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Fire Code Chemical Hazard Classification



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Agenda



Why I Care...



History of Loss, Prevention Efforts



MAQ (Maximum Allowable Quantities)



Classification Chemical Hazards – Physical & Health



Application Examples

Why I Care

- UC has a major focus on MAQ compliance
- The MAQ concept is new to most people
- The rules are complicated
- In academia, new faculty have very little control over where their rooms are assigned
- The rules seem arbitrary



History of Losses

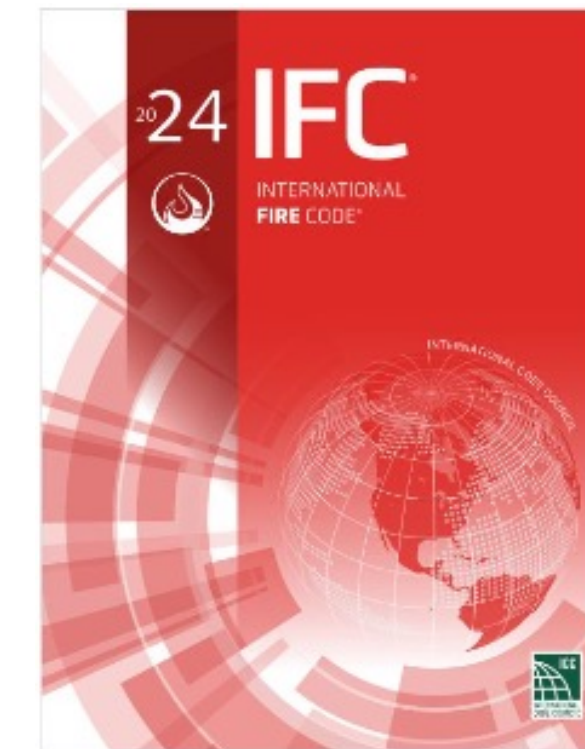
- 48 BCE Great Library of Alexandria Fire
- 64 CE Great Fire of Rome – Nero
- 1871 Great Chicago Fire ~300 deaths
- 1903 Chicago Iroquois Theatre Fire 602 deaths
- 1911 Triangle Shirtwaist Factory fire 147 deaths



The Fire of Rome, 18 July 64 AD' by Hubert Robert, 1733-1808 CE.
(Musee des Beaux-Arts Andre Malraux, Le Havre, France)

Rules that resulted...

- Fire resistive construction
- Active automatic suppression
- Compartmentalization to prevent spread
- Awareness of hazards
- Improved safety of response



Standardizing Codes in US

- Prior to 1994
 - the National Fire Prevention Code
 - the Standard Fire Prevention Code
 - the Uniform Fire Code,
 - National Fire Protection Association (NFPA) 1 – Fire Prevention Code
- 1994, International Code Council created IFC



IFC is Model Code in Most States



Complex Issues

- Prior to 2000, IFC has no comprehensive MAQ limits
- Starting in 2001 California Fire Codes systematically limits the maximum quantities of chemicals in 'control areas'
- Limits are by physical state at NTP, hazard type & class, locations in or near a building, type of storage, use and design of the building
- There can be up to four control areas in a building, not exceeding 10,000 sq ft each



Changes Can Occur Every Three Years

- In 2015 IFC (2016 CFC) MAQ rules changed again
- Now, more control areas (or lab suites) are allowed and varies in allowed number by floor
- A percentage reduction is imposed by floor
- These are all added to the 2001 hazardous hazard class limits



MAQ Tables are 5003.1.1(1-4)

<https://codes.iccsafe.org/content/IFC2024P1/chapter-50-hazardous-materials-general-provisions>

Indoor Control Areas

Outdoor Control Areas

TABLE 5003.1.1(1) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD^{a,b,c,d}

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE ^e			USE-CLOSED SYSTEMS ^f			USE-OPEN SYSTEMS ^g	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)
Combustible dust	NA	II-2	See Note q	NA	NA	See Note q	NA	NA	See Note q	NA
Combustible fibers ^h	Loose fibers ^h	H 3	(100) (1,000)	NA	NA	(100) (1,000)	NA	NA	(20) (200)	NA
Combustible liquid ⁱ	II	H-2 or H-3	NA	120 ^j 3,400 ^k	NA	NA	120 ^j 3,400 ^k	NA	NA	30 ^l 80 ^l
	III	H-2 or H-3	NA	13,200 ^m	NA	NA	13,200 ^m	NA	NA	3,300 ⁿ
Consumer fireworks	L4G	II-3	125 ^o	NA	NA	NA	NA	NA	NA	NA
Cryogenic flammable	NA	II-2	NA	45 ^p	NA	NA	45 ^p	NA	NA	10 ^q
Cryogenic inert	NA	NA	NA	NA	NL	NA	NA	NL	NA	NA
Cryogenic oxidizing	NA	H 3	NA	45 ^p	NA	NA	45 ^p	NA	NA	10 ^q
Explosives	Division 1.1	H 1	1 ^r	(1) ^r	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s
	Division 1.2	H-1	1 ^r	(1) ^r	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s
	Division 1.3	H-1 or H-2	1 ^r	(1) ^r	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s
	Division 1.4	H 3	50 ^t	(50) ^t	NA	50 ^t	(50) ^t	NA	NA	NA
	Division 1.4G	H 3	125 ^o	NA	NA	NA	NA	NA	NA	NA
	Division 1.5	H-1	1 ^r	(1) ^r	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s
Division 1.6	H-1	1 ^r	NA	NA	NA	NA	NA	NA	NA	NA
Flammable gas	Gaseous Liquefied	II-2	NA (150) ^u	NA (150) ^u	1,000 ^v NA	NA (150) ^u	NA (150) ^u	1,000 ^v NA	NA (150) ^u	NA (150) ^u
Flammable liquid ^w	IA	H-2 or H-3	NA	30 ^x	NA	NA	30 ^x	NA	NA	10 ^y
	II and IC	H-2 or H-3	NA	120 ^x	NA	NA	120 ^x	NA	NA	30 ^y
Flammable liquid combination (IA, II, IC)	NA	H 2 or H-3	NA	120 ^{x,z}	NA	NA	120 ^{x,z}	NA	NA	30 ^{y,z}
Flammable solid	NA	II-3	125 ^o	NA	NA	125 ^o	NA	NA	25 ^{aa}	NA

TABLE 5003.1.1(3) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD IN AN OUTDOOR CONTROL AREA^{a,b,c,d}

MATERIAL	CLASS	STORAGE ^e			USE-CLOSED SYSTEMS ^f			USE-OPEN SYSTEMS ^g	
		Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas cubic feet at NTP	Solid pounds (cubic feet)	Liquid gallons (pounds)
Flammable gas	Gaseous Liquefied	Not Applicable	Not Applicable (300)	3,000 Not Applicable	Not Applicable	Not Applicable (150)	1,500 Not Applicable	Not Applicable	Not Applicable
Flammable solid	Not Applicable	500	Not Applicable	Not Applicable	250	Not Applicable	Not Applicable	50	Not Applicable
Inert Gas	Gaseous Liquefied	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable
Cryogenic inert	Not Applicable	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable	Not Limited	Not Applicable	Not Applicable
Organic peroxide	Unclassified Detonable	1	(1)	Not Applicable	0.25	(0.25)	Not Applicable	0.25	(0.25)
Organic peroxide	I	20	(20)	Not Applicable	10	(10)	Not Applicable	2	(2)
	II	200	(200)	Not Applicable	100	(100)	Not Applicable	20	(20)
	III	500	(500)	Not Applicable	250	(250)	Not Applicable	50	(50)
	IV	1,000	(1,000)	Not Applicable	500	(500)	Not Applicable	100	(100)
	V	Not Limited	Not Limited	Not Applicable	Not Limited	Not Limited	Not Applicable	Not Limited	Not Limited
Oxidizer	4	2	(2)	Not Applicable	1	(1)	Not Applicable	0.25	(0.25)
	3	40	(40)	Not Applicable	20	(20)	Not Applicable	4	(4)
	2	1,000	(1,000)	Not Applicable	500	(500)	Not Applicable	100	(100)
	1	Not Limited	Not Limited	Not Applicable	Not Limited	Not Limited	Not Applicable	Not Limited	Not Limited
Oxidizing gas	Gaseous Liquefied	Not Applicable	Not Applicable (600)	6,000 Not Applicable	Not Applicable	Not Applicable (300)	1,500 Not Applicable	Not Applicable	Not Applicable
Pyrophoric materials	Not Applicable	8	(8)	100	4	(4)	10	0	0
Unstable (reactive)	4	2	(2)	20	1	(1)	2	0.25	(0.25)
	3	20	(20)	200	10	(10)	10	1	(1)
	2	200	(200)	1,000	100	(100)	250	10	(10)
Water reactive	3	20	(20)	Not Applicable	10	(10)	Not Applicable	1	(1)
	2	200	(200)	Not Applicable	100	(100)	Not Applicable	10	(10)
1	Not Limited	Not Limited	Not Applicable	Not Limited	Not Limited	Not Applicable	Not Limited	Not Limited	

TABLE 5003.1.1(1)—continued MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD^{a,b,c,d}

