ_g	1,782	kg/m³	
Density liquified gas	ρ_{lg}	1417	kg/m³	
Oxygen limit		19,5	v%	(Typical value: 19,5v%, Ref. OSHA 1910)

Working with cylinders/racks

# of cylinders	0	
Pressure in cylinder	0	bar
Volume in cylinder	0	m³
Total volume of gas	0	m³

Working with continuous source/silo

Volume of silo (Liquified gas)		0	m³	
Total volume of gas		0	m³	
Maximum available gas	V_g	0	m³	
Pressure in piping	p_g	0	bar	
Critical pressure	p_c	2,05	bar	(Ref. Formula B.2 of IEC 60079-10-1:2021)

Parameters & Constants

Release coefficient	C_d	0,99		(Typical value = 0,99, Ref. B.7.2.1 of IEC 60079-10-1:2021)
Opening dimension	S	0,00000025	m²	(Typical value = 0,25mm², Ref. Table B.1 of IEC60079-10-1:2021)
Compression factor	Z	1		(Typical value for ideal gasses, Ref. IEC 60079-10-1:2021)
Universal gas constant	R	8314,5	J/kmol K	(Fixed constant)
Gas/Room temperature	T_g	293	K	(Simplification to take room temperature and gas temperature equal)
Atmospheric pressure	p_a	101325	Pa	Sea level pressure
Ventilation safety factor	f	3		(Typical value for forced ventilation 3, generally between 2-5)
Polytropic index	y	1,67		(Ref. Formula B.2 of IEC 60079-10-1:2021)

Calculations

Gas Release Rate	W_g	0	kg/s	(Ref. Formula B.3 of IEC 60079-10-1:2021)
Gas Release Rate	Q_g	0	m³/s	(Ref. Formula B.4 of IEC 60079-10-1:2021)
Minimum ventilation capacity	V_{min}	0	m³/h	(Ref. Formula B.1 of IEC 60079-10-1:2008)
Refreshment Rate	C	##############	/h	(Ref. Formula B.3 of IEC 60079-10-1:2008)
Hazardous volume	V_z	##############	m³	(Ref. Formula B.4 of IEC 60079-10-1:2008)

Advice

Global situation (whole room)

Is the room ventilation sufficient to keep the oxygen concentration above the safe limit? **NO**

Advice: Increase the ventilation capacity to the required minimum ventilation or install global gas detection or require the use of personal gas detection

Minimum ventilation capacity **0 m³/h**

Local situation (near release)

Is the hazardous volume (Vz) smaller than 10m³? **#########**

#DELING.DOOR.0!

Decision Tree for Gas Detection: Toxic Gases

Business Unit		Building nr.	
Department		Room nr.	
Requester		Date	
ADV-number			

Fill in | Is calculated | Background info available

Important: This decision tool does not negate the need for a (process) risk assessment for the use of toxic gases!

Room Information

Dimensions

Length	l	0	m
Width	w	0	m
Height	h	0	m
Total room volume	V_r	0	m³
Forced ventilation		0	m³/u

Toxic Gas Information

Gas selection		**Sulfur Dioxide (SO2)**	
Molar mass	M	64	kg/kmol
Heat capacity	c_p	622	J/kg,K
Gas density (Room Temp.)	ρ_g	2,279	kg/m³
Density liquified gas	ρ_{lg}	1383	kg/m³
Time Weighted Average (8h)	TWA	0,5	ppm (Ref. Codex Belgium Safe Limits)
Short Term Exposure Limit (15min)	STEL	1	ppm (Ref. Codex Belgium Safe Limits)

Working with cylinders/racks

# of cylinders		0	
Pressure in cylinder		0	bar
Volume in cylinder		0	m³
Total volume of gas		0	m³

Working with continuous source/silo

Volume of silo (Liquified gas)		0	m³

Total volume of gas		0	m³	
Maximum available gas	V_g	0	m³	
Pressure in piping	p_g	0	bar	
Critical pressure	p_c	1,81	bar	(Ref. Formula B.2 of IEC 60079-10-1:2021)

