Classification of Toxic Hazard and Explosive Risk of Chemical Mediums in Pressure Vessels (HG 20660-2000)

1. Scope of Application

To determine the category and technical requirements for pressure vessels, this Standard classifies the toxic hazard and explosive risk of the mediums.

This Standard aims to classify the toxic hazard and explosive risk of the mediums (include raw material, finished products, semi finished articles, tertium quid, reactant, reaction outgrowth and impurity) used or stored in pressure vessels in chemical industry in order to determine the category of pressure vessels and the technical requirements for sealing.

2. Referenced Standards

GB 5044-85 *Classification of Health Hazard Levels from Occupational Exposure to Toxic Substances*

The Supervision Regulations on Safety Technology for Pressure Vessels (1990) published by the General Administration of Quality Supervision, Inspection, and Quarantine of P. R. China (hereinafter referred to as the Regulations)

3. Principles for Classification

3.0.1 The toxic hazard and explosive risk of chemical mediums defined in this Standard is classified according to the seriousness of the hazard caused by exposure to the medium and explosion due to accident or the chronic occupational hazard resulted from regular medium leaking during the operation of the pressure vessels.

3.0.2 The toxic hazard of chemical mediums is defined based on the six classification indicators stipulated in GB 5044 (please refer to Annex A Basis for Toxic Hazard Classification). According to the hazard of toxicity, chemical mediums are classified as extremely toxic, highly toxic and moderate toxic (Note 1).

3.0.3 When determining the category of pressure vessels, the accident situation and the hazard caused by exposure to the medium should be taken into consideration for the classification of toxic hazard. For this purpose, this Standard makes the classification after comprehensive study mainly to acute toxicity and the maximum allowable density as well as other parameters. The Tables from 3.0.3-1 to 3.0.3-3 list the common chemical mediums classified as extremely toxic, highly toxic and moderate toxic.

3.0.4 When determining the technical requirements for sealing of pressure vessels in chemical industry, besides the accident situation, the latent chronic hazard caused by regular leaking shall also be taken into consideration. Therefore, acute toxicity, maximum allowable density and carcinogenicity are the main items for comprehensive consideration to determine the classification. Some mediums are classified according to its most outstanding hazard (carcinogenicity for example). The classification of some mediums listed in Tables from 3.0.3-1 to 3.0.3-3 has been adjusted; please refer to the notes of the Tables for detail.

3.0.5 The classification of explosive mediums is according to the stipulations of The Supervision Regulations on Safety Technology for Pressure Vessels (Note 2). The explosive medium means the mixture of steam (produced by gas or liquid) and gas, with the explosion lower limit less than 10%, or the difference between the explosion upper limit and the lower limit higher or equal to 20%. Please refer to Table 3.0.5 for detail.

3.0.6 When more than one kind of medium are involved, the most hazardous or the medium with the highest risk for explosion shall be used as the criteria to determine its classification; when the content of a hazardous medium is very small, its content and hazard shall be considered comprehensively. According to the classification principles of this Standard, the design unit or the production department of the user can determine its classification.

3.0.7 The chemical mediums which are not listed in this Standard shall be classified according to the above principles and refer to the classification of similar mediums.

Table 3.0.3-1 Common Chemical Mediums Classified as Extremely Toxic

No.	Names	No.	Names
1	Disyston	11	Merhyl parathion
2	Ethyleneimine	12	Parathion
3	Dimethylnitrosamine	13	Phosgene
4	Diborane	14	Methylisocynate
5	Schradan	15	Mercury

6	Triethyl tin chloride	16	Benzo(α)pyrene
7	Pentaborane	17	Sulfur mustard
8	Systox	18	Hydrogen cyanide
9	Tetraethyl lead	19	Chloromethyl ether
10	Thimet	20	Nickel carbonyl

Note: When the classification of toxic hazard are used to determine the technical requirements for sealing of pressure vessels, Vinyl chloride and α—Naphthylamine shall be included in this table as extremely toxic.

Note 1: The chemical mediums classified as minor toxic are not included in this table.

Note 2: The explosive medium referred in this Standard is the inflammable medium defined in the Supervision Regulations on Safety Technology for Pressure Vessels.

