Defining hazardous areas for gas and vapours

What is said in official texts ?

The IEC international regulation (standard IEC 60079.10) makes a distinction between the following hazardous zones :

. zone 0,
. zone 1,
. zone 2.

Three types of zone

Since 1st of July 2003, with the new Directives ATEX, three types of zone :

. zone 0 - 20
. zone 1 - 21
. zone 2 - 22.

Zone 0 - 20

Zone in which an explosive mixture of gas, vapour or dust is continuously present (the gaseous phase inside a receptacle or a closed-off chamber constitutes a zone "0").

Zone 1 - 21

Zone in which an explosive mixture of gas, vapour or dust is likely to occur during normal operation.

Zone 2 - 22

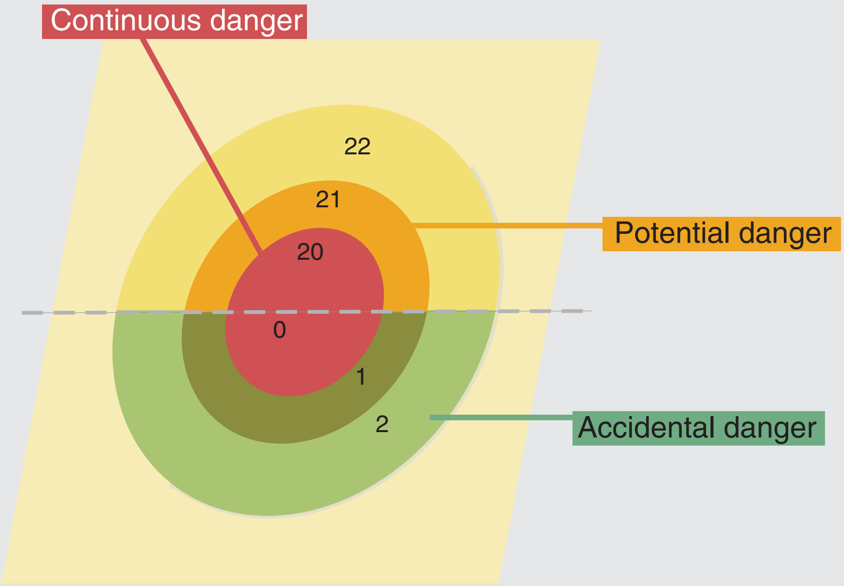
Zone in which an explosive mixture is not likely to occur in normal operation, and if it occurs will only exist for a short time (leaks or negligent use).

How to determine the zones ?

The plant manager or his employees, controlled by external accredited advisers, are the only people authorized to determine hazardous areas in a location where gas and vapour are present.

To determine these zones, 4 essential questions have to be solved.

THE THREE TYPES OF ZONE



Substances	Flash point in °C	Self-ignition temperature in °C	Infammability limits by volume % Miwed with air	
			Lower	Upper
Jet engine fuel JP3 (TR3)	-20	251	0,9	6,15
Jet engine fuel JP4 (TR4)	-20	249	0,8	5,63
Jet engine fuel JP5 (TR5)	58	246	0,6	4,53
Kerosene (lamp oil)	43-72	210	0,7	5
Limonene	45	235	0,7(à 150°C)	6,1(à150°C)
Linseed (oil)	220	340	-	-
Lubricating oil	150-225	260-370	-	-
Maleic anhydride	102	475	1,4	7,1
Mesityl oxide	30	344	1,4	7,2
Methane	gaz	535	5	15
Methanol	11	385	6,7	36
Methoxylbenzene	52 O.D.	475	-	-
Methyl acetate	-10	454	3,1	16
Methyl acrylate	-3	468	2,8	25
Methyl formate	-19	449	4,5	23
Methyl lactate	49	385	2,2(à 100°C)	-
Methyl metacrylate	10 O.D.	-	1,7	8,2
Methyl propionate	-2	465	2,5	13
Methylamine	gaz	430	4,9	20,7
Methylcyclohexane	-4	250	1,2	6,7
Methylcyclopentadiene	48	445	1,3(à 100°C)	7,6(à 100°C)
Methylcyclopentane	<- 7	258	1	8,3
Methyldichlorosilane	-9	316	6	55
Methylhydrazine	-8	194	2,5	92
Metyl butyrate	13	-	-	-
Mixed with water (10% alcohol)	49	-	-	-
Mixed with water (20% alcohol)	36	-	-	-
Mixed with water (30% alcohol)	29	-	-	-
Mixed with water (40% alcohol)	26	-	-	-
Mixed with water (5% alcohol)	62	-	-	-
Mixed with water (50% alcohol)	24	-	-	-
Mixed with water (60% alcohol)	22	-	-	-
Mixed with water (70% alcohol)	21	-	-	-
Mixed with water (80% alcohol)	20	-	-	-
Mixed with water (95% alcohol)	17	-	-	-
m-or p-Cresol	86	555	1,1(à150°C)	-
Morpholine	37 O.D.	290	1,4	11,2
m-Xylene	27	525	1,1	7
N,N-Diethylaniline	85	630	-	-
N,N-Dimethylaniline	62	370	-	-
N,N-Dimethylformamide	57	445	2,2(à 100°C)	15,2
Naphtalene	78	525	0,9	5,9
n-butyl acetate	22	420	1,7	7,6
N-butyle formate	17	320	1,7	8,2
n-Decane	46	205	0,8	5,4
n-Heptane	-5	204	1,05	6,7
n-Hexane	-22	223	1,2	7,4
Nicotine	-	240	0,7	4
Nitrobenzene	87	480	1,8(à 93°C)	-
Nitroethane	27	414	3,4	-
Nitromethane	35	415	7,3	-
Nonane	31	205	0,8	2,9
n-pentyl acetate	16	360	1,1	7,5
n-propyl acetate	13	450	1,7(à 100°C)	8
N-propyl formate	-3	455	-	-
N-propyl nitrate	20	175	2	100
o-Cresol	81	595	1,4(à149°C)	-
Octane	13	206	1	6,5
Octyl acetate	71	268	0,7	8
Olive (oil)	225	340	-	-
o-Toluidine	85	480	-	-
o-Xylene	32	460	1	7