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE ^e			USE-CLOSED SYSTEMS ^f			USE-OPEN SYSTEMS ^g	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)
Inert Gas	Gaseous Liquefied	NA	NA	NA	NL	NA	NL	NA	NA	
		NA	NA	NA	NL	NA	NL	NA	NA	
Organic peroxide	UD	H-1	1 ^r	(1) ^r	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s	0.25 ^s	
	I	H 2	5 ^t	(5) ^t	1 ^r	(1) ^r	1 ^r	(1) ^r	1 ^r	
	II	H 3	50 ^t	(50) ^t	NA	50 ^t	(50) ^t	NA	10 ^y	
	III	H 3	125 ^o	NA	NA	125 ^o	NA	NA	25 ^{aa}	
	IV	NA	NL	NL	NL	NL	NL	NL	NL	
Oxidizer	4	H-1	1 ^r	(1) ^r	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s	(0.25) ^s	
	3	H-2 or H-3	10 ^y	(10) ^y	NA	10 ^y	(10) ^y	NA	10 ^y	
	2	H-3	250 ^{aa}	(250) ^{aa}	NA	250 ^{aa}	(250) ^{aa}	NA	50 ^y	
1	NA	4,000 ^{ab}	(4,000) ^{ab}	NA	4,000 ^{ab}	(4,000) ^{ab}	NA	1,000 ^y	(1,000) ^y	
Oxidizing gas	Gaseous Liquefied	H-3	NA (150) ^u	NA (150) ^u	1,500 ^v NA	NA (150) ^u	NA (150) ^u	1,500 ^v NA	NA (150) ^u	
Pyrophoric	NA	H-2	4 ^{ac}	(4) ^{ac}	50 ^{ad}	1 ^r	(1) ^r	10 ^y	0	
Unstable (reactive)	4	H-1	1 ^r	(1) ^r	0.25 ^s	(0.25) ^s	0.25 ^s	(0.25) ^s	(0.25) ^s	
	3	H-1 or H-2	5 ^t	(5) ^t	1 ^r	(1) ^r	1 ^r	(1) ^r	1 ^r	
	2	H-3	50 ^t	(50) ^t	750 ^{ae}	50 ^t	(50) ^t	750 ^{ae}	10 ^y	
	1	NA	NL	NL	NL	NL	NL	NL	NL	
Water reactive	3	H-2	5 ^t	(5) ^t	NA	5 ^t	(5) ^t	NA	1 ^r	
	2	H-3	50 ^t	(50) ^t	NA	50 ^t	(50) ^t	NA	10 ^y	
1	NA	NL	NL	NL	NL	NL	NL	NL		

For SI: 1 cubic foot = 0.02832 m³, 1 pound = 0.454 kg, 1 gallon = 3.785 L.
 NA = Not Applicable, NL = Not Limited, UD = Unclassified Detonable.
 a. For use of control areas, see Section 5003.6.5.
 b. The aggregate quantity in use and storage shall not exceed the quantity listed for storage.
 c. The quantities of alcoholic beverages in retail and wholesale sales occupancies shall not be limited providing the liquids are packaged in individual containers not exceeding 1.5 gallons. In retail and wholesale sales occupancies, the quantities of medicines, foodstuff or consumer products and cosmetics containing not more than 20 percent by volume of water-miscible liquids with the remainder of the solutions not being flammable shall not be limited, provided that such materials are packaged in individual containers not exceeding 1.5 gallons.
 d. [IFM] In other than Group L occupancies, maximum allowable quantities shall be increased 100 percent in buildings equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1. Where Note e also applies, the increase for both notes shall be applied cumulatively.
TABLE 5003.1.1(1)—continued MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD^{a,b,c,d}
 e. Maximum allowable quantities shall be increased 100 percent where stored in approved storage cabinets, day boxes, gas cabinets, gas rooms, exhausted enclosures or in listed safety cans in accordance with Section 5003.9.10. Where Note d also applies, the increase for both notes shall be applied cumulatively.
 f. Quantities shall not be limited in a building equipped throughout with an approved automatic sprinkler system in accordance with Section 903.3.1.1.
 g. Allowed only in buildings equipped throughout with an approved automatic sprinkler system.
 h. Containing not more than the maximum allowable quantity per control area of Class IA, Class IB or Class IC flammable liquids.
 i. The maximum allowable quantity shall not apply to fuel oil storage complying with Section 603.2.2.
 j. Quantities in parentheses indicate quantity units in parentheses at the head of each column.
 k. A maximum quantity of 200 pounds of solid or 50 gallons of liquid Class 3 oxidizers is allowed where such materials are necessary for maintenance purposes, operation or sanitation of equipment where the storage containers and the manner of storage are approved.
 l. Net weight of pyrotechnic composition of the fireworks. Where the net weight of the pyrotechnic composition of the fireworks is not known, 25 percent of the gross weight of the fireworks including packaging shall be used.
 m. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.
 n. For storage and display quantities in Group M and storage quantities in Group S occupancies complying with Section 5003.1.1, see Table 5003.1.1.1.
 o. Densely-packed baled cotton that complies with the packing requirements of ISO 8115 shall not be included in this material class.
 p. The following shall not be included in determining the maximum allowable quantities:
 1. Liquid or gaseous fuel in fuel tanks on vehicles.
 2. Liquid or gaseous fuel in fuel tanks on motorized equipment operated in accordance with this code.
 3. Gaseous fuels in piping systems and fixed appliances regulated by the California Mechanical Code.
 4. Liquid fuels in piping systems and fixed appliances, regulated by the California Mechanical Code.
 5. Alcohol-based hand rubs classified as Class I or II liquids in dispensers that are installed in accordance with Sections 2705.3 and 2705.3.1. The location of the alcohol-based hand rub (ABHR) dispensers shall be provided in the construction documents.
 q. Where manufactured, generated or used in such a manner that the concentration and conditions create a fire or explosion hazard based on information prepared in accordance with Section 104.7.2.

TABLE 5003.1.1(4) MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A HEALTH HAZARD^{a,b,c,d}

MATERIAL	STORAGE			USE-CLOSED SYSTEMS			USE-OPEN SYSTEMS	
	Solid pounds	Liquid gallons (pounds)	Gas cubic feet at NTP (pounds)	Solid pounds	Liquid gallons (pounds)	Gas cubic feet at NTP (pounds)	Solid pounds	Liquid gallons (pounds)
Corrosives	20,000	2,000	Gaseous 1,620 Liquefied (300)	10,000	1,000	Gaseous 810 Liquefied (150)	1,000	100
Highly toxics	20	(20)	Gaseous 40 ^d Liquefied (8) ^d	10	(10)	Gaseous 20 ^d Liquefied (4) ^d	3	(3)
Toxics	1,000	(1,000) ^e	Gaseous 1,620 Liquefied (300)	500	50 ^e	Gaseous 810 Liquefied (150)	125	(125) ^e

For SI: 1 cubic foot = 0.02832 m³, 1 pound = 0.454 kg, 1 gallon = 3.785 L, 1 pound per square inch absolute = 6.895 kPa, °C = [(°F)-32]/1.8.
 a. For gallons of liquids, divide the amount in pounds by 10 in accordance with Section 5003.1.2.
 b. The aggregate quantities in storage and use shall not exceed the quantity listed for storage.
 c. The aggregate quantity of nonflammable solid and nonflammable or noncombustible liquid hazardous materials allowed in outdoor storage per single property under the same ownership or control used for retail or wholesale sales is allowed to exceed the maximum allowable quantity per control area where such storage is in accordance with Section 5003.11.
 d. Allowed only where used in approved exhausted gas cabinets, exhausted enclosures or under fume hoods.
 e. The maximum allowable quantity per control area for toxic liquids with vapor pressures in excess of 1 psia at 77°F shall be the maximum allowable quantity per control area listed for highly toxic liquids.
 f. Quantities in parentheses indicate quantity units in parentheses at the head of each column.

Limits by Storage & Use

TABLE 5003.1.1(1)—continued
 MAXIMUM ALLOWABLE QUANTITY PER CONTROL AREA OF HAZARDOUS MATERIALS POSING A PHYSICAL HAZARD^{a, j, m, n, p}

MATERIAL	CLASS	GROUP WHEN THE MAXIMUM ALLOWABLE QUANTITY IS EXCEEDED	STORAGE ^o			USE-CLOSED SYSTEMS ^b			USE-OPEN SYSTEMS ^b	
			Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)	Gas (cubic feet at NTP)	Solid pounds (cubic feet)	Liquid gallons (pounds)
Inert Gas	Gaseous	NA	NA	NA	NL	NA	NA	NL	NA	NA
	Liquefied	NA	NA	NA	NL	NA	NA	NL	NA	NA
Organic peroxide	UD	H-1	1 ^{e, g}	(1) ^{e, g}	NA	0.25 ^g	(0.25) ^g	NA	0.25 ^g	(0.25) ^g
	I	H-2	5 ^{d, e}	(5) ^{d, e}		1 ^d	(1) ^d		1 ^d	(1) ^d
	II	H-3	50 ^{d, e}	(50) ^{d, e}		50 ^d	(50) ^d		10 ^d	(10) ^d
	III	H-3	125 ^{d, e}	(125) ^{d, e}		125 ^d	(125) ^d		25 ^d	(25) ^d
	IV	NA	NL	NL		NL	NL		NL	NL
	V	NA	NL	NL		NL	NL		NL	NL
Oxidizer	4	H-1	1 ^g	(1) ^{e, g}	NA	0.25 ^g	(0.25) ^g	NA	0.25 ^g	(0.25) ^g
	3 ^k	H-2 or H-3	10 ^{d, e}	(10) ^{d, e}		2 ^d	(2) ^d		2 ^d	(2) ^d
	2	H-3	250 ^{d, e}	(250) ^{d, e}		250 ^d	(250) ^d		50 ^d	(50) ^d
	1	NA	4,000 ^{e, f}	(4,000) ^{e, f}		4,000 ^f	(4,000) ^f		1,000 ^f	(1,000) ^f
Oxidizing gas	Gaseous	H-3	NA	NA	1,500 ^{d, e}	NA	NA	1,500 ^{d, e}	NA	NA
	Liquefied			(150) ^{d, e}			(150) ^{d, e}			
Pyrophoric	NA	H-2	4 ^{e, g}	(4) ^{e, g}	50 ^{e, g}	1 ^g	(1) ^g	10 ^{e, g}	0	0
Unstable (reactive)	4	H-1	1 ^{e, g}	(1) ^{e, g}	10 ^{e, g}	0.25 ^g	(0.25) ^g	2 ^{e, g}	0.25 ^g	(0.25) ^g
	3	H-1 or H-2	5 ^{d, e}	(5) ^{d, e}	50 ^{d, e}	1 ^d	(1) ^d	10 ^{d, e}	1 ^d	(1) ^d
	2	H-3	50 ^{d, e}	(50) ^{d, e}	750 ^{d, e}	50 ^d	(50) ^d	750 ^{d, e}	10 ^d	(10) ^d
	1	NA	NL	NL	NL	NL	NL	NL	NL	NL
Water reactive	3	H-2	5 ^{d, e}	(5) ^{d, e}	NA	5 ^d	(5) ^d	NA	1 ^d	(1) ^d
	2	H-3	50 ^{d, e}	(50) ^{d, e}		50 ^d	(50) ^d		10 ^d	(10) ^d
	1	NA	NL	NL		NL	NL		NL	NL