Table 3.0.3-2 Common Chemical Mediums Classified as Highly Toxic

No.	English Names	No.	English Names
1	Dimethylhydrazine	32	Hydrazine
2	Toluene-2,4-diisocyanate	33	Ethylene oxide
3	Oxygen difluoxide	34	Epichlorohydrin
4	Dinitrobenzene (m,o,p)	35	Tsumacide
5	Chloro-dinitrobenzene	36	Ozone
6	1,2-dibromocthane	37	Fenthion
7	1,2-Dibromo-3-chloropropane	38	Dipterex
8	Dichlorotetrafluroproptone	39	DDVP
9	Selenium oxychloride	40	Fluorine
10	Allylcyanide	41	Hydrogen fluoride
11	Sulphurdecafluoxide	42	Arsine
12	Chlorine trifluoride	43	Nicotine
13	2,4,6-Trinitrotoluene	44	Hydrogen selenide
14	Phosphorus trichloride	45	Dimethyl sulfate
15	Phosphorus pentochloride	46	Cyanogen
16	Acrylonitrile	47	Chorine
17	Acrylamine	48	Chlordane
18	Acrolein	49	Chloropicrin
19	Acetone cyanohydrin	50	Cyanogen chloride
20	Demeton methyl	51	β-Chloropropionitrile

21	Formaldehyde	52	Chlorinated diphenyls
22	Formic acid	53	Monochloromethanc
23	n-Butyronitrile	54	Chlorinated naphthalenes
24	P-Nitroaniline	55	Chlorophenol
25	P-chloronitrobenzene	56	Trichloromethyl chloroformate
26	Isobutyronitrile	57	Bromomethane
27	Benzylchloride	58	Iodomethane
28	Carbofuran	59	Carbonyl fluoride
29	o-Chloronitrobenzene	60	Phosphine
30	Phenyl acetonitrile	61	Phosphamidon
31	Aniline		

Note: When the classification of toxic hazard are used to determine the technical requirements for sealing of pressure vessels, Carbontetrachloride, o-Toluidine and Benzene shall be included in this table as highly toxic chemical mediums.

Table 3.0.3-3 Common Chemical Mediums Classified as Moderate Toxic

No.	English Names	No.	English Names
1	Monoethanolamine	46	Glycidyl methacrylate
2	Carbon monoxide	47	Methyl mercaptan
3	Chloroacetic acid	48	Methanol
4	Ethylenediamine	49	Butyl mercaptan
5	Diethyloxalate	50	n-Butyraldehyde
6	Ethylidene norbormene	51	n-Methyl silicate
7	Ethylamine	52	Rogor
8	Ethyl mercaptan	53	Etrofolan
9	Acetonitrile	54	Cyclohexanone
10	Ethanoic acid	55	Isobutyraldehyde
11	Acetic anhydride	56	Carbaryl
12	2,6-Dimethylaniline	57	Sumithion
13	Dimethylamine	58	Pyridine
14	Dimethylacetamide	59	o-Toluidine
15	Dimethyldichlorsilane	60	o-Nitrotoluene
16	Dimethylformamide	61	o-Nitrophenol
17	Dimethylaniline	62	Benzene

18	N,N-Dimethylaniline	63	Phenol
19	Sulfurdioxide	64	Benzaldehyde
20	Nitrogenoxide	65	Styrene
21	Carbon disulfide	66	m-Cresol
22	1,1-Dichloroethylene	67	m-Methylaniline
23	1,2-Dichloroethylene	68	Resorcinol
24	1,2-Dichloroethane	69	m-Nitrotoluene
25	Dichloroethane	70	m-Chloroaniline
26	Dichloroethane	71	Fluorobenzene
27	1,3Dichloropropanol-2	72	Ammonia
28	Buthylamine	73	Vinylidene chloride
29	Crotonaldehyde	74	Naphthalene
30	Sulfur trioxide	75	α-Naphthylamine
31	Tribromomethane	76	α-Naphthol
32	1,1,2-Trichloroethane	77	Nitrobenzene
33	1,1,2-Trichloroethylene	78	Nitric acid
34	1,2,4-Trichlorobenzene	79	Hydrogen sulfide
35	Trichloroacetic acid	80	Sulfuric acid
36	Trichlorosilane	81	Vinyl chloride
37	Adiponitrile	82	Chloroethanol
38	Malathion	83	Chloroprene
39	Phosphorus pentosulfide	84	3-Chloropropene
40	Tetrabromoethane	85	Hydrogen chloride
41	Tetrachloroethane	86	Chlorobenzene
42	Carbontetrachloride	87	Tri-n-butyl phosphate
43	Allylalcohol	88	Trip-Cresyl phosphate
44	Propyl mercaptan	89	Furfural
45	Methylamine	90	Acetylene

Note: When the classification of toxic hazard are used to determine the technical requirements for sealing of pressure vessels, Carbontetrachloride, o-Toluidine and Benzene shall be classified as highly toxic; Vinyl chloride andα—Naphthylamine shall be classified as extremely toxic.

