



California Fire Code Chemical Hazard Classification discussion with examples

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W-L1

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Poll #1 Training/Experience



- Hazardous Materials Incident Commander
- Hazardous Materials Technician
- Hazardous Materials Instructor
- Haz Mat Technical Reference Specialist
- Haz Mat Specialist
- Haz Mat Assistant Safety Officer
- Chemistry Degree or Industrial Hygienist

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

Poll #2 Familiarity with MAQ

- Architect or building design planner
- Fire Marshal
- Fire Protection Engineer
- Involved in Construction
- I've heard of it
- What's MAQ?

History of loss

- 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.
(Musée des Beaux-Arts André Malraux, Le Havre, France)*

Rules that result...

- 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

MAQ Limits are Complex

- Prior to 2000, no comprehensive limits
- Starting in 2001 California Fire Codes limits quantities of chemicals
- 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

Changes in MAQ

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

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

Chemical Hazards in Fire Code MAQ limits

Health Hazards



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

Physical Hazards



- Combustibles
- Flammable
- Pyrophoric
- Oxidizer
- Explosives
- Organic peroxide
- Unstable (reactive)
- Water reactive

Compliance Challenges

- Flammable liquid IA MAQ
 - 1st floor - 30 gallons
 - 2nd floor - 22.5 gallons
 - 3rd floor - 15 gallons
 - 4th thru 6th floors - 3.75 gallons
 - 7th floor and higher - 1.5 gallons
- If there are 4 lab groups in one control area, it is possible that each would get 1/3rd of a gallon for all IA flammable liquids

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)

Resources

- Definitions from California Fire Code about Hazard Classes (<https://codes.iccsafe.org/content/CAFC2022P2/california-code-of-regulations-title-24>)
- GHS Pictogram Guide to CFC Hazard Classes
- GHS Pictograms & Hazard Statement to IFC Hazard Class (<https://codes.iccsafe.org/s/IFC2024P1/part-vii-appendices/IFC2024P1-Pt07-AppxE-SecE104.2>)
- GHS Classification Summary – PubChem (<https://pubchem.ncbi.nlm.nih.gov/ghs/>)