MAQ Reductions by Floor B Occupancy

Floor level (B Occupancy)		Percentage of the Maximum Allowable Quantity per Control Area	Number of Control Areas Per Floor
Above grade plane	Higher than 9	5	1
	7 thru 9	5	2
	6	12.5	2
	5	12.5	2
	4	12.5	2
	3	50	2
	2	75	3
	1	100	4
Below grade plane	-1	75	3
	-2	50	2
	Lower than -2	Not Allowed	Not Allowed

Compliance Challenges by Floor

Flammable liquid IA - MAQ

Floor	MAQ (gallons)
7 th & higher	1.5
4 th thru 6 th	3.75
3 rd	15
2 nd	22.5
1 st	30

B Occupancy,
no sprinkler,
not approved storage

If there are 4 groups in one control area, it is possible that each would get 1/3rd of a gallon for all IA flammable liquids

MAQ Limits for L Occupancy (Chapter 38) *per Lab Suites* are Limited by Floor & Construction Type

Floor Level	L Occupancy (Chapter 38)	Percentage Of The Maximum Allowable Quantity Per Control Area
Above grade plane	Above 20	0
	15 thru 20	25
	11, 12, 13, 14	50
	7, 8, 9, 10	50
	6	75
	4, 5	75
	3	100
	1, 2	100
Below grade plane	-1	75
	-2	50
	-3 and below	0

Number of Lab Suites allowed by Construction Type

Table 453.7.2.1

STORY		PERCENTAGE OF MAXIMUM ALLOWABLE QUANTITY PER LABORATORY SUITE ^a b	NUMBER OF LAB SUITES PER FLOOR BASED ON CONSTRUCTION TYPE				
			Type IA	Type IB	Type IIA, IIIA, IV	Type IIB, IIIB, VA	Type VB
Above grade plane	Above 20	0	NP	NP	NP	NP	NP
	15 to 20	25	4	NP	NP	NP	NP
	11, 12, 13, 14	50	8	NP	NP	NP	NP
	7, 8, 9, 10	50	16	NP	NP	NP	NP
	6	75	20	20	NP	NP	NP
	4, 5	75	20	20	20	NP	NP
	3	100	UL	UL	UL	UL	NP
	1, 2	100	UL	UL	UL	UL	UL
Below grade plane	1	75 ^c	10	10	10	10	10
	2	50 ^d	5	5	5	5	5
	3 and below	0	NP	NP	NP	NP	NP

Forbidden Classes

Only allowed with **sprinklers**

- Most explosives except commercial fireworks
- Organic Peroxides (UD), Oxidizer 4, Pyrophoric, Unstable (reactive) 4

Only allowed **in approved exhausted gas cabinets or exhausted enclosures**

- Highly Toxic Gas and Liquefied gas

Classes Not Limited

Regardless of sprinklers

- Cryogenic Inert, Inert Gas both Gaseous & Liquefied gas, Organic Peroxide classes IV and V, Unstable (reactive) class 1, Water reactive class 1
- Combustible Dust limited to:
 - Where manufactured, generated, or used in such a manner that the concentration and conditions create a fire or explosion hazard (reviewed by a PE)

Chemical Hazards in Fire Code MAQ Limits

Physical Hazards (8)

- Combustibles
- Flammables
- Pyrophorics
- Oxidizers
- Explosives
- Organic peroxides
- Unstables (reactive)
- Water reactives



Health Hazards (3)

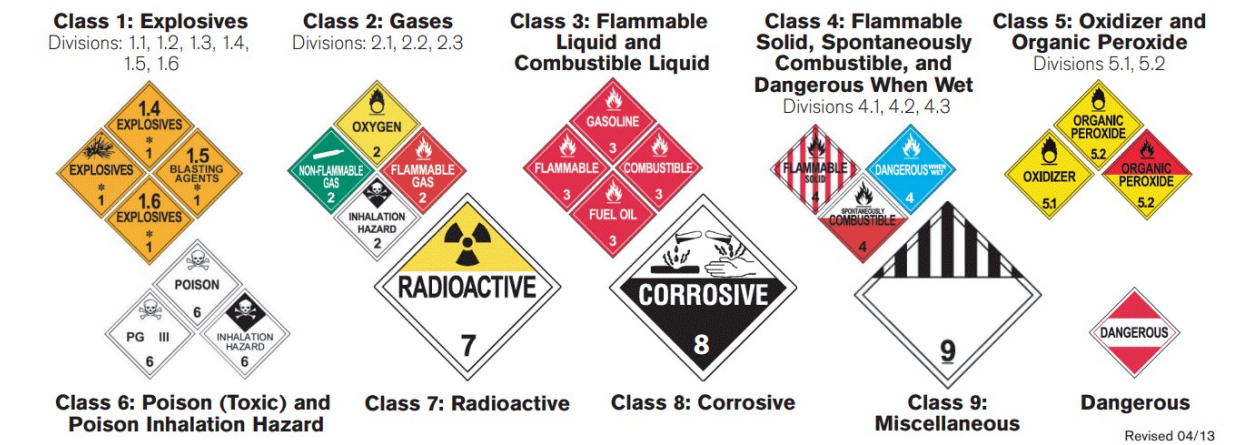
- Corrosives
- Toxics
- Highly Toxics
- Irritants
- Sensitizer
- Other Health Hazard Material

Other Hazard Classification Systems

US Department of Transportation – Pipeline and Hazardous Materials Safety Administration:

<https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-C/part-176>

- 17 major shipping groups



UN Globally Harmonized System:

<https://unece.org/transport/dangerous-goods/ghs-rev10-2023>

- 17 Physical Hazard classes, 10 Health Hazard classes & 2 Environmental Hazard classes



US Environmental Protection Administration

- 107 Compatibility mixing categories: <https://www.epa.gov/sites/default/files/2016-03/documents/compat-haz-waste.pdf>
- Listed & Characteristic Waste: <https://www.epa.gov/hw/defining-hazardous-waste-listed-characteristic-and-mixed-radiological-wastes> & <https://dtsc.ca.gov/defining-hazardous-waste/>



Classification Comparison

Fire Code	OSHA
Flammable Liquid, FP < 38 C	Liquid, Flammable, FP ≤ 93 C
Class IA , FP < 22.8 C, BP < 37.8 C	Category 1 , FP < 23 C, BP ≤ 35 C
Class IB , FP < 22.8 C, BP ≥ 37.8 C	Category 2 , FP < 23 C, BP > 35 C
Class IC , FP ≥ 22.8 C < 37.8 C Combustible Liquids, FP ≥ 37.8 C Class II , FP ≥ 37.8 C & < 60 C	Category 3 , FP ≥ 23 C & ≤ 60 C
Class IIIA , FP ≥ 60 C & 93.3 C Class IIIB , FP ≥ 93.3 C	Category 4 , FP > 60C & ≤ 93C