Table 3.0.5 Explosive Mediums

No.	English names	No.	English names
1	Monomethylamine	147	Propylene
2	Carbon monoxide	148	Allylamine
3	Chlorodlfluorocthane	149	Isopropenylbenzene
4	Ethylene glycol	150	Arcylonitrile
5	Acetylene	151	Ethyl acrylate
6	Ethylamine	152	n-Butylacrylate
7	Ethyl glycol	153	Methyl acrylate
8	Ethyl propylether	154	Propylcarbonate
9	Ethyl propylketone	155	Allyl alcohol
10	5-Ethyl-2-Methylpyridine	156	Acrolein
11	Ethyl cyclobutane	157	Propane
12	Ethyl cyclohexane	158	Propionitrile
13	Ethyl cyclopentane	159	Acetone
14	Ethyl benzene	160	Ethyl propionate
15	Ethylene	161	Methyl propionate
16	Vinylacetylene	162	n-Propyl alcohol
17	Vinylethylether	163	Isopropyl alcohol
18	Vinyltoluene	164	Propyl aldehyde
19	Ethane	165	Petroleum ether
20	Ethyl mercaptan	166	Isoprene
21	Acetonitrile	167	1-Pentylamine
22	Ethyl Dacetoacetate	168	1-Pentene
23	N,N-Dimethylacetamide	169	2-Pentene
24	Acetic acid	170	n-Pentane
25	Vinyl acetate	171	Isopentane
26	Ethyl acetate	172	Methyl propylkctone
27	Butyl acetate	173	3-Pentanone
28	Isobutyl acetate	174	n-Amyl alcohol

29	Sec-butyl acetate	175	3-Pentanol
30	Tert-butyl acetate	176	tert-Amyl alcohol
31	Propyl acetate	177	Isoamyl alcohol primary
32	Isopropyl acetate	178	Isoamyl alcohol secondary
33	Methyl acetate	179	Methyl ethyl ether
34	Amyl acetate	180	Toluene
35	Isopentyl acetate	181	2,4-Tolylene diisocyanate
36	Cyclohexyl acetate	182	Methoxy butylacetate
37	Acetic anhydride	183	o-Cresol
38	Ethyl alcohol	184	m-Cresol
39	Ethoxyglycolacetate	185	p-Cresol
40	Ethyleneimine	186	Methyl glycol
41	Acetaldehyde	187	Methoxyl glycolacetate
42	Etyl ether	188	Methyl vinyl ketone
43	1,1-Diethoxyethane	189	Methyldichlorosilane
44	Diethylamine	190	Methylisobutyketone
45	3,3-Diethylpentane	191	3-Methyl-1-butene
46	p-Diethylbenzene	192	Methyl trichlorosilane
47	N,N-Diethylaniline	193	Ethyl methacrylate
48	Diethyl selenide	194	Methyl methacrylate
49	m-Divinylbenzene	195	2-Methyl acrolein
50	Divinyl ether	196	2-Methyl-2,4-pentanedid
51	n-Dibutylamine	197	2-Methyl pentane
52	Diisobutyl ketone	198	3-Methyl pentane
53	Diacetone alcohol	199	2-Methyl pyridine
54	Diisopeopyl ether	200	3-Methyl pyridine
55	p-Xylene	201	Methyl cyclohexane
56	o-Xylene	202	Methyl cyclopentadiene
57	m-Xylene	203	Methyl cyclopentane
58	Dimethylamine	204	Methyl hydrazine
59	Dimethyldichlorosilane	205	Methane

60	2,2-Dimethylbutane	206	Methyl mercaptan
61	2,3-Dimethylbutane	207	Formic acid
62	2,2-Dimethylpeopane	208	Ethyl formate
63	2,3-Dimethylpentane	209	Butyl formate
64	Dimethylformamide	210	Isobutyl formate
65	N,N-Dimethylaniline	211	Amyl formate
66	(unsym)-Dimethylhydrazine	212	Isoamyl formate
67	Dimethyl sulfide	213	Methyl formate
68	Dimethyl ether	214	Methyl alcohol
69	Dimethyl ether	215	Formaldehyde
70	1,1-Vinyl difluoride	216	Lead tetraethyl
71	1,1-Difluoroethane	217	Tetramethyl lead
72	1,4-Dioxane	218	Tetramethyl tin
73	Carbon disulfide	219	Tetrahydrofuran
74	1,1-Dichloroethylene	220	Tetrahydrofuryl alcohol
75	1,2-Dichloroethylenecis	221	Nickel tetracarbonyl
76	1,2-Dichloroethylenetrans	222	Air gas
77	Ethylenedichloride	223	Ethyl nitrile
78	1,3-Dichloropropene	224	Fusel oil
79	1,2-Dichloropropane	225	Dowtherm
80	Dichloromethane	226	Furan
81	o-Dichlorobenzene	227	Pyridine
82	Diborane	228	1-Octene
83	Dodecane	229	n-Octane
84	n-Tetradecane	230	Gasoline
85	Decahydronaphthalene	231	Cyclobutane
86	1,3-Butadiene	232	Cyclohexane
87	1,3-Butanediol	233	Cyclohexanone
88	n-Butylbenzene	234	Cyclopropane
89	Isobutylbenzene	235	Cyclopentane
90	2-Butyne	236	Ethylene oxide