Resources in pdf

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

SDS Resources

Dibenzylamine MilliporeSigma SDS 2023.06.06.pdf

DIBENZYLAMINE-ThermoFisher SDS 2021.12.24.pdf

ethyl alcohol Millipore Sigma SDS 2023.08.23.pdf

tert-butyllithium 1.7 M in pentane Millipore Sigma SDS.pdf

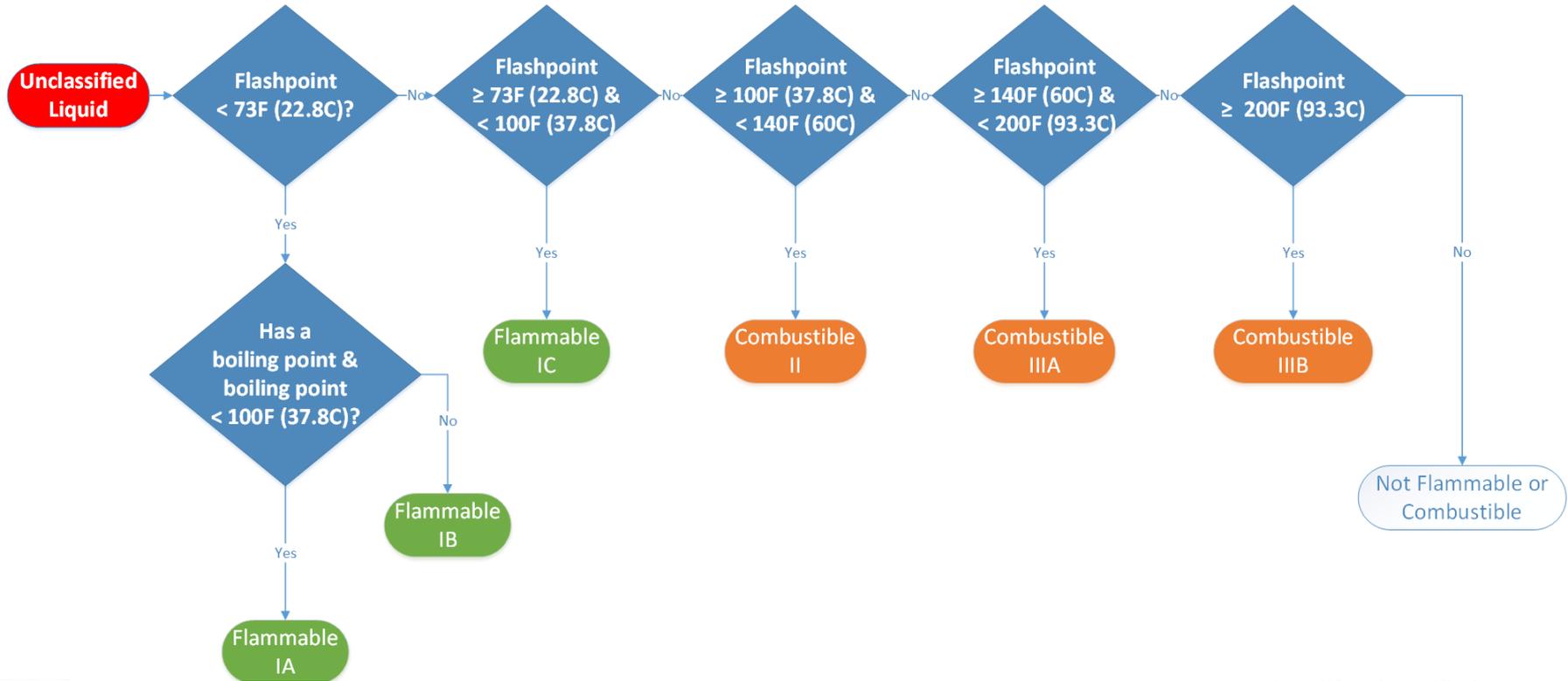
Acetone MilliporeSigma SDS 2023.07.25.pdf

BREAK TIME!

Classes w/ quantitative definitions

- Flammable & combustible Liquids
- Pyrophorics
- Toxic & Highly Toxic

Flammable & Combustible Liquids



Classification Comparison

Fire Code

Flammable Liquid, FP < 38 C

- Class IA, FP < 22.8 C, BP < 37.8 C ≈
- Class IB, FP < 22.8 C, BP ≥ 37.8 C ≈
- Class IC, FP ≥ 22.8 C < 37.8 C

Combustible Liquids, FP ≥ 37.8 C

- Class II, FP ≥ 37.8 C & < 60 C } ≈
- Class IIIA, FP ≥ 60 C & 93.3 C ≈
- Class IIIB, FP ≥ 93.3 C

OSHA

Liquid, Flammable, FP ≤ 93 C

- Category 1, FP < 23 C, BP ≤ 35 C
- Category 2, FP < 23 C, BP > 35 C
- Category 3, FP ≥ 23 C & ≤ 60 C
- Category 4, FP > 60C & ≤ 93C

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>

Unstable (reactive) Material

A material, other than an explosive, which in the pure state or as commercially produced, will vigorously polymerize, decompose, condense or become self-reactive and undergo other violent chemical changes, including explosion, when exposed to heat, friction or shock, or in the absence of an inhibitor, or in the presence of contaminants, or in contact with incompatible materials.

Unstable (reactive) materials are subdivided as follows:

- Class 4; Class 3; Class 2; Class 1

Unstable (reactive) Material

Class 4. Materials that in themselves are **readily capable of detonation** or explosive decomposition or explosive reaction at normal temperatures and pressures. This class includes materials that are sensitive to mechanical or localized thermal shock at normal temperatures and pressures.

MAQ 1st floor, B occupancy, only allowed with sprinklers:

1 pounds for solid & liquids, 10 cubic feet for gas

Unstable (reactive) Material

Class 3. Materials that in themselves are **capable of detonation** or of explosive decomposition or explosive reaction but which require a strong initiating source or which must be heated under confinement before initiation. This class includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

MAQ 1st floor, B occupancy, no sprinklers:

5 pounds for solid & liquids, 50 cubic feet for gas

Unstable (reactive) Material

Class 2. Materials that in themselves are normally unstable and readily undergo violent chemical change but **do not detonate**. This class includes materials that can undergo chemical change with rapid release of energy at normal temperatures and pressures, and that can undergo violent chemical change at elevated temperatures and pressures.