Derived Tools

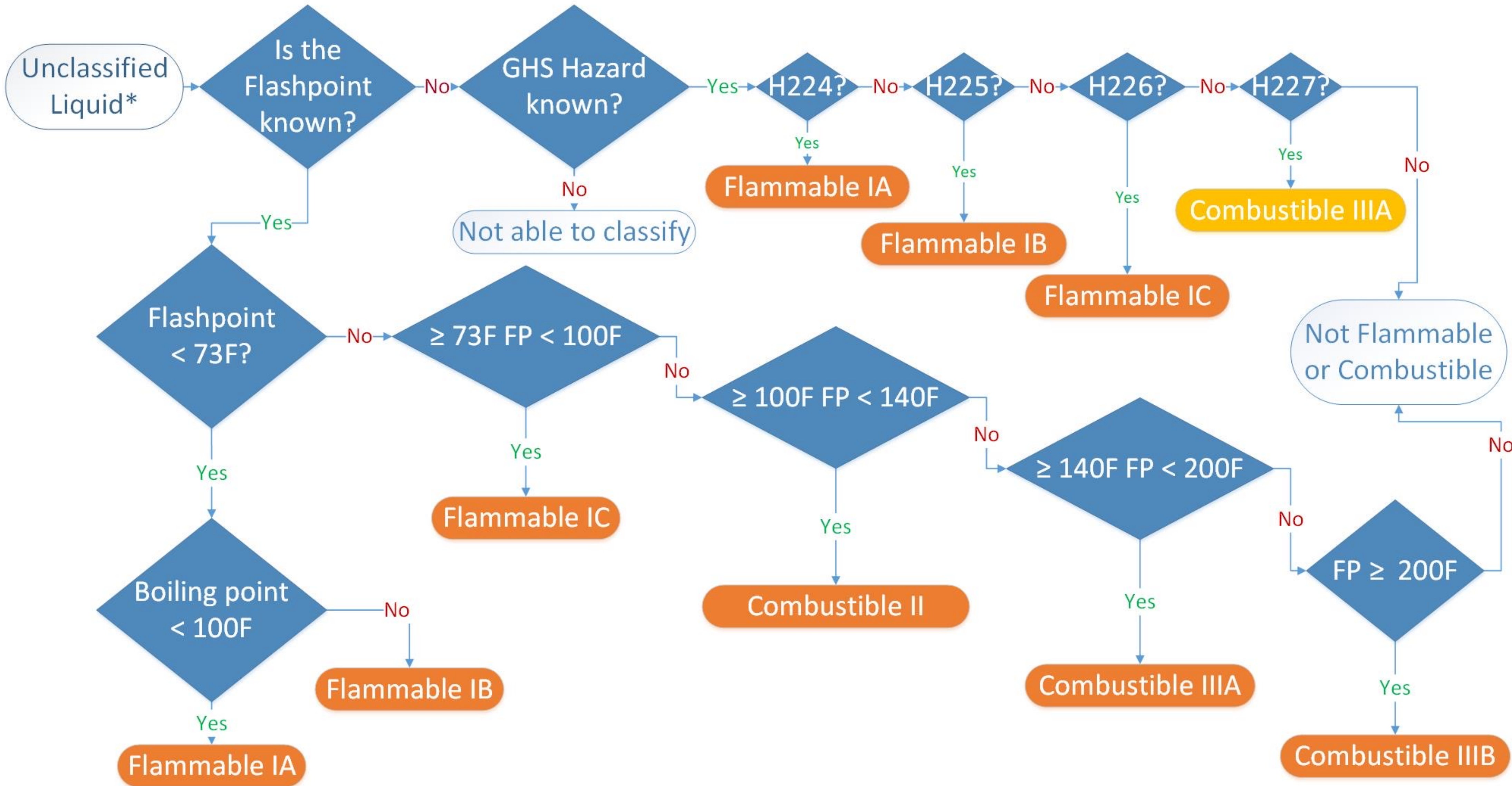
- [GHS Pictogram Guide to CFC Hazard Classes.pdf](#)
- [GHS Classification Summary – PubChem.pdf](#)
- [Definitions from California Fire Code about Hazard Classes.pdf](#)
- [GHS Pictograms & Hazard Statement to IFC Hazard Class.pdf](#)
- [ToxicFlammable Notes.pdf](#)

Available on <https://riskandsafety.com/rss-talks>

Fire Code


Flammable & Combustible Decision Flowchart

Based on Flash Point & Boiling Point First then GHS Hazard Statements



Using the GHS Pictogram Guide to CFC Hazard Classes

Flammable Liquids

Pictogram	Signal Word	Hazard Statement	Hazard Code	Hazard Class
	Danger	Extremely flammable liquid and vapor	H224, Category 1	IA
	Danger	Highly Flammable liquid and vapor	H225, Category 2	IB
	Warning	Flammable liquid and vapor	H226, Category 3	IC

<https://codes.iccsafe.org/content/IFC2024P1/appendix-e-hazard-categories>

<https://riskandsafety.com/sites/default/files/inline-files/GHS%20Pictogram%20Guide%20to%20CFC%20Hazard%20Classes.pdf>

RSS GHS → Fire Code for Highly Toxic Hazard Classes



Skull and Crossbones

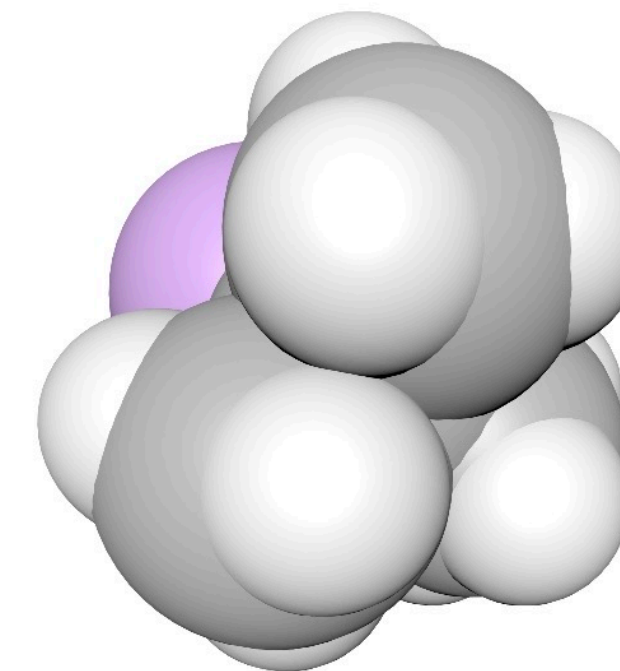
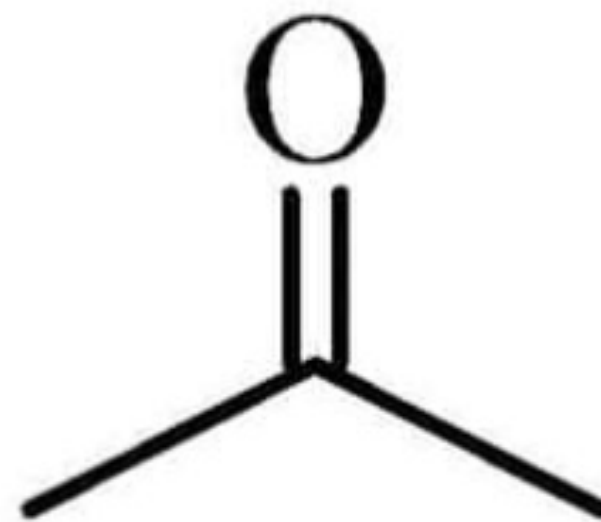
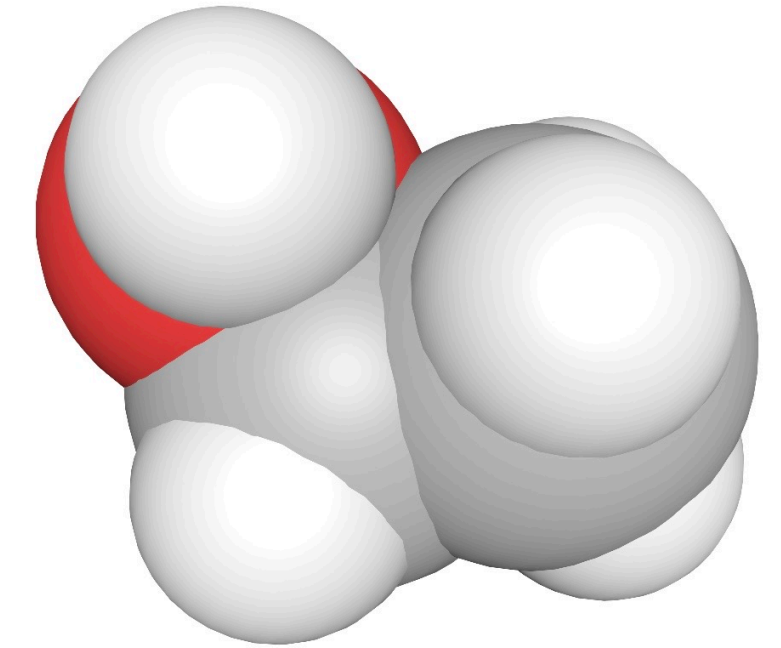
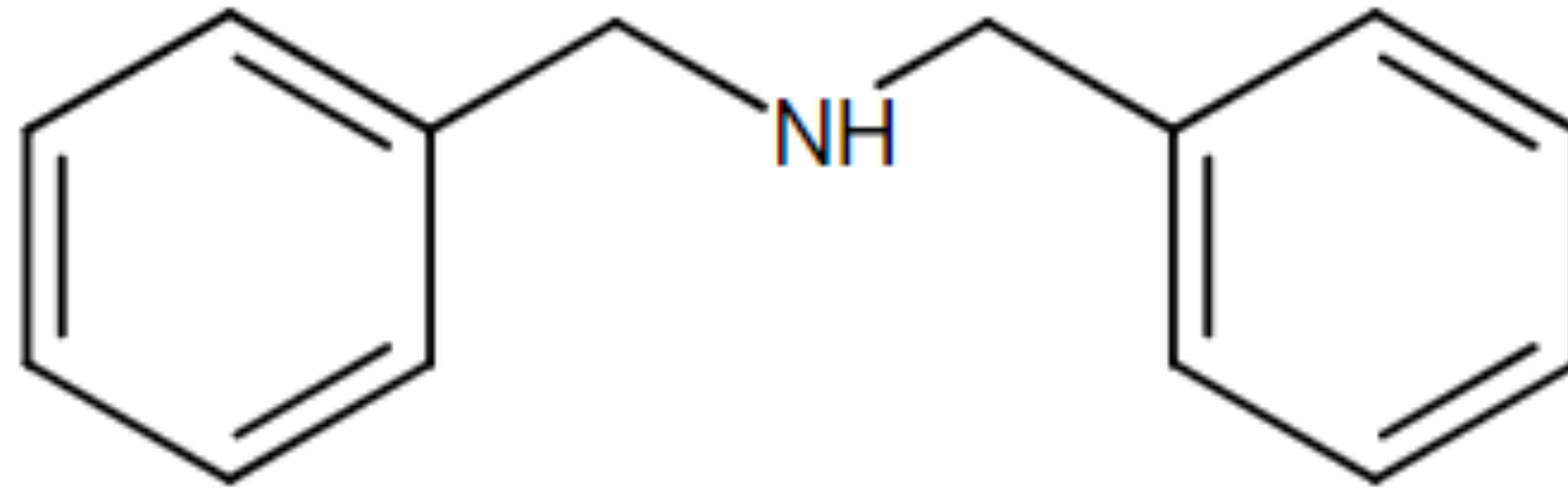
Signal Words	Hazard Statement	Code	Fire Code Material	Fire Code Hazard Class
Danger	Fatal if swallowed Fatal in contact with skin Fatal if inhaled	H300, Category 1 or H300, Category 2 or H310, Category 1 or H310, Category 2 or H330, Category 1	Highly Toxic	any physical state