Parameters & Constants

Release coefficient	C_d	0,99		(Typical value = 0,99, Ref. B.7.2.1 of IEC 60079-10-1:2021)
Opening dimension	S	0,00000025	m²	(Typical value = 0,25mm², Ref. Table B.1 of IEC60079-10-1:2021)
Compression factor	Z	1		(Typical value for ideal gasses, Ref. IEC 60079-10-1:2021)
Universal gas constant	R	8314,5	J/kmol K	(Fixed constant)
Gas/Room temperature	T_g	293	K	(Simplification to take room temperature and gas temperature equal)
Atmospheric pressure	p_a	101325	Pa	Sea level pressure
Ventilation safety factor	f	3		(Typical value for forced ventilation 3, generally between 2-5)
Polytropic index	y	1,26		(Ref. Formula B.2 of IEC 60079-10-1:2021)

Calculations

Gas Release Rate	W_g	0,00000	kg/s	(Ref. Formula B.3 of IEC 60079-10-1:2021)
Gas Release Rate	Q_g	0,00000	m³/s	(Ref. Formula B.4 of IEC 60079-10-1:2021)
Minimum ventilation capacity STEL	$V_{min\ STEL}$	0	m³/h	(Ref. Formula B.1 of IEC 60079-10-1:2008)
Minimum ventilation capacity TWA	$V_{min\ TWA}$	0	m³/h	(Ref. Formula B.1 of IEC 60079-10-1:2008)
Refreshment Rate	C	##########	/h	(Ref. Formula B.3 of IEC 60079-10-1:2008)
Hazardous volume	V_z	##########	m³	(Ref. Formula B.4 of IEC 60079-10-1:2008)

Advice

Global situation (whole room)

Is the room ventilation sufficient to reduce the hazardous gas concentration below the STEL (15min) limit? **NO**

Is the room ventilation sufficient to reduce the hazardous gas concentration below the TWA (8h) limit? **NO**

Advice: Increase room ventilation to minimum 10 air changes per hour (10 ACH) and install global gas detection

Minimum ventilation capacity **0 m³/h**

Local situation (near release)

Is the hazardous volume (V_z) smaller than 10m³? **#########**

#DELING.DOOR.0!

Decision Tree for Gas Detection: Flammable Gases

Business Unit	CRD	Building nr.	719
Department	TS	Room nr.	N/A
Requester	Steven Vandewalle	Date	19-1-2026
ADV-number			

Fill in | Is calculated | Background info available

Important: This decision tool does not negate the need for an explosion safety study for flammable gases!

Room Information

Dimensions			
Length	l	0	m
Width	w	0	m
Height	h	0	m
Total room volume	V_r	0	m³
Forced ventilation		0	m³/u

Flammable Gas Information

Gas selection		Methane (CH4)		
Molar mass	M	16	kg/kmol	
Heat capacity	c_p	35800	J/kg,K	
Gas density (Room Temp.)	ρ_g	0,657	kg/m³	
Density liquified gas	ρ_{lg}	423	kg/m³	
Lower Explosion Limit	LEL	4,4	v%	
ATEX Safety Factor		10	%	(Typical value = 10% of the LEL is safe limit)

Working with cylinders/racks

# of cylinders	0	
Pressure in cylinder	0	bar
Volume in cylinder	0	m³
Total volume of gas	0	m³

Working with continuous source/silo

Volume of silo (Liquified gas)	0	m³

Total volume of gas		0	m³	
Maximum available gas	V_g	0	m³	
Pressure in piping	p_g	0	bar	
Critical pressure	p_c	1,66	bar	(Ref. Formula B.2 of IEC 60079-10-1:2021)