MAQ 1st floor, B occupancy, no sprinklers:

50 pounds for solid & liquids, 750 cubic feet for gas

Unstable (reactive) Material

Class 1. Materials that in themselves are normally stable but which can become unstable at elevated temperatures and pressure.

MAQ 1st floor, B occupancy, no sprinklers:

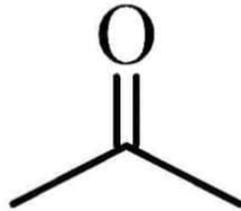
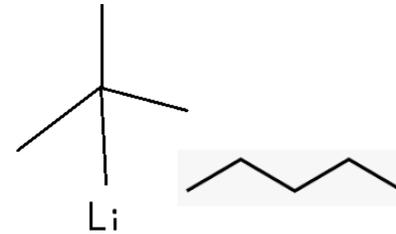
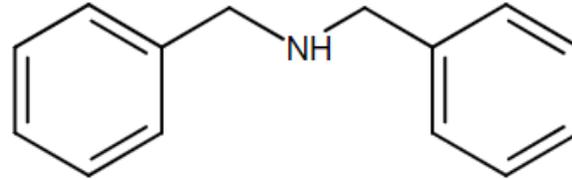
No limit

Unstable (reactive) w/ GHS

Pictogram	Signal word	Hazard Statement	Hazard Code	Hazard Class
	Danger	Heating may cause an explosion	H240, Type A	4
	Danger	Heating may cause a fire or explosion	H241, Type B	3
	Danger	Heating may cause a fire	H242, Type C <i>or</i> H242, Type D	2
	Warning	Heating may cause a fire	H242, Type E <i>or</i> H242, Type F	1

Let's classify 😊

- dibenzylamine
- ethyl alcohol
- tert-butyllithium
- acetone

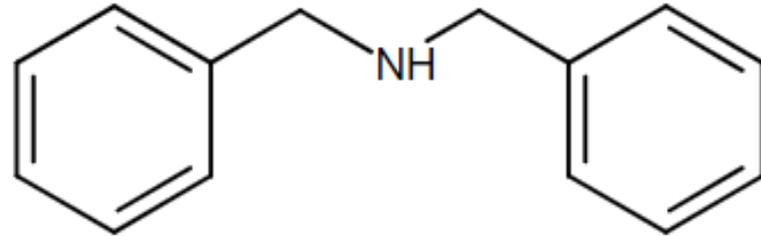


Short

Break Time!

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]



Corrosive



Irritant



Environmental
Hazard

Dibenzylamine *(continued)*

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

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



Corrosive



Irritant



Environmental
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 data

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



GHS Pictogram Guide to CFC 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



Danger

Harmful if swallowed.

Causes severe skin burns and eye damage.

Toxic to aquatic life.

Very toxic to aquatic life with long lasting effects.

Fisher Scientific



Danger

Harmful if swallowed

Causes severe skin burns and eye damage

May cause respiratory irritation

Extracted Toxicity Data

MilliporeSigma-Aldrich

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

Acute toxicity

LD50 Oral 632 mg/kg (Rat)

LC50 Inhalation Not listed

LD50 Dermal >2000 mg/kg (Rat)

CFC Definitions

NTP state = Liquid (*boiling point > 20 C, melting point < 20 C*) @ 1atm

Toxic

- LD50 is greater than 50 mg/kg and less than 500 mg/kg in rat, oral
- LC50 is greater than or equal to 200 ppmv and less than 2000 ppmv OR LC50 is greater than 2 mg/L and less than 20 mg/L in rat, inhalation, 1 hr or less
- LD50 is greater than 200 mg/kg and less than 1000 mg/kg, rabbit, dermal

Corrosive

...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.

