



Gas Detection Requirements

Maine, ICC and NFPA



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May 13, 2022

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Your Instructor



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Course Goal

- Provide you an overview of the important gas detection requirements from the State of Maine and the model building and fire codes.





Learning Objectives

By the end of the course, you will be able to:

1. Identify Maine Title 25 §2469, the International Building and Residential Codes, and NFPA 1 gas detection requirements.
2. Provide examples of common sources of physical and health hazard gases.
3. Demonstrate how these regulations apply to new and existing construction.





Course Layout

- Gas characteristics and hazards
- Maine Title 25 §2469 “Fuel Gas Detectors”
- IBC/IRC/IMC/NFPA I requirements
- Flammable refrigerants
- Carbon monoxide





Critical Thinking Skills

- Observation
 - Notice opportunities, problems and solutions
 - Ask “Why?”
- Analysis
 - Gather, understand, interpret data
- Inference
 - Draw conclusions based on empiricism: data and experience
- Communications
 - Clear and comprehensible





Discussion

What is a “gas”?



Sample Characteristics

| Gas | Lighter than Air | Heavier than Air | Toxic | Flammable | Corrosive | Oxidizing | Inert |
|-----------------------|------------------|------------------|-------|-----------|-----------|-----------|-------|
| Hydrogen | X | | | X | | | |
| Nitrogen | X | | | | | | X |
| Carbon dioxide | | X | | | | | X |
| Oxygen | | X | | | | X | |
| LP-gas (propane) | | X | | X | | | |
| Methane (natural gas) | X | | | X | | | |
| Ammonia | | X | X | ? | X | | |
| Chlorine | | X | X | | X | X | |



Propane

Section 9. Physical and chemical properties

| | |
|---|---|
| Critical temperature | : 96.55°C (205.8°F) |
| Flash point | : Closed cup: -104°C (-155.2°F) Open cup: -104°C (-155.2°F) |
| Evaporation rate | : Not available. |
| Flammability (solid, gas) | : Extremely flammable in the presence of the following materials or conditions: open flames, sparks and static discharge and oxidizing materials. |
| Lower and upper explosive (flammable) limits | : Lower: 1.8% Upper: 8.4% |
| Vapor pressure | : 109 (psig) |
| Vapor density | : 1.6 (Air = 1) |
| Specific Volume (ft³/lb) | : 8.6206 |
| Gas Density (lb/ft³) | : 0.116 (25°C / 77 to °F) |
| Relative density | : Not applicable. |
| Solubility | : Not available. |
| Solubility in water | : 0.0244 g/l |
| Partition coefficient: n-octanol/water | : 1.09 |
| Auto-ignition temperature | : 287°C (548.6°F) |
| Decomposition temperature | : Not available. |
| Viscosity | : Not applicable. |
| Flow time (ISO 2431) | : Not available. |
| Molecular weight | : 44.11 g/mole |
| <u>Aerosol product</u> | |
| Heat of combustion | : -46012932 J/kg |



Maine Title 25 §2469

Fuel Gas Detectors



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Legislative and Administrative Requirements

- Maine Title 25, §2469 “Fuel Gas Detectors” (Effective January 1, 2022)
- Maine Uniform Building and Energy Code
 - 10 M.R.S. §9722, Technical Building Codes and Standards Board
 - International Building Code
 - International Residential Code
- Title 16 Chapter 219 Department of Public Safety
- Maine Title 25 §2452 Fire Marshal rule promulgation
 - NFPA I



Fuel Gas Detector

- Assembly with sensor control and alarm notification that detects elevations in
 - Propane, natural gas or any liquified petroleum gas.
- Sounds a warning alarm, and,
- Approved or listed by a nationally recognized independent testing laboratory.
- May be battery-operated, plugged into an electrical outlet or hardwired.



Locations/Due Dates

| Location or Occupancy | Deadline |
|---|----------|
| Each unit in any multifamily building | 1/1/2022 |
| Fraternity, sorority or dormitory affiliated with educational facility | |
| Children's home, emergency children's shelter, children's residential care facility, shelter for homeless children or specialized children's home | |
| Hotel, motel or inn | |
| Mixed use occupancy that contains a dwelling unit | |
| Business occupancy | 1/1/2026 |
| Mercantile occupancy | |
| Assembly occupancy | |



Title 22 – 1669 – Children’s Homes §8101

| | Category | Description |
|---|------------------------------|--|
| 1 | Children’s Home | Residence exclusively or in part for board/care of one or more children under the age of 18. |
| | | Does not include: <ul style="list-style-type: none">• Facility established primarily to provide medical care; licensed youth camp; or school established solely for educational purposes |
| 2 | Emergency Children’s Shelter | Receives children under 21 years old 24-hours-a-day and limits stay to 90 consecutive days or less. |
| | | Does not include: <ul style="list-style-type: none">• Family foster home or specialized children's home. |



Title 22 – I 669 – Children’s Homes §8101 (continued)

| | Category | Description |
|-----|-------------------------------|---|
| 4 | Children’s Residential Care | Provides board/care for one or more children under 21 years old on a regular, 24-hours-a-day, residential basis. |
| | | Includes: <ul style="list-style-type: none"> • Approved treatment facility • Drug treatment center • Residential facility • Children's residential treatment facility with secure capacity. |
| 4-A | Shelter for Homeless Children | Provides overnight lodging and supervision of children 10 years of age or older for no more than 90 consecutive overnights. |
| | | |
| 5 | Specialized Children’s Home | Care provided by qualified caretaker to no more than 4 children who are moderately to severely disabled. |



Residential Rental Unit Responsibilities



- Occupied under rental agreement or month-to-month tenancy:
 - Landlord
 - At the time of each occupancy, install or verify installation and operation.
 - After tenant's written notification, repair or replace inoperable detector.
 - Tenant
 - Keep detectors in working condition and periodically test.