Substances	Flash point in °C	Self-ignition temperature in °C	Inflammability limits by volume % mixed with air	
			Lower	Upper
Paraformaldehyde	70	300	7	73
Peanut oil	282	445	-	-
Pentaboron			0,4	-
Pentane	<- 40	260	1,5	7,8
Pentanol	12 O.D.	222	-	-
Pentylamine	-1	-	2,2	22
Petrol (octane number 100)	-38	456	1,4	7,4
Petrol (octane number 115 à 145)	-46	440	1,2	7,1
Petrol (octane number 50 à 60)	-43	280	1,4	7,6
Petrol A	< 0	230-240	1	6,5
Petrol B	< 0	245	1	6,5
Petrol C	< 0	230-260	1	6,5
Petrol E	< 0	230-260	1	6,5
Petrol F	< 0	230-260	1	6,5
Petrol G (ether petrol)	< 0	245	1	6,5
Petrol H	< 0	230-260	1	6,5
Phenol	79	715	1,8	-
Phenylhydrazine	88	-	-	-
Phosphoru trihydride	gaz	100	2	-
Phtalic anhydride	151	570	1,7	10,5
Pinane	-	273	0,7(à 160°C)	7,2(à 160°C)
Piperidine	16	-	-	-
p-Isopropyltoluene	47	435	0,7(à 100°C)	5,6
Propane	gaz	450	2,2	10
Propanol	-30	205	2,6	17
Propene	gaz	455	2	11,1
Propionic acid	52	465	2,9	12,1
Propionic anhydride	63	285	1,3	9,5
Propionyl chloride	12	-	-	-
Propylamine	-37	315	2	10,4
Propylbenzene	30	450	0,8	6
Propylene oxide	-37	449	2,3	37
p-Xylene	27	525	1,1	7
Pyridine	20	480	1,8	12,4
Silane	gaz			
Soya (Oil)	280	440	-	-
Stéaric acid	196	395	-	-
Styrene	31	490	1,1	7
Tartric acid	210 O.D.	425	-	-
Tetradecane	100	200	0,5	-
Tetrahydrofuranne	-14	320	2	11,8
Tetrahydronaphtalene	71	380	0,8(à 100°C)	5(à 150°C)
Tetrahydropyranne	-20	-	-	-
Tetramethylpentane	< 21	430	0,8	4,9
Toluene	4	480	1,2	7,1
Tributyl Phosphate	146 O.D.	-	-	-
Tributylamine	86 O.D.	-	-	-
Trichloroethylene	diff. infl.	410	8(à 25°C)	10,5(à 25°C)
Triethylamine	- 7 O.D.	249	1,2	8
Triethyleneglycol	176 O.D.	370	0,9	9,2
Trimethylamine	gaz	190	2	11,6
Tri-o-tolyl phosphate	225	385	-	-
Tripentylbenzene	132 O.D.	-	-	-
Triphenyl phosphate	220	-	-	-
Tripropylamine	40	-	-	-
Turpentine	35	250	0,8	-
Vinyl acetate	-8	402	2,6	13,4
Vinyl butyrate	20 O.D.	-	1,4	8,8
Vinyl chloride	gaz	470	3,6	33
Vinyl propionate	1 O.D.	-	-	-
White-spirit	30-65	230-260	1,1	6,5

continuation> Gas substances likely to form explosive atmospheres

Substances	Flash point in °C	Self-ignition temperature in °C	Inflammibility limits by volume % mixed with air	
			Lower	Upper
Acrylic acid	49 O.D.	438	2,4	8
Acrylonitrile	0 O.D.	480	3	17
Adipic acid	196	420	-	-
Allyl and vinyl oxide	< 20 O.D.	-	-	-
Ammonia	gaz	650 (*)	15	28
Aniline	70	615	1,3	11
Anthracene	121	540	0,6	-
Anthraquinone	185	-	-	-
a-Pinene	32	255	-	-
Benzaldehyde	63	190	-	-
Benzene	-11	498	1,3	7,9
Benzoic acid	121	570	-	-
Benzoyl chloride	72	-	-	-
Benzyl acetate	90	460	-	-
Benzyl chloride	67	585	1,1	-
Biphenyl	112	540	0,6(à 111°C)	5,8(à 155°C)
Bis (2-hydroxyethyl) oxide	123	224	-	-
Bromobenzene	51	565	-	-
Bromomethane	diffic. inflam.	510	6,7	11
Butane	gaz	287	1,8	8,4
Butyl and vinyl oxide	- 9 O.D.	255	-	-
Butylamine	-12	310	1,7	9,8
Butylbenzene	71 O.D.	410	0,8	5,8
Butyraldehyde	-22	218	1,9	12,5
Butyric acid	72	443	2	10
Camphor (oil)	47	-	-	-
Carbon disulphide	-30	90	1,3	50
Carbon oxide	gaz	605	12,5	74
Carbon oxysulphide	gaz	-	12	29
Castor (Oil)	229	445	-	-
Chlorobenzene	28	593	1,3	9,6
Chlorodinitrobenzene	194	-	2	22
Chloroethane	-50	515	3,8	15,4
Chloromethane	gaz (- 50)	630	8,1	17,4
Crotonaldehyde	12	230	2,1	15,5
Crotonic acid	87 O.D.	396	-	-
Cumene	36	424	0,9	6,5
Cyanogene	gaz	-	6,6	32
Cyclohexane	-20	245	1,3	8
Cyclohexanol	67	300	-	-
Cyclohexanone	43	420	1,1(à100°C)	9,4
Cyclohexene	< - 7	244	-	-
Cyclohexyl acetate	57	330	-	-
Cyclohexylamine	31	290	-	-
Cyclopentane	< - 7	361	1,5	-
Cyclopentanone	26	-	-	-
Cyclopropane	gaz	495	2,4	10,4
Decahydronaphtalene	57	250	0,7(à100°C)	4,9(à100°C)
Deuterium	gaz	-	5	75
Di (2-ethylhexyl) phtalate	215 O.D.	390	0,3(à 245°C)	-
Diallyl oxide	- 7 O.D.	-	-	-
Dibutyl oxidee	25	194	1,5	7,6
Dibutyl phtalate	157	400	0,5(à 235°C)	-
Dibutyl Sebacate	178 O.D.	365	0,4(à 243°C)	-
Dichlorine oxide	gaz	-	23,5	100
Dichloromethane	diffic. inflam.	556	13	22
Diesel Fuel	70-120	250-280	0,6	-
Diethyl oxide	-45	160	1,9	3
Diethyl phtalate	163 O.D.	-	-	-
Diethylacetaldehyde	21 O.D.	-	1,2	7,7
Diethylamine	-23	310	1,8	10,1
Diethylcyclohexane	48	240	0,8(à 60°C)	6(à110°C)

Substances	Flash point in °C	self-ignition temperature in °C	Inflammability limits by volume % mixed with air	
			Lower	Upper
Diisopropylbenzene	76 O.D.	445	0,9	5,6
Dimethoxymethane	- 32 O.D.	235	2,2	13,8
Dimethyl phtalate	146	490	0,9(à 180°C)	-
Dimethyl sulphide	<- 18	205	2,2	19,7
Dimethylamine	gaz	400	2,8	14,4
Dimethylsulfoxyde	95 O.D.	215	2,6	42
Dimthyl oxide	gaz	350	3,4	27
Dipentyl oxide	57	170	-	-
Diphenyl oxide	112	615	0,8	1,5
Diphenylamine	152	630	-	-
Diphenylmethane	130	485	-	-
Dipropyl oxide	21	188	1,3	7
Dipropylamine	17 O.D.	299	-	-
Disopropyl oxide	-28	440	1,4	7,9
Disulphur Dichloride	118	230	-	-
Divinyl oxide	<- 30	360	1,7	27
Divinylbenzene	76 O.D.	-	1,1	6,2
Dodecane	73	203	0,6	-
Ethane	gaz	472	3	12,5
Ethanethiol	<- 18	295	2,8	18
Ethanol	12	363	3,3	19
Ethyl acetate	-4	425	2	11,5
Ethyl acrylate	9	372	1,4	14
Ethyl and Methyl oxide	-37	190	2	10,1
Ethyl and propenyl oxide	<- 7 O.D.	-	-	-
Ethyl and Vinyl oxide	<- 46	200	1,7	28
Ethyl butyrate	24	460	-	-
Ethyl formate	-20	455	2,8	16
Ethyl lactate	46	400	1,5(à 100°C)	-
Ethyl nitrite	-35	90(décomp.)	4	50
Ethyl propionate	12	440	1,9	11
Ethylamine	<- 18	380	3,5	14
Ethylbenzene	15	430	1	6,7
Ethylcyclobutane	<- 16	210	1,2	7,7
Ethylcyclohexane	35	238	0,9	6,6
Ethylcyclopentane	< 21	260	1,1	6,7
Ethylene	gaz	450	2,7	36
Ethylene oxide	- 17,8 O.D.	425	3	100
Ethyleneglycol	111	398	3,2	28
Formaldehyde	gaz	424	7	73
Formamide	154 O.D.	-	-	-
Formic acid	46,5	480	14,3	34
Fuels distilling between :				
Furane	< 0	-	2,3	14,3
Furfurylic alcohol	65	490	1,8	16,3
Hexanoïc acid	101	380	-	-
Hydrazine	38	23-270(*)	2,9	100
Hydrogen	gaz	500	4	75
Hydrogen cyanide	-17	535	6	41
Hydrogen sulphide	gaz	260	4	44
Isobutane	gaz	460	1,8	9,8
Isobutanol	27	415	1,7(à 51°C)	10,6(à 94°C)
Isobutyl acetate	17	420	1,3	10,5
Isobutylamine	-9	375	-	-
Isobutylbenzene	55	425	0,8	6
Isopentanol	42	345	1,2	9(à 100°C)
Isopentyl acetate	25	360	1 (à 100°C)	7,5
Isopropyl acetate	2	460	1,8	8
Isopropyl and vinyl oxide	-32	270	-	-
Isopropyl formate	-6	485	-	-
Isopropylamine	- 37 O.D.	400	-	-
Jet engine fuel JP1 (TRO)	38	255	0,67	4,96