91	Butylamine	237	1,2-Butylene oxide
92	tert-Butylamine	238	Propylene oxide
93	Butyl glycol	239	Epichlorohydrin
94	sec-butylbenzene	240	Benzene
95	tert-butylbenzene	241	Phenylethylene
96	Butyllithium in hydrocarbon solvents	242	Ethyl benzoate
97	Butyllithium in hydrocarbon solvents	243	Benzaldehyde
98	Butyllithium in hydrocarbon solvents	244	Aniline oil
99	1-Butene	245	Ethyl lactate
100	Isobutylene	246	Methyl lactate
101	cis-Butene-2	247	1-Heptene
102	Trans-Butene-2	248	n-Heptane
103	Crotonaldehyde	249	Isoheptane
104	Butane	250	Hydrogen
105	Isobutene	251	1-Decene
106	Butylnitrile	252	Decane
107	2-Butanone	253	Nicotine
108	Butyric acid	254	Liquefied petroleum gas
109	Butyl alcohol	255	Bicyclohexyl
110	Isobutyl alcohol	256	Nitroethane
111	sec-Butyl alcohol	257	1-Nitropropane
112	tert-Butyl alcohol	258	2-Nitropropane
113	n-Butyraldehyde	259	Nitromethane
114	Isobutyraldehyde	260	Nitrobenzene
115	Butyl ether	261	Ethyl nitrate
116	Triethylamine	262	Propyl nitrate
117	Triethylene glycol	263	Hydrogen sulfide
118	Trimethylamine	264	Quinoline
119	2,2,5-Trimethylhexane	265	Cyanogen
120	2,2,3-Trimethylpentane	266	Hydrogen cyanide
121	2,2,4-Trimethylpentane	267	Vinyl chloride

122	Isophorone	268	Chloroethane
123	1,2,4-Trimethylbenzene	269	Monochloroaceticacid
124	Trichloroethylene	270	Ethylene chlorohydrine
125	Trichloroethane	271	2-Chlorobutadiene-[1,3]
126	1,2,3-Trichloropropane	272	Chlorobutene
127	Trichlorosilane	273	1-chloro-2-butene
128	Paraldehyde	274	1-Chlorobutane
129	1,4-Hexadiene	275	Isobutyl chloride
130	1-Hexene	276	Benzyl chloride
131	n-Hexane	277	Allyl chloride
132	Isohexane	278	2-Chloropropene
133	2-Hexanone	279	n-Propyl chloride
134	Hydrazine anhydrous	280	Isopropyl chloride
135	Natural gas	281	1-Chloropentane
136	1-Nonene	282	Isoamyl chloride
137	n-Nonane	283	3-Chloro-2-methylpropene
138	Dipentene	284	Methyl chloride
139	Water gas	285	Chlorobenzene
140	1,2-Propanediol	286	Coke oven gas
141	n-Propylbenzene	287	Bromoethane
142	Isopropylbenzene	288	1-bromobutane
143	Propylamine	289	Allyl bromide
144	Isopropylamine	290	Bromobenzene
145	p-Isopropyltoluene	291	Furfuryl alcohol
146	Methyl acetylene	292	Furfural

Appendix A Basis for Toxic Hazard Classification

Items		Classification			
		Ⅰ Extremely Toxic	Ⅱ Highly Toxic	Ⅲ Moderate Toxic	Ⅳ Minor Toxic
Acute Toxicity	Inhalation LC_{50}.mg/m^3	＜200	200 —	2000 —	＞20000
	Exposure LD_{50}.mg/kg	＜100	100 —	500 —	＞2500
	Oral LD_{50}.mg/kg	＜25	25 —	500 —	＞5000
Acute poisoning		Poisoning easily happens during operation with serious aftereffect	Poisoning may happen during operation, but has good healing	Poisoning happens occasionally	No acute poisoning has been seen so far, but has acute effect.
Chronic poisoning		High Morbidity （≥5%）	Comparatively high morbidity ＜ 5% or high symptom occurrence （≥20%）	Poisoning happens occasionally or high symptom occurrence （≥10%）	No chronic poisoning but have chronic effect.
Chronic poisoning aftereffect		Continue to exacerbation after detoxification or cannot be cured	Can be cured after detoxification	Can recover without serious aftereffect after detoxification	Can recover by itself without bad aftereffect
Carcinogenicity		Carcinogenic to human	Dubious carcinogenic to human	Carcinogenic to experimental animals	Non-carcinogenic
Maximum allowable density mg/m^3		＜0.1	0.1—	1.0—	＞10

Note: * quoted from GB 5044-85