Fire Code Definitions

Fire Code	Definition
NTP state	Liquid (boiling point > 20 C, melting point < 20 C) @ 1atm
Toxic	<p><u>LD50</u> is greater than 50 <u>mg/kg</u> and less than 500 <u>mg/kg</u> in <u>rat</u>, <u>oral</u></p> <p><u>LC50</u> is greater than or equal to 200 <u>ppmv</u> and less than 2000 <u>ppmv</u> OR <u>LC50</u> is greater than 2 <u>mg/L</u> and less than 20 <u>mg/L</u> in <u>rat</u>, <u>inhalation</u>, 1 <u>hr</u> or less</p> <p><u>LD50</u> is greater than 200 <u>mg/kg</u> and less than 1000 <u>mg/kg</u>, <u>rabbit</u>, <u>dermal</u></p>
Corrosive	<p>...visible destruction of, or irreversible alterations in, living tissue by chemical action at the point of contact. ... intact skin of albino rabbits...following an exposure period of 4 hours. This term does not refer to action on inanimate surfaces.</p>

Lets' Classify 😊

- dibenzylamine
- ethanol
- *t*-butyllithium 1.7 M in pentane
- acetone



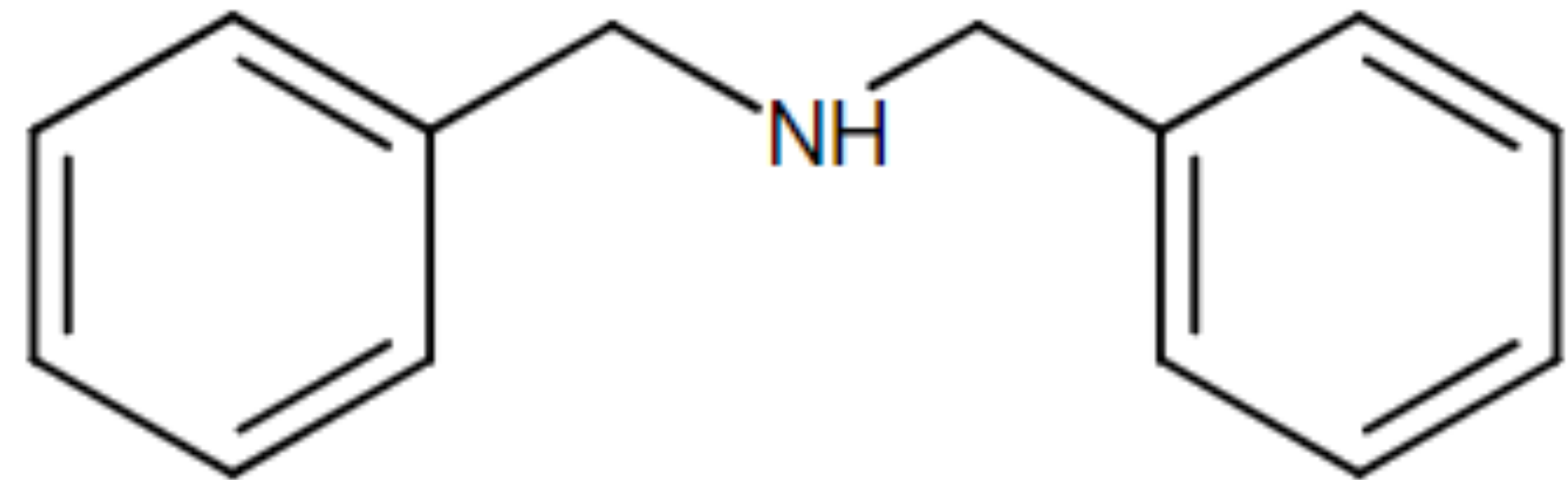
dibenzylamine

<https://commonchemistry.cas.org/>

CAS: 103-49-1

Boiling Point 270 ° C

Melting Point -26 ° C



dibenzylamine *(continued)*

<https://pubchem.ncbi.nlm.nih.gov/>

<https://pubchem.ncbi.nlm.nih.gov/compound/7656>



GHS Hazard Statements

H302 (**99.58%**): Harmful if swallowed [**Warning** Acute toxicity, oral]

H314 (73.31%): Causes severe skin burns and eye damage [**Danger** Skin corrosion/irritation]

H315 (26.69%): Causes skin irritation [**Warning** Skin corrosion/irritation]

H318 (36.86%): Causes serious eye damage [**Danger** Serious eye damage/eye irritation]

H319 (26.69%): Causes serious eye irritation [**Warning** Serious eye damage/eye irritation]

H410 (39.41%): Very toxic to aquatic life with long lasting effects [**Warning** Hazardous to the aquatic environment, long-term hazard]

H412 (20.34%): Harmful to aquatic life with long lasting effects [Hazardous to the aquatic environment, long-term hazard]

dibenzylamine *(continued 2)*

Search for SDS “dibenzylamine SDS”

Millipore Sigma

- <https://www.sigmaaldrich.com/US/en/sds/aldrich/d34108>

ThermoFisher

- <https://www.fishersci.com/store/msds?partNumber=AC112612500&productDescription=DIBENZYLAMINE%2C+98%25+250MLDIBEN&vendorId=VN00032119&countryCode=US&language=en>

Extracted SDS data dibenzylamine

Sigma-Aldrich (6/6/2023)

Danger



Harmful if swallowed.

Causes severe skin burns and eye damage.

Toxic to aquatic life.

Very toxic to aquatic life with long lasting effects.

Flash point 143 C (289 F)

Autoignition Temp 395 C (743 F)

Fisher Scientific (12/24/2021)

Danger



Harmful if swallowed

Causes severe skin burns and eye damage

May cause respiratory irritation

Flash point 138 C (280 F)


Autoignition Temp 425 C (797 F)

NFPA 704



RSS → GHS Fire Code for Corrosive Hazard Classes

Corrosion

Pictogram	Signal Words	Hazard Statement	Code	Fire Code Material
	Danger	Causes severe skin burns and eye damage	H314, Category 1 (1A, 1B, 1C)	Corrosive

Sigma-Aldrich SDS

dibenzylamine

Fisher Scientific SDS

Danger

Harmful if swallowed

Causes severe skin burns and eye damage

Toxic to aquatic life

Very toxic to aquatic life with long lasting effects

Danger

Harmful if swallowed

Causes severe skin burns and eye damage

May cause respiratory irritation

Extracted Toxicity Data

dibenzylamine

MilliporeSigma-Aldrich SDS

Acute toxicity

- LD50 Oral - Rat - female - 632 mg/kg
- Inhalation: No data available
- LD50 Dermal - Rat - > 2,000 mg/kg
- Skin corrosion/irritation
- Skin – Rabbit: Corrosive, category 1C

ThermoFisher Scientific SDS

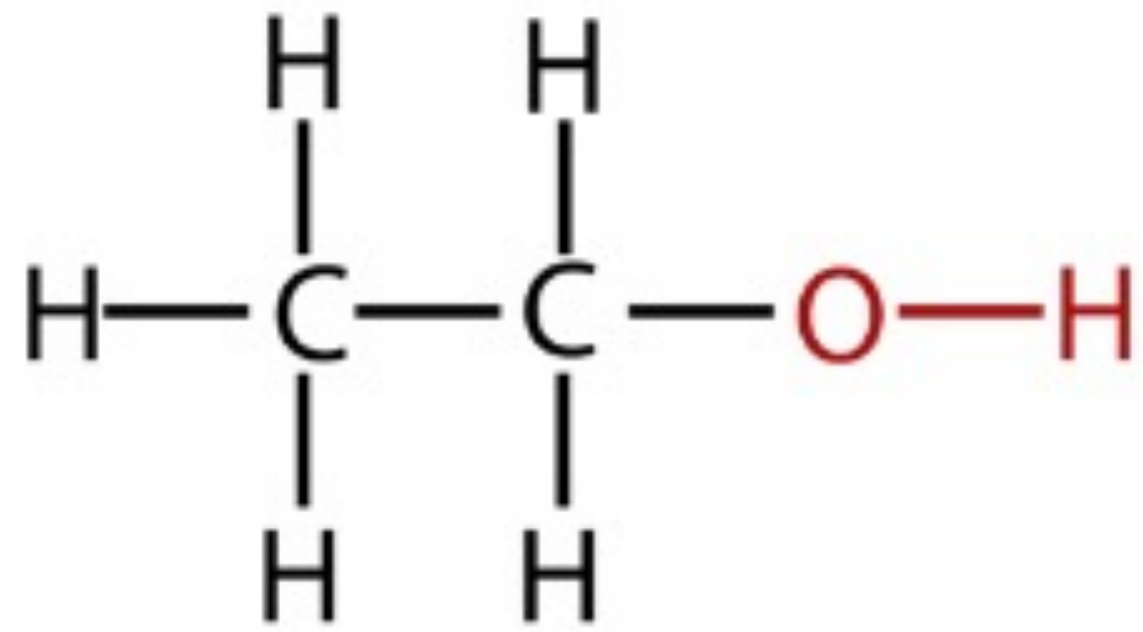
Acute toxicity

- LD50 Oral 632 mg/kg (Rat)
- LC50 Inhalation Not listed
- LD50 Dermal >2000 mg/kg (Rat)

RSS dibenzylamine Classifications

Fire Code Hazard Class	MAQ 1st floor B, No Sprinklers
Combustible Liquid: IIIB	13,200 gal
Irritant (CFC2001)	No Limit (2001 CFC)
Corrosive Liquid	500 gal