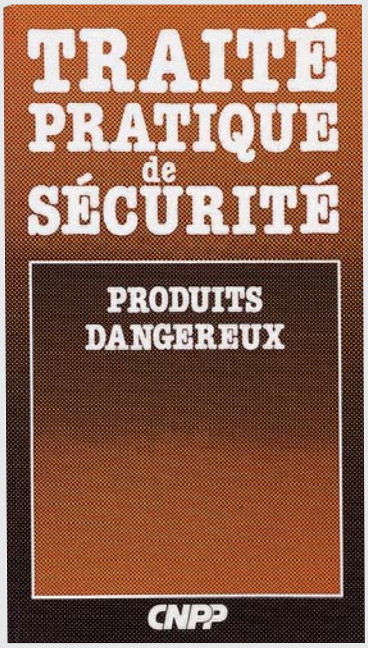
Substances	Flash point in °C	Self-ignition temperature in °C	Inflammability limits by volume % mixed with air	
			Lower	Upper
1 - Bromobutane	18	265	0,6(à 111°C)	5,8(à 155°C)
1 - Bromopentane	32	-	-	-
1 - Butanol	29	343	1,4	11,2
1 - Butene	gaz	380	1,6	10
1,1,1-Trichloroethane	diff. infl.	537	7,5	12,5
1,1-Dichloroethane	-6	-	5,6	-
1,1-Dichloroethylene	-28	565	6,5	15,5
1,1-Diethoxyethane	-21	230	1,6	10,4
1,1-Dimethylhydrazine	-15	249	2	95
1,2,3-Propanetriol	199	370	-	-
1,2,4-Trichlorobenzene	105	571	2,5(à 150°C)	6,6(à 150°C)
1,2,4-Trimethylbenzene	44	500	0,9	6,4
1,2-Diaminopropane	33 O.D.	416	-	-
1,2-Dichlorobenzene	66	645	2,2	9,2
1,2-Dichloroethane	13	410	6,2	16
1,2-Dichloroethylene	2	460	5,6	12,8
1,2-Dichloropropane	15	555	3,4	14,5
1,2-Propanediol	98	370	2,6	12,5
1,3 - Benzenediol	127	608	1,4(à 200°C)	-
1,3 - Butadiene	gaz	420	2	12
1,3,5-Trioxan	45 O.D.	414	3,6	29
1,3-Diaminopropane	24 O.D.	-	-	-
1,3-Dioxolanne	1 O.D.	-	-	-
1,4 - Benzenediol	165	515	-	-
1,4-Dichlorobenzene	65	-	-	-
1,4-Dioxanne	12	180	2	22
175°C and 275°C	> 70	254	0,58	4,45
185°C and 330°C	> 70	259	0,52	4,09
1-Chloro-1,2,2--trifluoroethylene	gaz	-	8,4	16
1-Chloro-2 methylpropane	< 21	-	2	8,8
1-Chloro-2,3-epoxypropane	31 O.D.	411	3,8	21
1-Chloro-4 nitrobenzene	127	-	-	-
1-Chlorobutane	-9	240	1,8	10,1
1-Chloropentane	12,8 O.D.	260	1,6	8,6
1-Chloropropane	<- 18	520	2,6	11,1
1-Chloropropene	<- 6	-	4,5	16
1-Hexene	<- 7	253	-	-
1-Naphtylamine	157	-	-	-
1-Nitropropane	36	420	2,2	-
1-Octene	21 O.D.	230	-	-
1-one	84	460	0,8	3,8
1-Pentanol	32	300	1,2	10 (à 100°C)
1-Pentene	- 18 O.D.	275	1,5	8,7
1-Phenylethanone	77	570	-	-
1-Propanol	15	370	2,1	13,5
2 - Aminoethanol	85	410	-	-
2 - Butanone	-9	404	1,4(à93°C)	11,4(à93°C)
2 - Butene	gaz	320	1,7	9
2 - Butene-1-ol	27	349	4,2	35,3
2,2',2"-Nitrilotriethanol	196	-	-	-
2,2,4-Trimethylpentane	-12	415	1,1	6
2,2,5-Trimethylhexane	13 O.D.	-	-	-
2,2-Dimethylbutane	-47	405	1,2	7
2,2-Dimethylpropane	gaz	450	1,4	7,5
2,2'-Iminodiethanol	172 O.D.	660	-	-
2,3-Dimethylbutane	-29	405	1,2	7
2,3-Dimethylhexane	7 O.D.	435	-	-
2,3-Dimethylpentane	< - 7	335	1,1	6,7
2,4- Toluylene diisocyanate	127	-	0,9	9,5
2,4,4-Trimethyl-1-pentene	-5	390	0,8	4,8
2,4,4-Trimethyl-2-pentene	2 O.D.	305	-	-
2,4,6-Trimethyl-1,3,5-trioxanne	35	235	1,3	-