Combustible Liquid IIB

No GHS Hazard Statement or pictogram

Fire Code Based on IFC

Flammable Liquid, FP < 38 C

- Class IA, FP < 22.8 C, BP < 37.8 C ≈
- Class IB, FP < 22.8 C, BP ≥ 37.8 C ≈
- Class IC, FP ≥ 22.8 C < 37.8 C

Combustible Liquids, FP ≥ 37.8 C

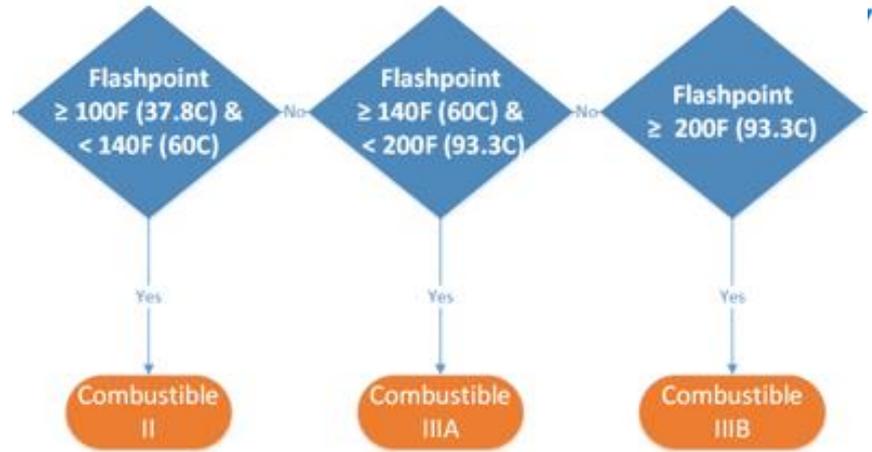
- Class II, FP ≥ 37.8 C & < 60 C ≈
- Class IIIA, FP ≥ 60 C & 93.3 C ≈
- Class IIIB, FP ≥ 93.3 C

OSHA Based on GHS

Liquid, Flammable, FP ≤ 93 C

- Category 1, FP < 23 C, BP ≤ 35 C
- Category 2, FP < 23 C, BP > 35 C
- Category 3, FP ≥ 23 C & ≤ 60 C
- Category 4, FP > 60C & ≤ 93C

CFC Definitions



Combustible Liquids

A liquid having a closed cup flash point at or above 100°F (38°C). Combustible liquids shall be subdivided as follows:

Class II. Liquids having a closed cup flash point at or above 100°F (38°C) and below 140°F (60°C).

Class IIIA. Liquids having a closed cup flash point at or above 140°F (60°C) and below 200°F (93°C).

Class IIIB. Liquids having closed cup flash points at or above 200°F (93°C).

RSS Dibenzylamine Classifications at UC

Fire Code Hazard Class

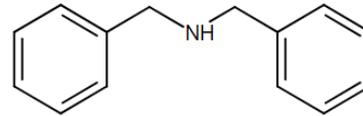
- Combustible Liquid : IIIB
- Irritant (CFC2001)
- Corrosive Liquid

MAQ 1st floor B, No Sprinklers

- 13,200 gal
- No Limit (2001 CFC)
- 500 gal

Let's classify 😊

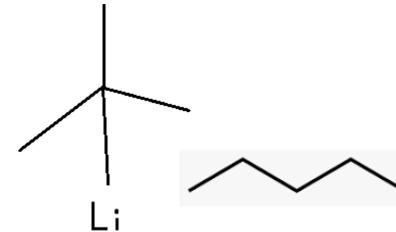
✓ dibenzylamine



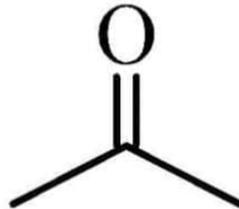
• ethyl alcohol



• tert-butyllithium



• acetone



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 compare to resources

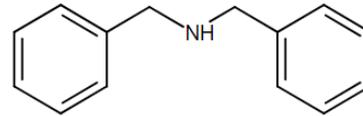
From SDS	GHS guide	CFC Definition
Danger; Highly flammable liquid and vapor.” 	Flammable Liquid IB	
FP: 13 C (55 F); BP: 78 C (172 F)”		Flammable Liquids Class IB. Liquids flash point < 73°F (23°C) and boiling point ≥ 100°F (38°C).
Flammable liquids (Category 2), H225	Flammable Liquid IB	
Eye irritation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

RSS Ethanol Classifications at UC

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)