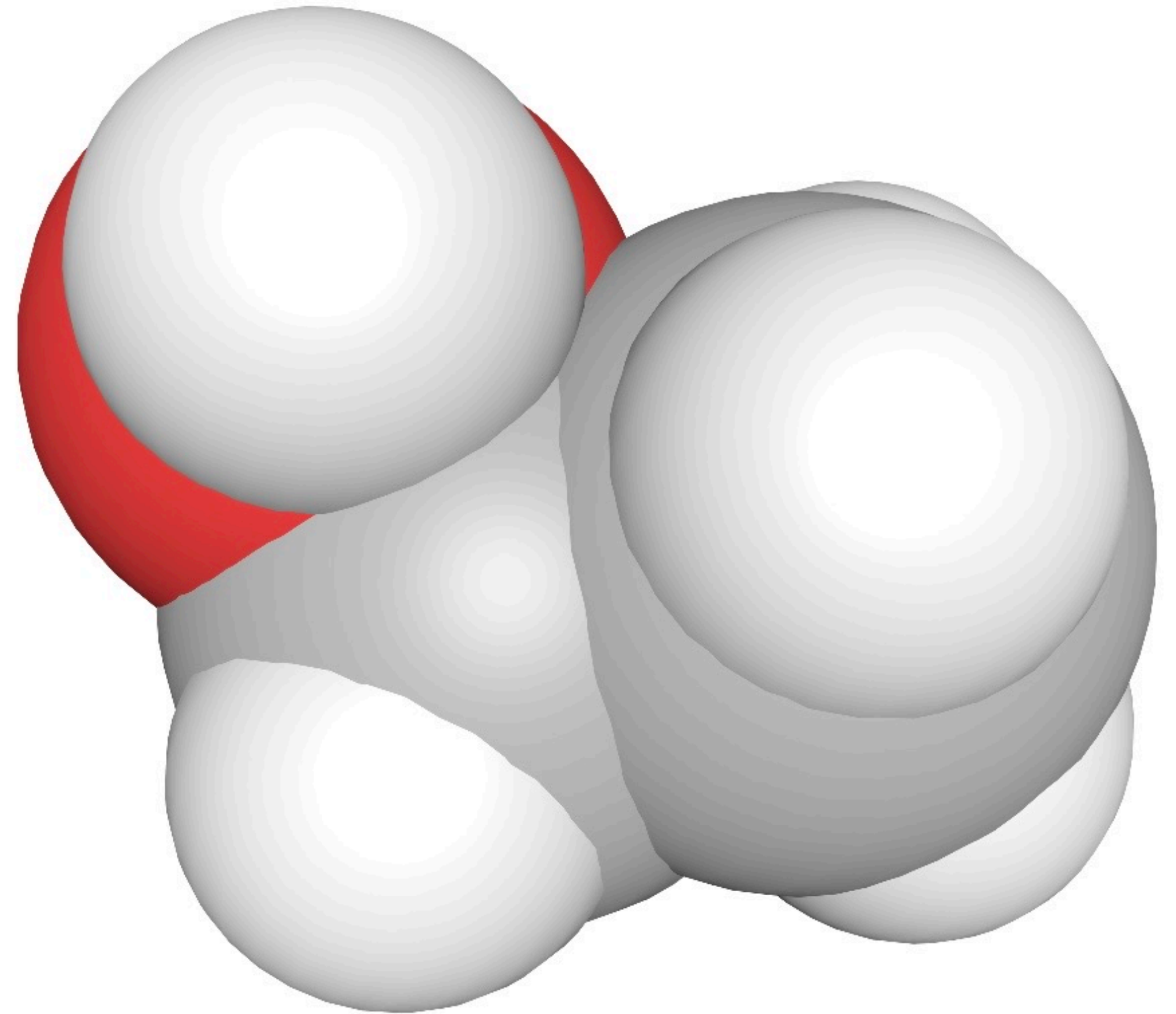
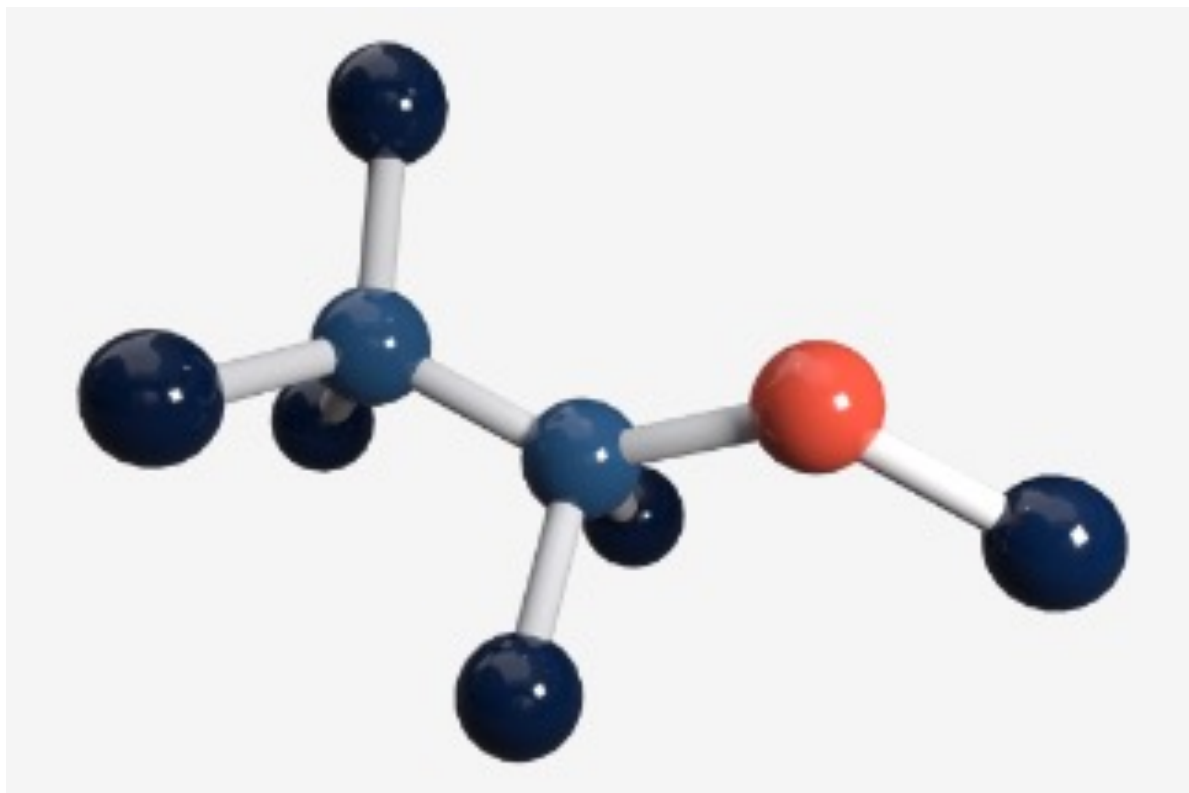
Ethanol (ethyl alcohol)



Structural
formula



Molecular
formula



Ethyl Alcohol

Sigma-Aldrich (8/23/2023) CAS [64-17-5]

Danger

Highly flammable liquid and vapor

Causes serious eye irritation

Flammable liquids (Category 2)H225

Eye irritation (Category 2A), H319

BP: 78 C (172 F)

FP: 13 C (55 F)

AIT: 363-425 C (685-797 F)