Classified on first number

Substances	Flash Point in °C	Self-ignition temperature in °C	Inflammability limits by volume % mixed with air	
			Lower	Upper
2,4-Dimethylhexane	10 O.D.	-	-	-
2,4-Dimethylpentane	-12	-	-	-
2,4-Pentanedione	33	340	-	-
2,5-heptadièee-4-one	85 O.D.	-	-	-
2,5-Hexanedione	78	499	-	-
2,6-Dimethyl-4-heptanol	74	-	0,8(à 100°C)	6,1(à 100°C)
2,6-Dimethyl-4-heptanone	49	396	0,8(à 93°C)	7,1(à 93°C)
210°C and 365°C	> 70	263	0,45	3,71
2-Chloro-1,1-dimethoxyethane	43	232	-	-
2-Chloro-1,3-butadiene	-20	-	4	20
2-Chloro-2-butene	-19	-	2,3	9,3
2-Chloroethanol	60	425	4,9	15,9
2-Chlorophenol	64	-	-	-
2-Chloropropane	-32	590	2,8	10,7
2-Ethoxyethanol	43	235	1,7(à 93°C)	15,6(à 93°C)
2-éthoxyéthyle acetate	47	380	1,7	-
2-Furaldehyde	60	315	2,1	19,3
2-Hexanone	25	423	-	8
2-hydroxybenzoïc acid	157	540	1,1(à 200°C)	-
2-Methyl-1,3-butadiene	-54	395	1,5	8,9
2-Methyl-1-pentanal	20 O.D.	-	-	-
2-Methylacrylaldehyde	1 O.D.	-	-	-
2-Methylbutane	<- 51	420	1,4	7,6
2-Methylfuranne	-30	-	-	-
2-Methylhexane	<- 18	-	1	6
2-Methylpentane	<- 29	264	1	7
2-Methylpropanal	-18	196	1,6	10,6
2-Methylpropene	gaz	465	1,8	9,6
2-Methylpyridine	38 O.D.	535	-	-
2-Naphtol	152	-	-	-
2-Nitropropane	24	428	2,6	11
2-Octanone	52	-	-	-
2-Pentanone	7	452	1,5	8,2
2-Phenylpropene	58	489	0,7	11
2-Propanol	11	395	2	12
2-Propene-1-ol	21	375	2,5	18
2-Propenylamine	-29	370	2,2	22
3 - Bromo - 1 - propène	-1	295	4	7,3
3 - Butene-2-one	-7	491	2,1	15,6
3,6-Diazaoctane-1,8-diamine	135	335	-	-
3-Azapentane-1,5-diamine	98	358	2	6,7
3-Chloropropene	-32	485	2,9	11,1
3-Hexanone	35 O.D.	-	~1	~8
3-Methyl-1-butene	<- 7	365	1,5	9,1
3-Pentanone	12	450	1,6	-
4-Heptanone	49	-	-	-
4-Hydroxy-4-methyl-2-pentanone	64	600	1,8	6,9
4-Methyl-1,3-pentadiene	-34	-	-	-
4-Methyl-2-pentanol	41	-	1	5,5
4-Methyl-2-pentanone	16	448	1,2(à 93°C)	8(à 93°C)
4-Methylpyridine	56 O.D.	-	-	-
4-Nitrotoluene	106	-	-	-
Acetaldehyde	-37	175	4	60
Acetanilide	169 O.D.	530	-	-
Acétic acid	39	463	4	20
Acetic anhydride	49	315	2,7	10,3
Acetone	-20	465	2,6	13
Acetonitrile	2	520	3	16
Acetyle chloride	4	390	-	-
Acetylene	gaz	300	2,5	81
Acrolein	-26	220	2,8	31

Classified on first letter

Gas substances likely to form explosive atmospheres



TRAITÉ
PRATIQUE
de
SÉCURITÉ

PRODUITS
DANGEREUX

CNPP

Being re-printed. Volume 1 : Gas, vapours ; Volume 2 : Dusts - First half of year 2003

ATX advice

Following informations are given just as an example to explain the French rules on those subjects : please identify in your country the equivalent and remember, if there is no rule, that gaz, vapour and dust have no nationality: the way to explose or protect yourselves are the same everywhere.

It is important to be familiar with inflammability characteristics of substances that could form explosive atmospheres - this includes the flash point and self-ignition temperature in °C for gases, self-ignition temperature in layers or in clouds for dust. Furthermore, the practical safety guide published by the CNPP contains lists of all data sheets for dangerous products.

The table opposite indicates the flash points, the self- ignition temperatures and the inflammability limits in the air of the usual gas and vapours.

Gas and vapour inflammability characteristics (limits of concentration, flash points, inflammation temperatures) differ depending on the method used to determine them. Therefore, slightly different values (flash points, inflammability limits) or significantly different values (inflammation temperatures) may be found in other sources.

Flash points were determined in a closed dish, unless mentioned otherwise (open dish “O.D.“).

butyl acetate, amyl acetate, butanol and ethylene oxide.

Knowing that the most dangerous gas is the gas with the lowest ignition temperature, in this case butanol (343°), we can deduce that the electrical equipment installed on this site must be kept at a temperature below 343°, and therefore should be in class T2, T3, T4, T5 or T6.

The most explosive gas is ethylene oxide (subdivision B). The installed electrical equipment should be at least class II or IIB.

A																	B			C		
Hexane	**Ammoniac**	**Carbon monoxide**	**Pentane**	**Heptane**	**Iso-octane**	**Decane**	**Benzene**	**Xylene**	**Cyclohexane**	**Ethyl/Methyl ketone**	**Methyl acetate**	**n-propyl acetate**	**n-butyl acetate**	**Amyl acetate**	**Butanol**	**Ethyle nitrate**	**Ethylene**	**Butadene 1.3**	**Ethylene oxide**	**Hydrogen**	**Carbon disulphide**	**Acetylene**
223°C	650°C	605°C	260°C	204°C	530°C	205°C	498°C	460°C	245°C	510°C	454°C	450°C	420°C	360°C	343°C	90°C	450°C	420°C	425°C	500°C	90°C	300°C
							●	●	●	●	●						●					
												●	●			●				●		
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Classification of equipment for gas and vapour environment

The various regulations have taken into account a certain number of the most widely used gases.

The following table can be used to determine gases which may be present, their subdivision and self-ignition temperature, for each type of site. The classification of the equipment to be used can thus be determined.

Note : Temperatures in this table are given in °C. Gas mixtures are given for information only.

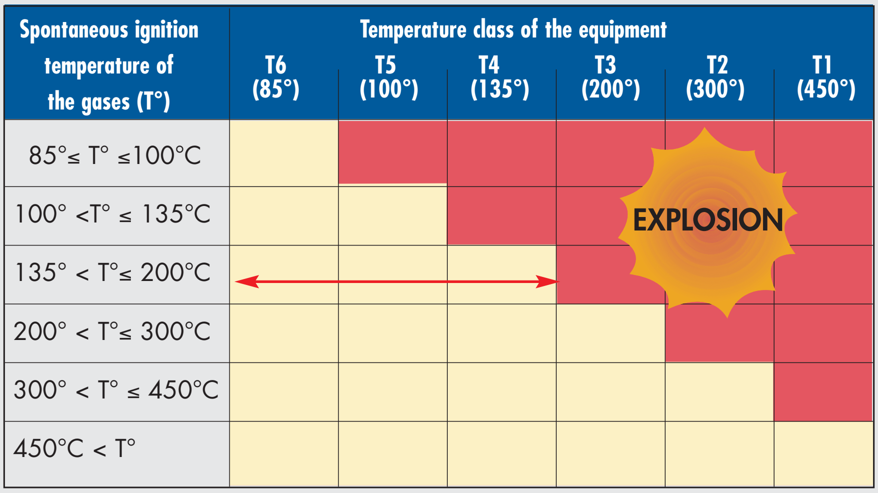
- See page 30 list of substances likely to create an explosive atmosphere .

How to read this table ?