Parameters & Constants

Release coefficient	C_d	0,99		(Typical value = 0,99, Ref. B.7.2.1 of IEC 60079-10-1:2021)
Opening dimension	S	0,00000025	m²	(Typical value = 0,25mm², Ref. Table B.1 of IEC60079-10-1:2021)
Compression factor	Z	1		(Typical value for ideal gasses, Ref. IEC 60079-10-1:2021)
Universal gas constant	R	8314,5	J/kmol K	(Fixed constant)
Gas/Room temperature	T_g	293	K	(Simplification to take room temperature and gas temperature equal)
Atmospheric pressure	p_a	101325	Pa	Sea level pressure
Ventilation safety factor	f	3		(Typical value for forced ventilation 3, generally between 2-5)
Polytropic index	y	1,01		(Ref. Formula B.2 of IEC 60079-10-1:2021)

Calculations

Gas Release Rate	W_g	0,00000	kg/s	(Ref. Formula B.3 of IEC 60079-10-1:2021)
Gas Release Rate	Q_g	0,00000	m³/s	(Ref. Formula B.4 of IEC 60079-10-1:2021)
Minimum ventilation capacity	V_{min}	0	m³/h	(Ref. Formula B.1 of IEC 60079-10-1:2008)
Refreshment Rate	C	###############	/h	(Ref. Formula B.3 of IEC 60079-10-1:2008)
Hazardous volume	V_z	###############	m³	(Ref. Formula B.4 of IEC 60079-10-1:2008)

Advice

Global situation (whole room)

Is the room ventilation sufficient to reduce the hazardous gas concentration below the safe limit? **NO**

Advice: Increase the ventilation capacity to the required minimum ventilation or install global gas detection or require the use of personal gas detection

Minimum ventilation capacity **0 m³/h**

Local situation (near release)

Is the hazardous volume (V_z) smaller than 0,1 m³? **#########**

#DELING.DOOR.0!

Decision Tree for Gas Detection: Oxygen Rich Environments

Business Unit		Building nr.	
Department		Room nr.	
Requester		Date	
ADV-number			

Fill in | Is calculated | Background info available

Important: This decision tool does not negate the need for a (process) risk assessment for the use of hazardous gases!

Room Information

Dimensions			
Length	l	0	m
Width	w	0	m
Height	h	0	m
Total room volume	V_r	0	m³
Forced ventilation		0	m³/u

Oxygen Rich Environment Information

Gas selection		Oxygen (O2)		
Molar mass	M	32	kg/kmol	
Heat capacity	c_p	915	J/kg,K	
Gas density (Room Temp.)	ρ_g	1,429	kg/m³	
Density liquified gas	ρ_{lg}	1141	kg/m³	
Oxygen limit		23,5	v%	(Typical value: 23,5v%, Ref. OSHA 1910)

Working with cylinders/racks

# of cylinders	0	
Pressure in cylinder	0	bar
Volume in cylinder	0	m³
Total volume of gas	0	m³

Working with continuous source/silo

Volume of silo (Liquified gas)		0	m³	
Total volume of gas		0	m³	
Maximum available gas	V_g	0	m³	
Pressure in piping	p_g	0	bar	
Critical pressure	p_c	1,89	bar	(Ref. Formula B.2 of IEC 60079-10-1:2021)

Parameters & Constants

Release coefficient	C_d	0,99		(Typical value = 0,99, Ref. B.7.2.1 of IEC 60079-10-1:2021)
Opening dimension	S	0,00000025	m²	(Typical value = 0,25mm², Ref. Table B.1 of IEC60079-10-1:2021)
Compression factor	Z	1		(Typical value for ideal gasses, Ref. IEC 60079-10-1:2021)
Universal gas constant	R	8314,5	J/kmol K	(Fixed constant)
Gas/Room temperature	T_g	293	K	(Simplification to take room temperature and gas temperature equal)
Atmospheric pressure	p_a	101325	Pa	Sea level pressure
Ventilation safety factor	f	3		(Typical value for forced ventilation 3, generally between 2-5)
Polytropic index	y	1,40		(Ref. Formula B.2 of IEC 60079-10-1:2021)