UEL: 27.7 %

LEL: 3.1 %

LD50 Oral – Rat: 10,470 mg/kg

LC50 Inhalation – Rat, 4h: 124.7 mg/L

Skin - Rabbit: No skin irritation



Ethyl Alcohol Comparison of Resources

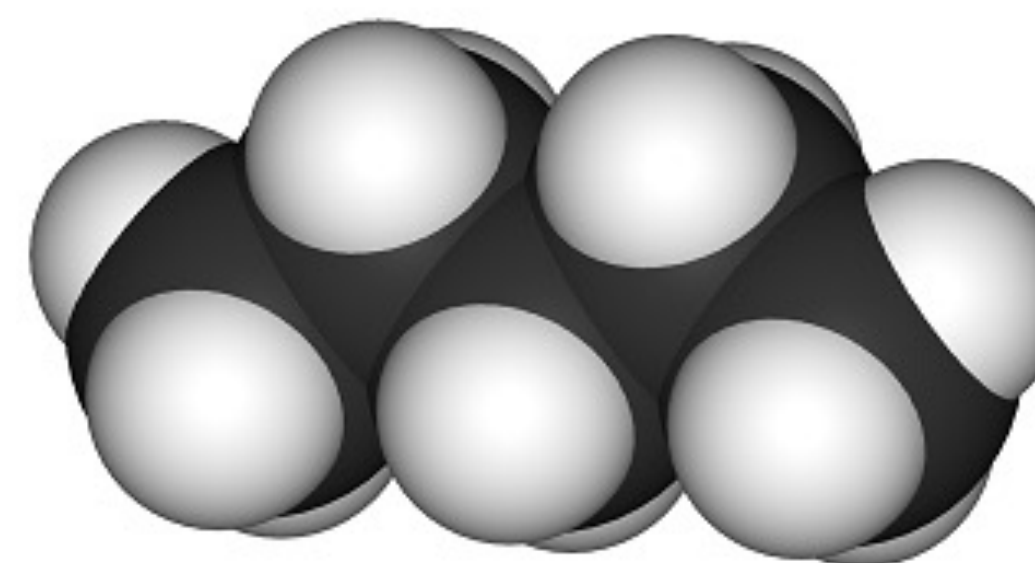
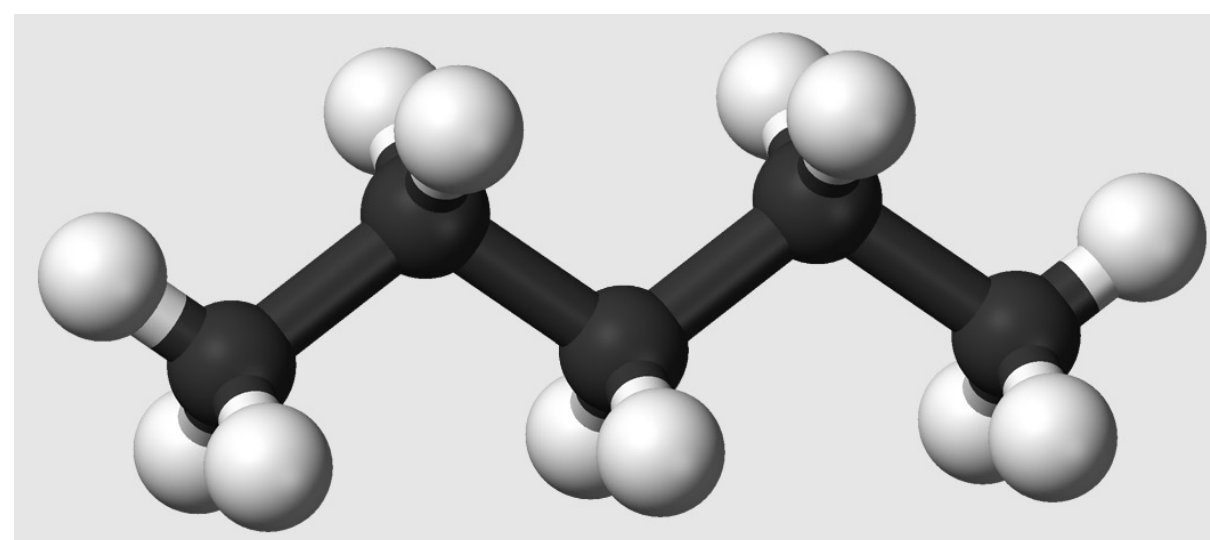
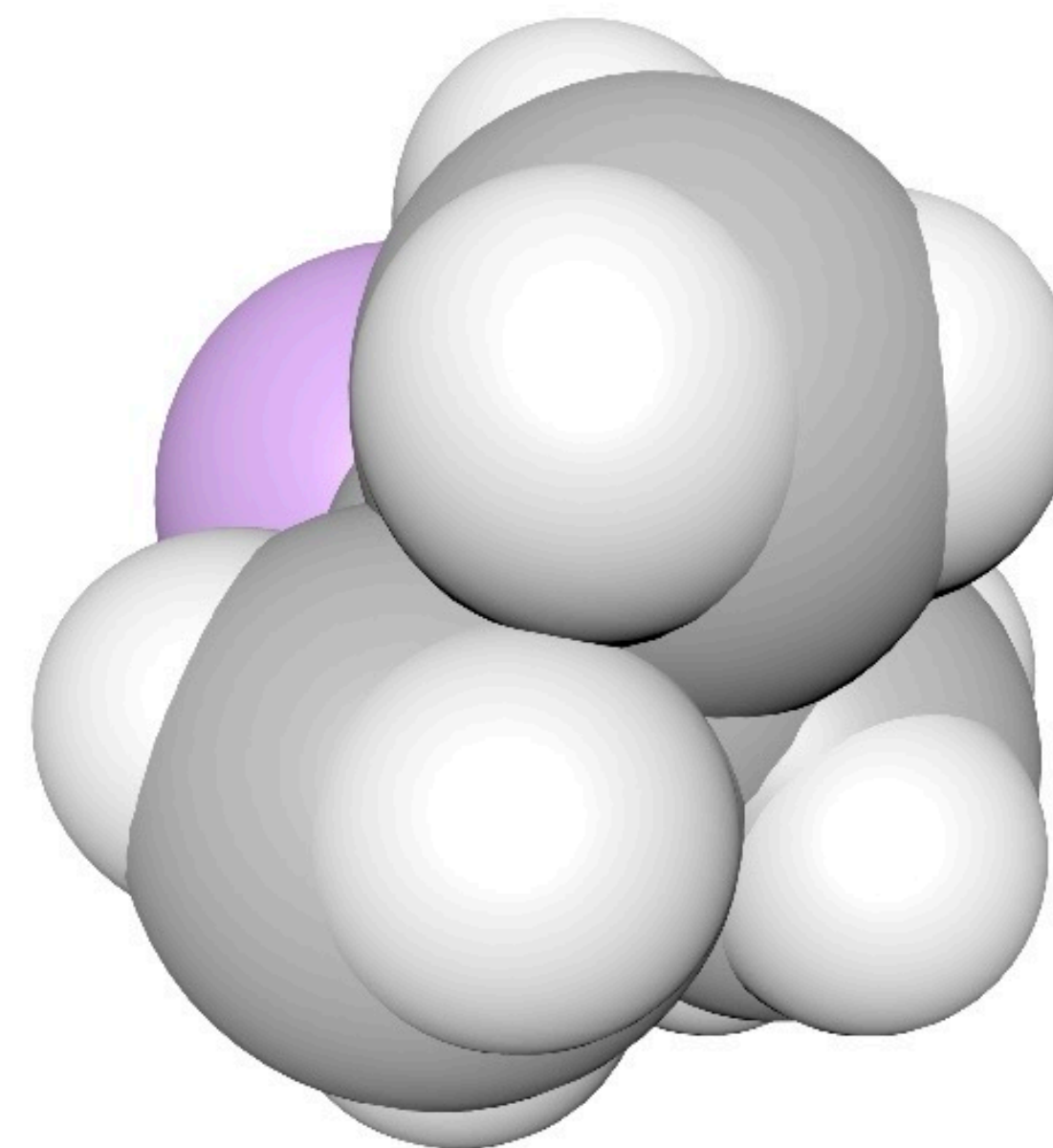
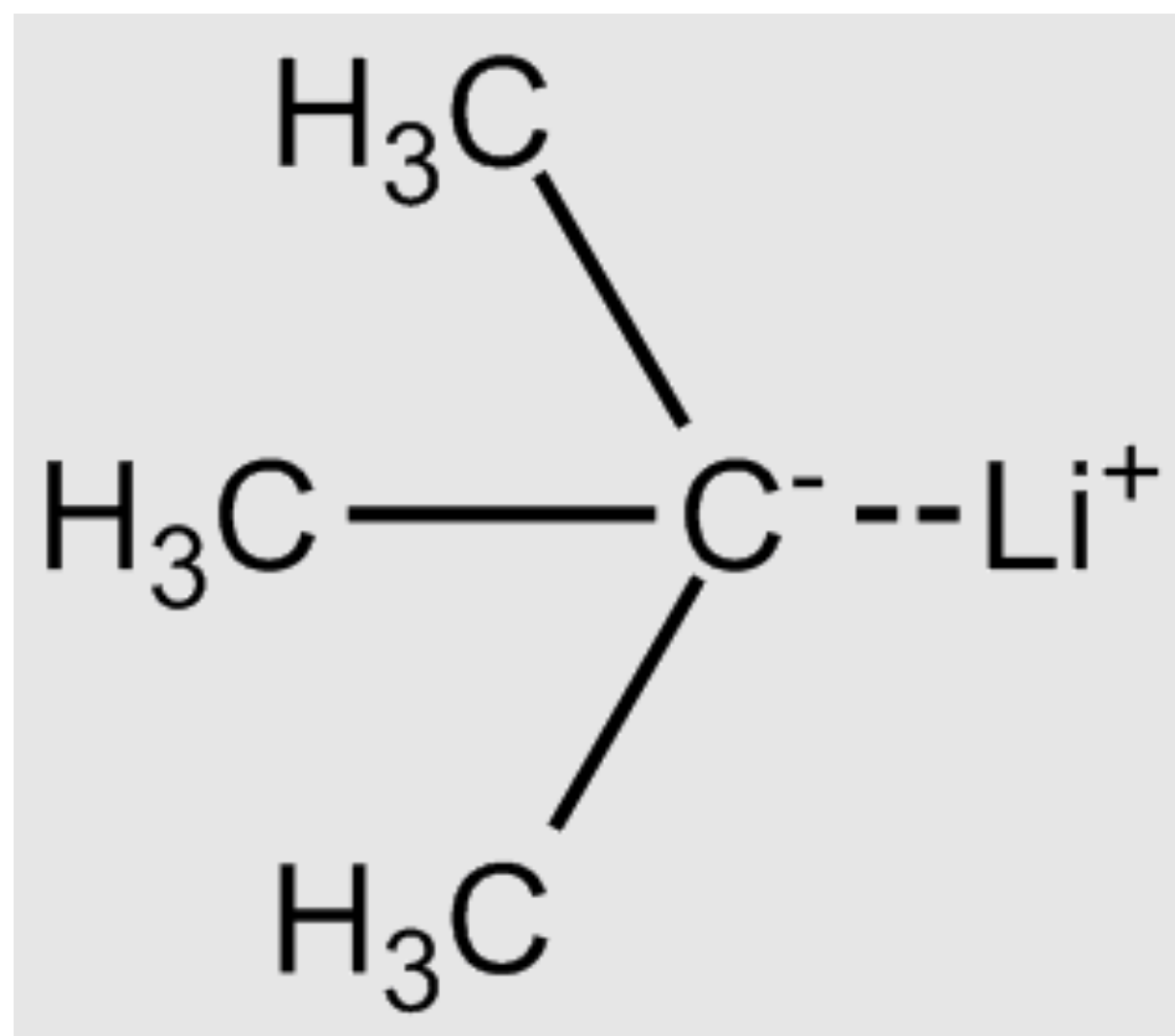