Consider the example of a varnish making workshop. Dots in the following table indicate the presence of acetone, ethyl acetate, benzene, ethyl/methyl ketone, methyl acetate, n-

SUBDIVISIONS				**A**					
APPLICATION AREA OF THE SITE (1)	**GAS AND VAPOURS** (with self-ignition temperature, according, to the IRNS document)			**Acetone**	**Industrial methane**	**Ethyl acetate**	**Methanol**	**Butane**	**Propane**
				465°C	**535°C**	**425°C**	**385°C**	**287°C**	**450°C**
	Self-ignition temperature of the site	Subdivision							
Cleaning product industry	245°C	II or II B	T3	●		●			
Pharmaceutical industry	90°C	II or II C	T6		●	●	●		
Dye industry	385°C	II or II A	T2		●		●		
Artificial rubber industry	300°C	II or II C	T3		●	●			
Perfumery	375°C	II or II A	T2	●		●	●		
Spirits	375°C	II or II A	T2				●		
Artificial fruit flavourings	90°C	II or II A	T6			●			
Artificial textile manufacture	90°C	II or II C	T6			●			
Paint manufacture	343°C	II or II B	T2	●		●			
Varnish manufacture	343°C	II or II B	T2	●		●			
Grease solvent	465°C	II or II A	T1	●					
Resin solvent	343°C	II or II A	T2	●			●		
Plastic manufacture	300°C	II or II C	T3	●	●				
Hydrocarbons	90°C	II or II C	T6		●			●	●
Gas used as a fuel	300°C	II or II C	T3		●		●	●	●
Fertiliser manufacture	500°C	II or II C	T2						

TEMPERATURE CLASS OF THE EQUIPMENT



Spontaneous ignition temperature of the gases (T°)	Temperature class of the equipment					
	T6 (85°)	T5 (100°)	T4 (135°)	T3 (200°)	T2 (300°)	T1 (450°)
85°≤ T° ≤100°C	🟨	🟥	🟥	🟥	🟥	🟥
100° <T° ≤ 135°C	🟨	🟨	🟥	🟥	🟥	🟥
135° < T°≤ 200°C	🟨	🟨	🟨	🟥	🟥	🟥
200° < T°≤ 300°C	🟨	🟨	🟨	🟨	🟥	🟥
300° < T° ≤ 450°C	🟨	🟨	🟨	🟨	🟨	🟥
450°C < T°	🟨	🟨	🟨	🟨	🟨	🟨

🟥 *Danger : explosion* 🟨 *Equipment which can be used.*

Acetaldehyde spontaneous ignition temperature 175°C ↔ *Class of equipment which can be used : T4, T5 or T6.*

Which temperature class should be used ?

According to the spontaneous ignition temperature of the gases, this table indicates the temperature class of the equipment which can be used (see page 31).

- The temperature class of the equipment must always be lower than the spontaneous ignition temperature of the gases.
- Equipment must never be used in an atmosphere capable of ignition at the temperature indicated on the marking (temperature class).

Selection of equipment for gas and vapour environment

Criteria of selection of equipment

The criteria of selection are the following :

- Gas and vapours classification.
- Protection indexes
- Protection modes.
- Industrial environment(corrosion).

The 2 tables below indicate the equipment groups which can be used depending on the gas and vapour subdivision.

ELECTRICAL EQUIPMENT WHICH CAN BE USED

Gas-vapour subdivision	Equipment groups which can be used		
	increased safety « e »	flameproof « d »	Associated Protection modes « d » + « e »
A	II	IIA - IIB - IIC	IIA - IIB - IIC
B	II	IIB - IIC	IIB - IIC
C	II	IIC	IIC

Which equipment group should be chosen ?

This table indicates the equipment groups which can be used depending on the gas and vapour classification (see page 28).

A distinction is made between two groups of electrical equipment :

Group I

- electrical equipment intended for underground work in mines with explosive atmospheres

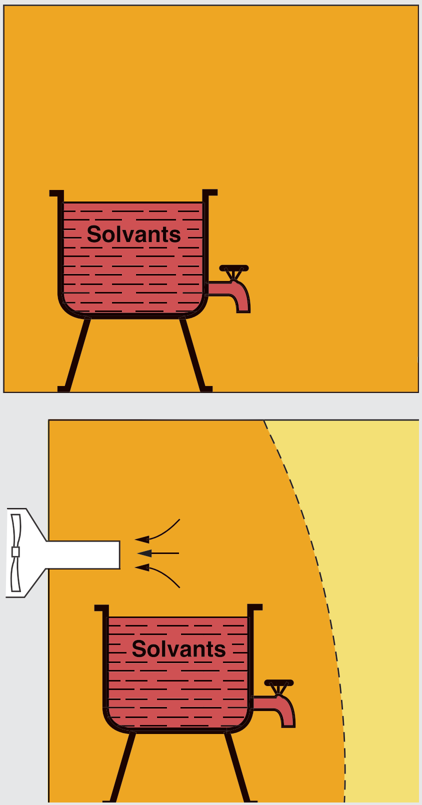
Group II

- electrical equipment designed for surface industry.

🟥 **ZONE 0** 🟧 **ZONE 1** 🟨 **ZONE 2** ☐ **Non- hazardous ZONE**

Definition of zones : see page 18

BEFORE AND AFTER PROTECTION



A zone 1 classified workshop becomes zone 1 (in part) and zone 2 (for the remainder) by installing a suction device at source.

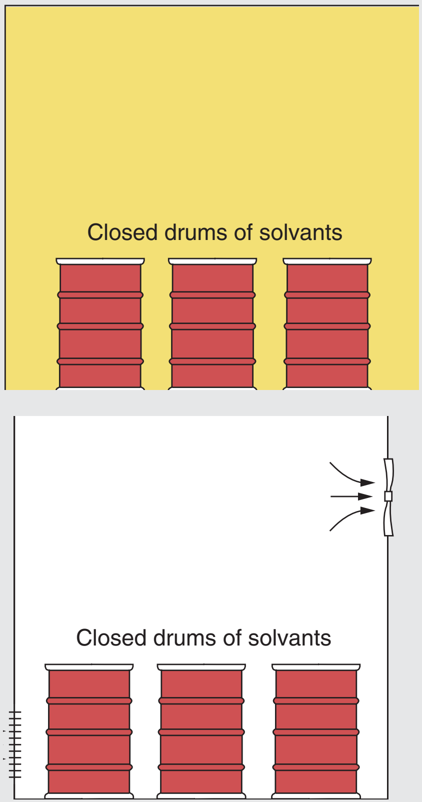
Protection by suction at source

The creation of a localised depression by means of ducting diverts the inflammable gases and vapours to a zone carrying no risk of explosion when in operation.

This type of protection is essentially used in workshops where there are few discharge points.

Inside the suction zone safety type electrical equipment should be used.

BEFORE AND AFTER PROTECTION



A zone 2 classified warehouse can become a non hazardous zone by installing a very good quality general forced ventilation system.

Protection by general suction

The inflammable gas and vapour content is maintained at a level below that of the lower explosive limit in a large zone by a general suction device.

This type of protection is very delicate to operate because hazardous concentrations of inflammable gases and vapours generally remain at their point of discharge and in dead zones.

Protection by under-pressure

The diffusion of inflammable gases or vapours outside an enclosure is prevented by the maintenance therein of a pressure lower than that of the surrounding zone.

The surrounding zone, which is not hazardous, can also contain without risk conventional electrical equipment or any other inflammable sources.

Protection by continuous dilution

The inflammable gas and vapour content is reduced to a value below that of the lower explosive limit(1) by adding a protective gas which is continuously fed into the required zone. The protective gas is, in general, air.

* Switch-off threshold set at 25% of the L.E.L. if personnel are absent and at 10% if personnel are present.