Let's classify 😊

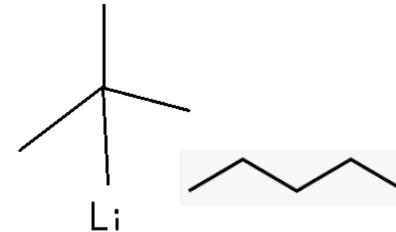
✓ dibenzylamine



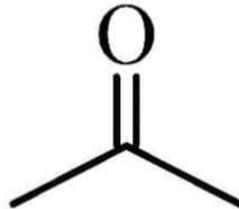
✓ ethyl alcohol



• tert-butyllithium

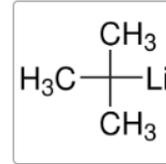


• acetone



tert-butyllithium 1.7 M 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 (AIT) = No data available
 Flash Point = -49 C (-56 F)
 Boiling Point = No data
 Acute toxicity estimate
 Inhalation - 4 h - 30.1 mg/l
 - vapor

t-butyllithium 1.7 M in pentane

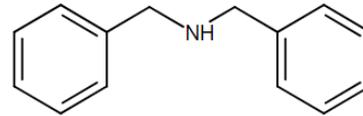
Pictogram	Hazard Statements (Signal Word - Danger)	GHS Classification	CFC Hazard Class
	Highly flammable liquid and vapor.	Flammable liquids (Cat 2), H225	Flammable Liquid IB
	Catches fire spontaneously if exposed to air.	Pyrophoric liquids (Cat 1), H250	Pyrophoric
	In contact with water releases flammable 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 1.7 M in pentane Classifications at UC

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)
Other Health Hazard Material	No Limit (2001 CFC)

Let's classify 😊

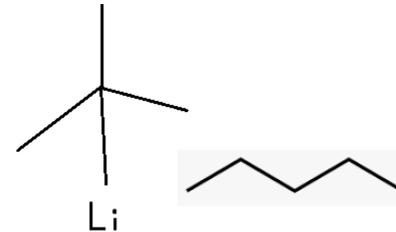
✓ dibenzylamine



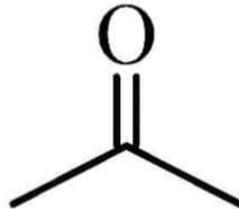
✓ ethyl alcohol



✓ tert-butyllithium



• acetone



Acetone



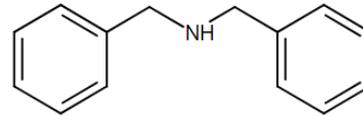
- Sigma-Aldrich
- Highly flammable liquid and vapor.
 - Flammable liquids (Cat 2), H225
- Causes serious eye irritation.
 - Eye irritation (Cat 2A), H319
- May cause drowsiness or dizziness.
 - Specific target organ toxicity - single exposure (Cat 3), Central nervous system, H336

RSS *Acetone* Classifications at UC

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)
Other Health Hazard Material	Not Included

Let's classify 😊

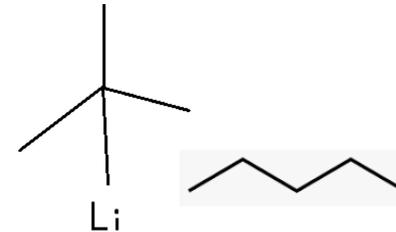
✓ dibenzylamine



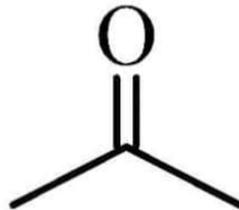
✓ ethyl alcohol



✓ tert-butyllithium



✓ acetone



Common Chemicals *Extra Credit*



Solid

Sodium hydroxide

Aluminum oxide

Sodium bicarbonate

Calcium carbonate

Liquid

Sulfuric acid

Benzene

Ethanol

Ethylene glycol

Acetic acid

Acetone

Hydrochloric acid

Formaldehyde (aq)

Ammonia (aq)

Sodium hydroxide (aq)

Gas

Ethylene

Ammonia

Propylene

Chlorine

Nitrogen

Formaldehyde

Summary

- No need to have a chemistry degree
- Seemingly arbitrary and complicated regulations can be the basis for employment
- Making reasonable approximations of hazard classes can be fun 😊

Additional 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



Safety & Compliance Intelligent Software



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| RiskandSafety.com



Risk Assessments



Inspections & Audits



Injury & Illness Reporting



Chemical Inventory Management



Computer Ergonomics



Respirator Fit



Any Questions?

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www.linkedin.com/in/russellvernon

26th California Unified Program
Annual Training Conference
February 26-29, 2024