Calculations

Gas Release Rate	W_g	0	kg/s	(Ref. Formula B.3 of IEC 60079-10-1:2021)
Gas Release Rate	Q_g	0	m³/s	(Ref. Formula B.4 of IEC 60079-10-1:2021)
Minimum ventilation capacity	V_{min}	0	m³/h	(Ref. Formula B.1 of IEC 60079-10-1:2008)
Refreshment Rate	C	##############	/h	(Ref. Formula B.3 of IEC 60079-10-1:2008)
Hazardous volume	V_z	##############	m³	(Ref. Formula B.4 of IEC 60079-10-1:2008)

Advice

Global situation (whole room)

Is the room ventilation sufficient to keep the oxygen concentration below the safe limit? **NO**

Advice: Increase the ventilation capacity to the required minimum ventilation or install global gas detection or require the use of personal gas detection

Minimum ventilation capacity **0 m³/h**

Local situation (near release)

Is the hazardous volume (Vz) smaller than 10m³? **#########**

#DELING.DOOR.0!

Look-up Table for Flammable gasses					
Gas	Molar mass (kg/kmol)	Heat capacity cp (J/kg.K)	Gas density room temperature (kg/m³)	LEL (v%)	Density liquified gas (kg/m³)
Hydrogen (H2)	2	14300	0,08375	4	71
Acetylene (C2H2)	26	1674	1,1772	2,3	693
Carbon Monoxide (CO)	28	1040	1,139	12,5	1250
Hydrogen Sulfide (H2S)	34	760	1,505	4,3	916
Propane (C3H8)	44	1685	1,8316	2,1	493
Butane (C4H10)	58	1730	2,48	1,9	572
Methane (CH4)	16	35800	0,657	4,4	423
Ammonia (NH3)	17	2294	0,73	15	683

Constants				
Name	Sign	Value	Dimension	Information
Release coefficient for openings	Cd	0,99	Dimensionless	(Typical value = 0,99, Ref. B.7.2.1 of IEC 60079-10-1:2021)
Opening dimension	S	0,00000025	m²	(Typical value = 0,25mm², Ref. Table B.1 of IEC60079-10-1:2021)
Compression factor	Z	1	Dimensionless	(Typical value for ideal gasses, Ref. IEC 60079-10-1:2021)
Universal gas constant	R	8314,5	J/kmol K	(Fixed constant)
Gas/Room temperature	Tg	293	K	(Simplification to take room temperature and gas temperature equal)
Atmospheric pressure	pa	101325	Pa	Sea level pressure

Look-up Table for Toxic Gases						
Gas	Molar mass (kg/kmol)	Heat capacity cp (J/kg.K)	Gas density room temperature (kg/m³)	Density liquified	TWA (8h) (ppm)	STEL (15min)
Sulfur Dioxide (SO2)	64	622	2,279	1383	0,5	1
Ammonia (NH3)	17	2294	0,73	683	20	50
Hydrogen Sulfide (H2S)	34	760	1,505	916	1,64	4
Carbon Monoxide (CO)	28	1040	1,139	1250	20	100
Chlorine (Cl2)	71	476	3,2	1558	0,5	0,5
Carbon Dioxide (CO2)	44	840	1,85	1100	5000	30000
Nitrogen Dioxide (N2O)	44	880	1,977	1220	0,5	1

Look-Up Table for Asphyxiating Gases				
Gas	Molar mass (kg/kmol)	Heat capacity cp (J/kg.K)	Gas density room temperature (kg/m³)	Density liquified gas (kg/m³)
Nitrogen (N2)	28	1040	1,2506	806
Argon (Ar)	40	520	1,782	1417
Helium (He)	4	5193	0,1785	125

Look-Up Table for Oxygen Rich Environments				
Gas	Molar mass (kg/kmol)	Heat capacity cp (J/kg.K)	Gas density room temperature (kg/m³)	Density liquified gas (kg/m³)
Oxygen (O2)	32	915	1,429	1141