ATX advice

- What should be done in order to prevent if possible failure in one of the types of protection ?

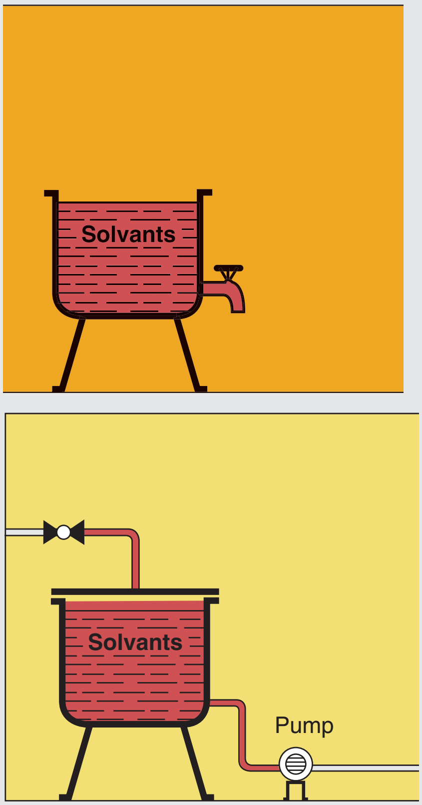
These types of protection use equipment that is often very complex (inerting, over-pressure, suction devices, etc), which could malfunction. If a malfunction occurs, the room reverts to its initial classification.

It is therefore necessary, for each device, to define additional safety measures to be taken, to guarantee, in the event of failure, the safety of workers.

For example : the disruption of energy sources (such as electricity, water, inert gas, etc) can cause a failure in the mode of protection. It is therefore necessary to study the room from the start, to provide for built-in backup energy circuits to ensure total safety.

continuation> Example of French regulation for liquid hydrocarbon storage

BEFORE AND AFTER PROTECTION



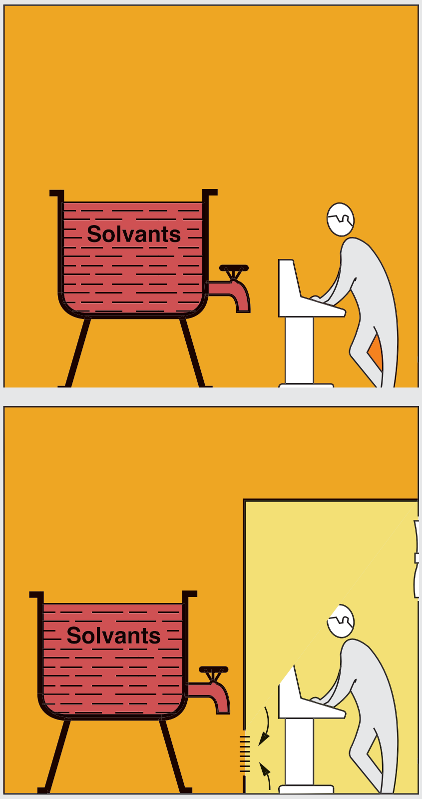
The workshop classified as zone 1 becomes zone 2 by installing a closed circuit process : using a closed tank supplying reagents and emptying the finished product via piping.

Protection by closed circuit operation

When this method can be used it is the safest way to limit risks. The explosive atmosphere is confined to the interior of one or several storage receptacles.

The electrical equipment can easily be installed outside.

BEFORE AND AFTER PROTECTION



The control station of a workshop classified as zone 1 can be derated to zone 2 by installing an over-pressure cubicle.

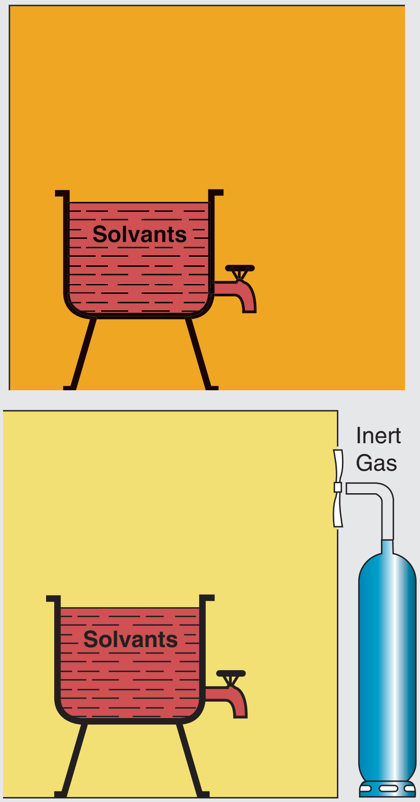
Protection by over-pressure

The entry of inflammable gases or vapours into an enclosure containing ordinary electrical equipment or any other ignition source, is prevented by maintaining, in this enclosure, a gas pressure (usually air) higher than the pressure outside (e.g. in the control room).

Over-pressure may be static after the initial sweep, the apertures in the enclosure are closed and the air flow provides simple counteraction to natural leaks.

Over-pressure may also be of a dynamic nature : an air-flow is deliberately created across apertures of a chosen cross-section.

BEFORE AND AFTER PROTECTION



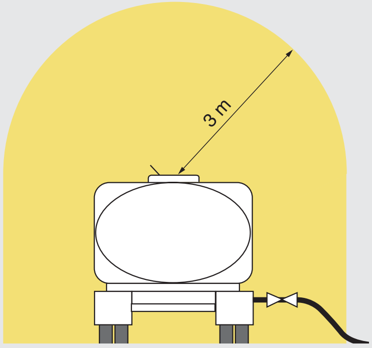
The workshop becomes zone 2 by introducing an inert gas which prevents the formation of an explosive atmosphere.

Protection by inert gas

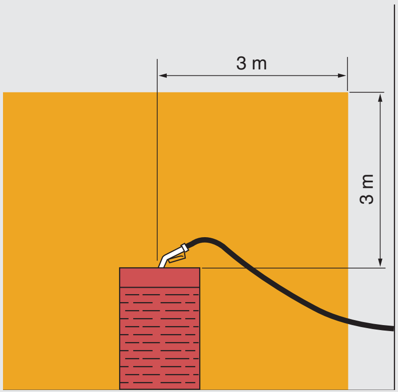
By adding an inert gas, the oxygen content of the air in an enclosure is reduced to such a weak value that the atmosphere would no longer be explosive, whatever the concentration of inflammable gases and vapours.

The inert gas generally used is nitrogen, but carbon dioxide is used on some occasions.

Typical guide for liquid hydrocarbon storage



Tanker truck unloading station.



Mobile tank filling device

Compulsory protection measures

The risk of explosion must be safe guarded by the concurrent use of specific protection measures :

. Internal overpressure in the room,
. Continuous dilution,
. Intake at the source.

The latter two measures are only possible when the maximum discharge flow is known accurately.

Measures must be taken to compensate for a possible failure in the particular measures used:

. Light and/or sound alarm,
. Measures necessary to repair and restart the protection device as quickly as possible
. Automatic power off device controlled by :
- a tester that checks that overpressure, dilution or ventilation devices are working correctly,
- or an atmosphere tester (fixed explosion meter with continuous operation) that switches power off at a control threshold set to 25% of the LEL (lower explosive limit) if no personnel are present and 10% of the LEL if there are personnel present.

ATX advice

The additionnal measures are difficult and expensive, so that Zone 1 equipment is frequently used over entire sites.

This equipment covers explosion risks at all times, regardless of uncontrollable environmental variations.