From SDS	GHS guide	CFC Definition
Danger; Highly flammable liquid and vapor	Flammable Liquid IB	
FP: 13 C (55 F); BP: 78 C (172 F)		Flammable Liquids Class IB flash point < 73°F (23°C) and boiling point ≥ 100°F (38°C)
Flammable liquids (Cat 2), H225	Flammable Liquid IB	
Eye irritation (Cat 2A), H319	Irritant (CFC2001)	eye irritant 16 C.F.R. 1500.42 or other approved techniques

RSS Ethanol Classifications

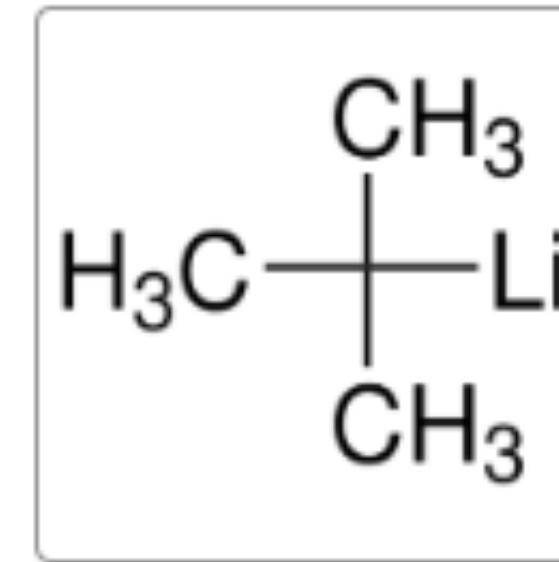
Fire Code Hazard Class	MAQ 1st floor B, No Sprinklers
Flammable Liquid : IB, IC	120 gal
Flammable Liquid : IA, IB, IC	120 gal
Irritant (CFC2001)	No Limit (2001 CFC)

t-butyllithium 1.7M in pentane



tert-butyllithium 1.7M in pentane

Sigma-Aldrich



tert-Butyllithium solution

Synonym(s): Lithium-2-methyl-2-propanide, t-BuLi

Linear Formula: (CH₃)₃CLi

CAS No.: 594-19-4

Molecular Weight: 64.06

Beilstein No.: 3587204

H225 Highly flammable liquid and vapor.

H250 Catches fire spontaneously if exposed to air.

H260 In contact with water releases flammable gases which may ignite spontaneously.

H304 May be fatal if swallowed and enters airways.

H314 Causes severe skin burns and eye damage.

H336 May cause drowsiness or dizziness.

Autoignition Temperature

- No data

Flash Point

- -49 C (-56 F)







Boiling Point

- No data

Acute toxicity estimate (ATE)

- Inhalation - 4 h - 30.1 mg/l - vapor

t-butyllithium 1.7M in pentane

Pictogram	Hazard Statements (Signal Word - Danger)	GHS Classification	Fire Code Hazard Class
	Highly flammable liquid and vapor	Flammable liquids (Cat 2), H225	Flammable Liquid IB
	Catches fire spontaneously if exposed to air	Pyrophoric liquids (Cat 1), H250	Pyrophoric
	In contact with water releases flammable gases which may ignite spontaneously	Chemicals which, in contact with water, emit flammable gases (Cat 1), H260	Water Reactive 3
	May be fatal if swallowed and enters airways	Aspiration hazard (Cat 1), H304	Other Health Hazard Material
	May cause drowsiness or dizziness	Specific target organ toxicity - single exposure (Cat 3), Central nervous system, H336	Other Health Hazard Material
	Causes severe skin burns and eye damage	Skin corrosion (Cat 1B), H314 Serious eye damage (Cat 1), H318	Corrosive

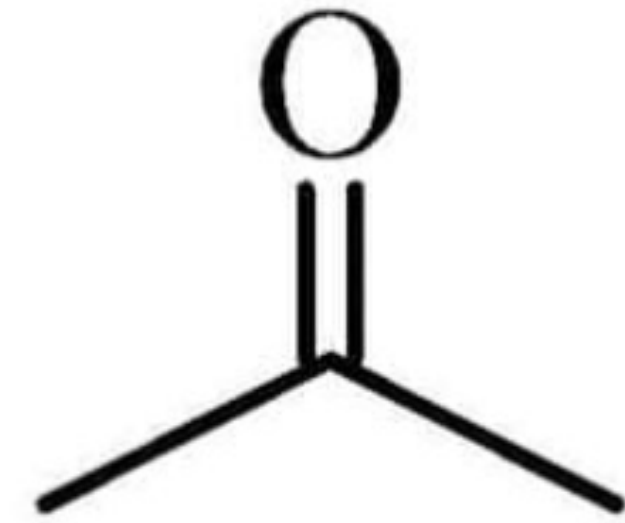
RSS t-butyllithium 1.7M in pentane Classifications

Fire Code Hazard Class	MAQ 1st floor B, no Sprinklers
Corrosive	500 lbs
Flammable Liquid : IB, IC	120 gal
Flammable Liquid : IA, IB, IC	120 gal
Irritant (CFC2001)	No Limit (2001 CFC)
Other Health Hazard Material	No Limit (2001 CFC)
Pyrophoric	Not Allowed
Water reactive : 3	5 lbs

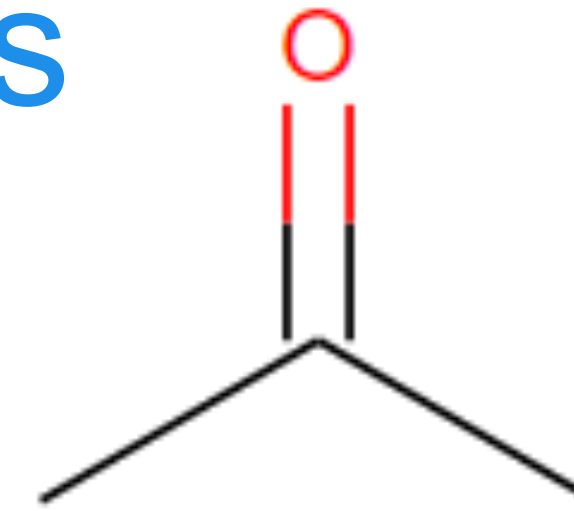
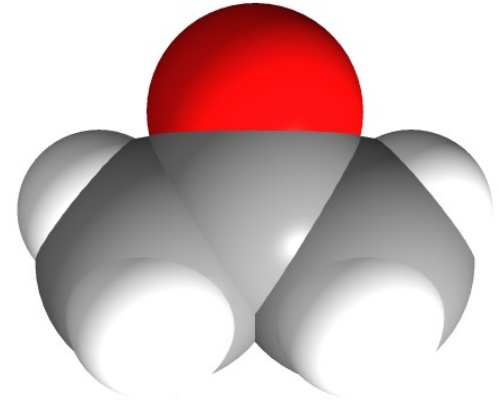
acetone

Sigma-Aldrich SDS

- Highly flammable liquid and vapor.
 - Flammable liquids (Cat 2), H225
- Causes serious eye irritation.
 - Eye irritation (Cat 2A), H319
- May cause drowsiness or dizziness.
 - Specific target organ toxicity - single exposure (Cat 3), Central nervous system, H336



RSS Acetone Classifications



Fire Code Hazard Class	MAQ 1st floor B, No Sprinklers
Flammable Liquid : IB	-
Flammable Liquid : IB, IC	120 gal
Flammable Liquid : IA, IB, IC	120 gal
Irritant (CFC2001)	No Limit (2001 CFC)
Other Health Hazard Material	No Limit (2001 CFC)

Summary

- Data from SDS and other resources
- Compare to RSS tools to approximate the right answer
- Use Fire Code Definitions, when possible, to know its right
- RSS Chemicals can help solve these problems

Sign up to see how we can help

<https://linktr.ee/riskandsafetysolutions>

Fire Code Hazard Classes

dibenzylamine

- **Flammable Liquid : IB**
- *Irritant (CFC2001)*
- *Other Health Hazard Material*

ethanol

- **Flammable Liquid : IB**
- *Irritant (CFC2001)*
- *Other Health Hazard Material*

t-butyllithium in 1.7 M pentane

- **Flammable Liquid : IB**
- **Pyrophoric**
- **Water reactive : 3**
- *Irritant (CFC2001)*
- *Other Health Hazard Material*

acetone

- **Flammable Liquid : IB**
- *Irritant (CFC2001)*
- *Other Health Hazard Material*

Questions?



Derived Tools

- [GHS Pictogram Guide to CFC Hazard Classes.pdf](#)
- [GHS Classification Summary – PubChem.pdf](#)
- [Definitions from California Fire Code about Hazard Classes.pdf](#)
- [GHS Pictograms & Hazard Statement to IFC Hazard Class.pdf](#)
- [ToxicFlammable Notes.pdf](#)

Available on <https://riskandsafety.com/rss-talks>

Resources

NIST

- <https://webbook.nist.gov/chemistry/>
- <https://www.nist.gov/pml/productservices/physical-reference-data>

UNECE GHS

- <https://unece.org/transport/dangerous-goods/ghs-rev10-2023>

CFC 2022

- <https://codes.iccsafe.org/content/CAFC2022P2/california-code-of-regulations-title-24>

NIH NLM PubChem

- <https://pubchem.ncbi.nlm.nih.gov/ghs/>
- All suppliers who sell to people who are required to provide SDS to the people who obtain use the hazardous material* in their work

**as defined by OSHA, excludes 'articles', additives and alcoholic beverages, cosmetics, drugs and pharmaceuticals, hazardous wastes & remediation, tobacco & tobacco products, wood & lumber, consumer products, non-hazardous nuisance particulates & dust, ionizing & non-ionizing radiation, biological hazards, office & school supplies*



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We want to hear from you!



<https://calendly.com/saroper/15min>