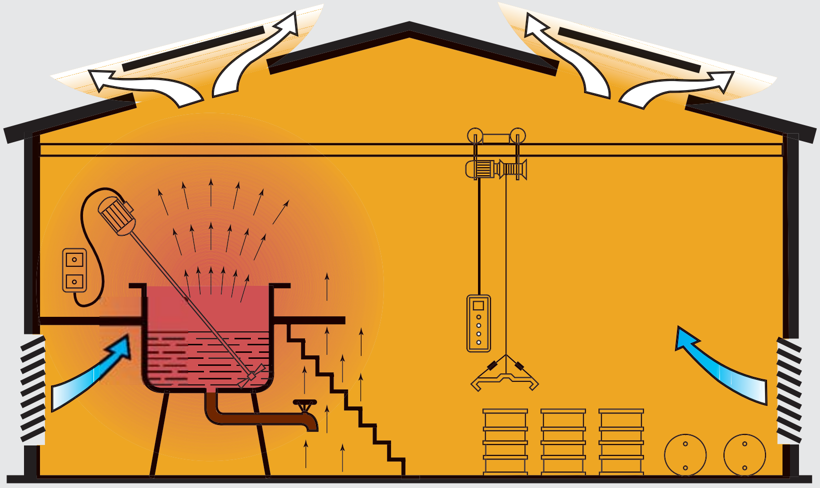
This position was adapted by same significate oil companies

Illustration of gas and vapour environment

Modifications of zones related to appropriate equipment

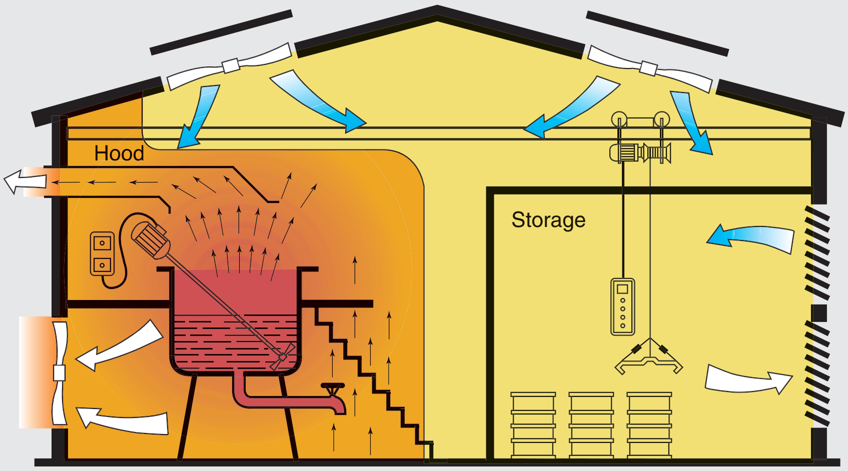
Example 1

- The mixing tank is in the open air.
- The room is not ventilated mechanically.
- The products are always present in the workshop.
- All operations are manual.



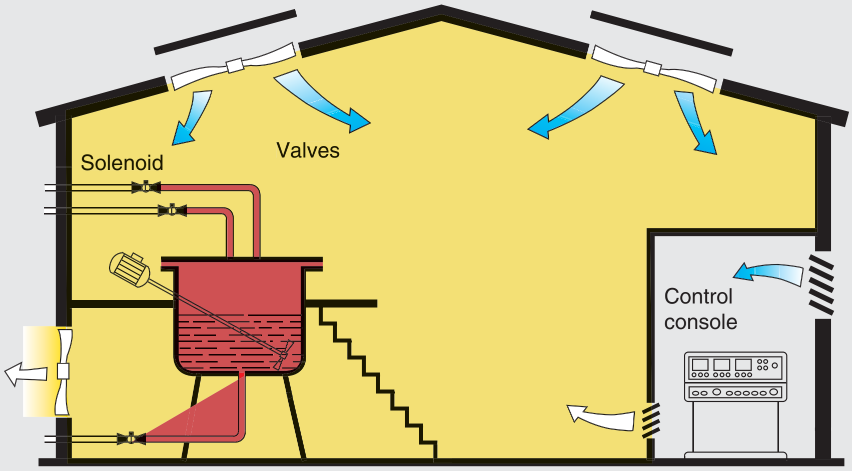
Example 2

- A hood has been fitted above the tank.
- The room is ventilated.
- The products in stock are separated from the rest of the workshop
- part of the work is manual.



Example 3

- The tank is closed off.
- The room is ventilated mechanically
- The products are stored outside.
- All operations are controlled via a console outside the zone.
  The only risk that remains is when the tank is opened for inspection or maintenance.



SUMMARY TABLE FOR GAS AND VAPOURS

The table below corresponds to IEC standard 60 079.10 which can determine the type of zone according to three criteria : the release emission level, the ventilation level and the ventilation availability.

Release emission level	Ventilation level						
	Weak	Average			High		
	Ventilation availability						
	Good or Very good	Poor	Poor Good	Very good	Poor	Good	Very good
Continuous	Zone 0	Zone 0 + Zone 1	Zone 0 + Zone 2	Zone 0	Zone 1	Zone 2	Zone 0 (NE)* non hazardous
First	Zone 0 or Zone 1	Zone 1 + Zone 2	Zone 1 + Zone 2	Zone 1	Zone 2	Zone 2	Zone 1 (NE)* non hazardous
Second	Zone 0 and Zone 1	Zone 2	Zone 2	Zone 2	Zone 2	Non hazardous	Zone 2 (NE)* non hazardous

🟧 🟨 *Zones in which "e" increased safety (page 48) or flameproof "d" (page 46) material can be installed .*
** NE = negligible extent*

ATX advice for installing electrical equipment in areas with explosion risks

Process for installing electrical equipment in areas with explosion risks.
The manager of the installation is solely responsible for (March 31, 1980 regulation for France) :
1- Determining hazardous areas (see p. 18).
2- Defining zone boundaries - volumes (see p. 19-20).
3- If necessary, delimiting zones (see page 21 above).
4- Knowing the characteristics of flammable substances present on the site (see p. 31 and 38).
5- Defining the tempeature class and the explosion group of the equipment
(see p. 31 and 38).
6- Choosing equipment depending on :
. the temperature class and the explosion group (see p. 26 and 39),
. environmental constraints specific to the site - corrosion, exposure to UV, mechanical strength (see p. 59),
. protection indexes (see p. 42).
7- Installing equipment (see p. 56).
8- Starting up.
9- Checking the installation (see p. 66).

4- What level is the ventilation ?

Evaluation of the ventilation level requires a knowledge of the maximum gas or vapour release rate at the release source, either by controlled tests, by calculation, or by established hypotheses.

There are three levels of ventilation :

High

Ventilation reduces the concentration at the release source and reduces it to a level below the LEL value (lower explosive limit).

Average

Ventilation controls the concentration, leading to a stable situation.

Weak

Ventilation cannot control the concentration during release and/or cannot prevent the explosive atmosphere continuing after release is over.

ATX advice for designing a ventilation system

Here are the important points to remember for designing a ventilation system * :

- Air for ventilation should be taken from a non hazardous area.

- Artificial ventilation should be controlled and monitored.

-As gases and vapours often have different densities to that of air, they have a tendency to accumulate where air movement is likely to be reduced.

- Obstacles can reduce the movement of air. Therefore the «topography» of geographical locations should be taken into account (inside and/or outside).

* See standards IEC 60 079.10

Frontiers between zones

These zones are geographic, but the frontiers between them are never precisely determined, because a zone can move for several reasons : product warm-up, faulty ventilation of the room, climate variations, handling mistake, air movement.

1- What is the emission level of my release source ?

These are the emission points of inflammable substances into the atmosphere.

Three levels of release source can be distinguished :

1- Continuous emission level.
The release source is the surface of an inflammable liquid :
. in an enclosed receptacle
. in an open receptacle
. inside enclosed manufacturing or mixing equipment.

2- First level emission.
Release during normal operation. The main release sources are the following :
. open manufacturing or mixing equipment,
. vents on enclosed receptacles,
. hydraulic guard venting holes,
. extremities of articulated loading arms for tankers and containers,
. apparatus loading bungs and emptying valves,
. sampling and venting valves,
. pump and compressor gaskets, where leaks persist (example: cable gland operating leaks),
. non-watertight switches and conduits

3- Second level emission.
Release during abnormal operation. The main release sources are the following :
- flanges, connections, vents and pipe joints,
. glass inspection holes or level indicators,
. - gaskets in pumps or compressors, designed to prevent leaks,
- fragile apparatus such as glass, ceramic, graphite, etc...,
- breathing holes in pressure reduction valve membranes,
- retaining sumps.

2- What type of opening do I have?

All openings (doors, windows, ventilation outlets, etc) between two geographical locations should be considered as possible release sources.

The release level depends on the following :
. the type of zone of the adjoining geographical area,
. the frequency and duration of opening,
. the pressure difference between the geographical areas,
. the effectiveness of the gaskets or joints.

There are 4 types of opening :

1- Type A openings.
. Open passages : conduits, piping through walls, ceilings and floors,
. Fixed ventilation outlets installed in rooms and buildings, opened frequently or for long periods.

2- Type B openings.
. Normally closed (example : automatic closing), rarely open, and difficult to adjust.

3- Type C openings.
. Type B openings, with watertightness in addition to that, equiped with independent automatic closing,
. two type B opening in series.

4- type D openings.
. can only be opened using a special device or in an emergency,
. completely weatherproof openings,
. combination of a type B and a type C opening, in series (joined together).

3- What is the ventilation availability ?

The efficiency of ventilation in dispersing or maintaining the explosive atmosphere depends on its quality and level, as well as its design. An artificial ventilation system is therefore :

Very good
Operates almost continuously and therefore backed up.

Good
operated while the site is operating.

Poor
Does not operate continuously or during normal site operation, it operates without any interruption for long periods.

DOWNSTREAM EFFECT ON THE DEGREE OF RELEASE OF THE OPENING

Probable zones in upstream of the opening	**Types of openings**			
	A	**B**	**C**	**D**
Zone 0	Continuous	(Continuous) First	Second	No release
Zone 1	Premier	(First) Second	(Second) No release	No release
Zone 2	Second	(Second) No release	No release	No release

Note : for the release emission levels between parenthesis, it is advised to consider the opening frequency of the doors when at the design stage.

🟥	**Continuous emission release usually leads to classification as zone 0**	🟧	**First level emission release usually leads to classification as zone 1**	🟨	**Second level emission usually leads to classification as zone 2**

Gas and vapour classification according to CENELEC

CENELEC EN 50 014 and IEC 60 079-12 standards

These gases or vapours are classified in three subdivisions : A, B and C, depending on their experimental safety gap (IEMS) and their minimum inflammation current (CMI).

SUBDIVISION A

Hydrocarbons

Alkanes :

Butane
Cyclobutane
Cycloheptane
Cyclohexane
Cyclopentane
Decahydronaphtalene (decaline)
Decane
Ethane
Ethylcyclobutane
Ethylcyclohexane
Ethylcyclopentane
Heptane
Hexane
Methane
Methylcyclobutane
Methylcyclohexane
Methylcyclopentane
Nonane
Octane
Pentane
Propane

Alkenes :

Propene (propylene)

Aromatic hydrocarbons :

Methylstyrene
Styrene

Benzenic hydrocarbons :

Benzene
Cumene
Cymene
Éthylbenzene
Naphtalene
Toluene
Trimethylbenzene
Xylene

Mixtures of *Hydrocarbons :*

Benzol for cars
Gas-oil
Kérosene
Fuel oil
Industrial methane (1)
Oil naphta
Petroleum naphta
Petroleum (included petroleum spirits)
Dry cleaning solvents
Turpentine

Compounds containing oxygen

Acids :

Acetic acid

Alcohols et phenols :

Butanol
Cresol
Cyclohexanol
Diacetone-alcohol
Ethanol
Heptanol
Hexanol
Methanol
Methylcyclohexanol
Monanol
Octanol
Pentanol
Phenol
Propanol

Aldehydes :

Acetic Aldehyde
Metaldehyde

Ketones :

Acetone
Amyl-methyl-ketone
Butyl-methyl-ketone
Cyclohexanone
Ethyl-methyl-ketone
2,4 - Pentanedione (acetylacetone)
Propyl-methyl-ketone

Esters :

Methyl acetate
Ethyl acetate
Propyl actate
Butyl acetate
Amyl acetate
Vinyl acetate
Ethyl Acetylacetate
Methyl formate
Ethyl formate
Methyl methacrylate
Ethyl methacrylate

Oxides :

(included ethers) :
Dipropyl ether
Carbon monoxide (2)

Compounds containing halogens

Compounds with no oxygen :

Bromoethane
Bromobutane
Chlorobenzene
Chlorobutane
Chloroethane
Chlorethylene (Vinyl chloride)
Chloromethane
Chloropropane
Allyl chloride
Benzyl chloride
Methylene chloride
Dichlorobenzene
Dichloroethane
Dichloroethylene
Dichloropropane
Benzyl trifluoride

Compounds containing oxygen :

Chloroethanol
Acetyl chloride

Compounds containing sulphurs :

Ethyl mercaptan
Propyl-mercaptan
Tetrahydrothiophene
Thiophene

Compounds containing sulphurs :
Ammonia
Acetonitrile
Nitroethane
Nitromethane

Amines :

Amphetamine
Aniline
Butylamine
Cyclohexylamine
Diaminoethane
Diethylamine
Diethylaminoethanol
Dimethylamine
Dimethylaniline
Methylamine
Mono-ethanolamine
Propylamine
Pyridine
Toluidine
Triethylamine
Trimethylamine

SUBDIVISION B

Hydrocarbons

Allylene (Propyn)
Butadiene
Cyclopropane
Ethylene

Compounds containing nitrogen

Hydrocyanidric acid
Acrylonitrile
Isopropyl nitrate

Compounds containing oxygen

Acrolein
Ethyl acrylate
Methyl acrylate
Tetrahydrofurfuryl alcohol
Crotonaldehyde
Dioxalan
Dioxan
Epoxy-propane
Butyl ether of hydroxyacetic acid
Butyl ether
Ethylic ether
Ethyl méthyl ether
Méthylic ether
Furane
Ethylene oxide (epoxyethane)
Tétrahydrofuran
Trioxane

Mixtures

Gas from a coke furnace

Compounds containing haogens

Propane, 1 chloro, 2,3 epoxy (épichlorhydrin)
Tétrafluorethylene

SUBDIVISION C

Acetylene
Carbon disulphide
Hydrogen
Ethyl nitrate