Location

- Detector must be installed in accordance with the manufacturer's requirements in each area containing an appliance fueled by propane, natural gas or liquified petroleum gas.



Ownership Transfer

- If fuel gas detectors not already present, must install detectors within 30 days of acquisition or building occupancy, whichever is later.
- Certify at closing that fuel gas detectors will be installed.
- Must be signed and dated by the person acquiring the building.

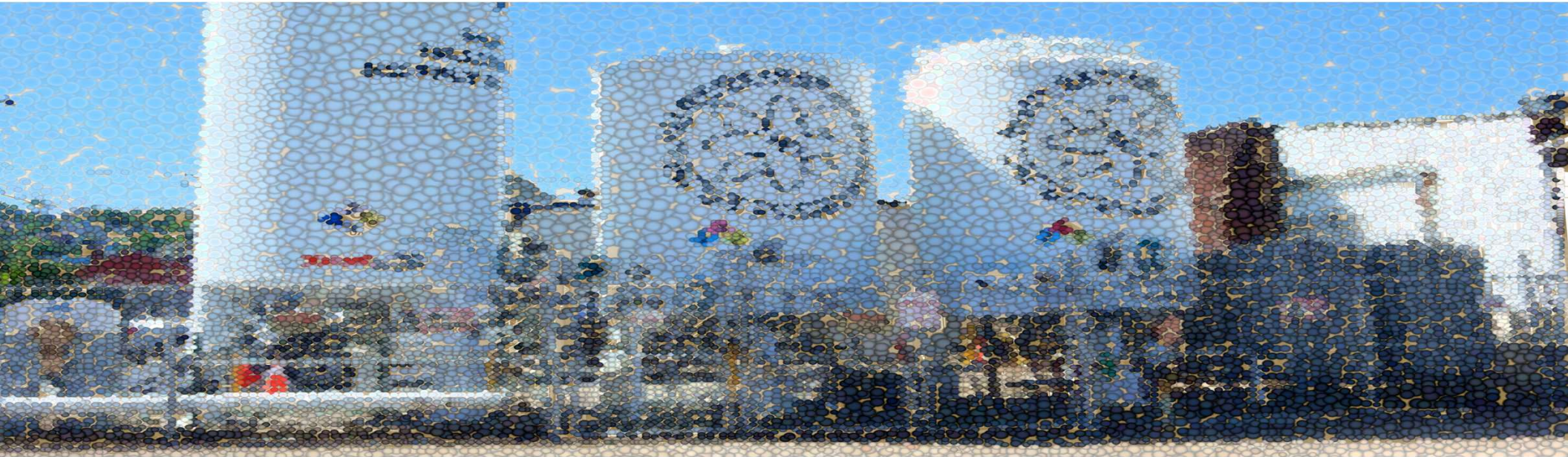


Penalties



- Civil violation
- Fine of not more than \$500 for each violation
- Court may waive any penalty or cost if violation was corrected within 10 days of the issuance of a complaint.





IBC/IRC/IMC/NFPA I

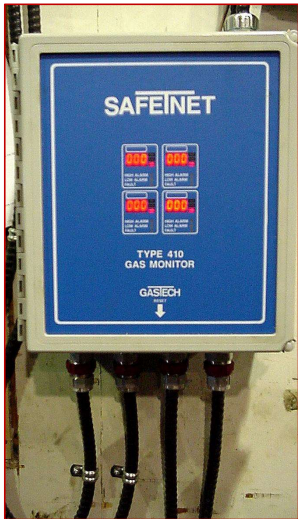
Gas Detection Requirements



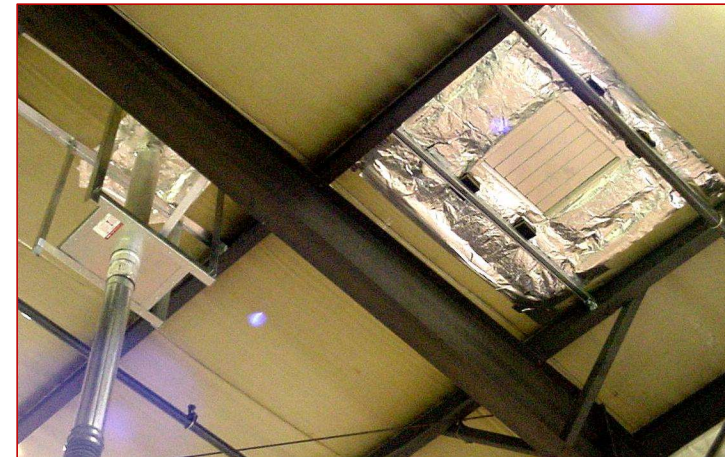
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IBC - Motor Vehicle Repair Garages



- Vehicles fueled by nonodorized gases such as hydrogen and nonodorized LNG.
- Listed or approved flammable gas detection system.
- Activate when flammable gas exceeds 25 % LFL
- Operation and fail-safe design:
 - Distinct audible and visual alarm
 - Deactivation of all heating systems
 - Mechanical ventilation system activation



IBC – H-4 Occupancies

- Gas detection required when toxic or highly toxic gases exceed the maximum allowable quantity (MAQ)

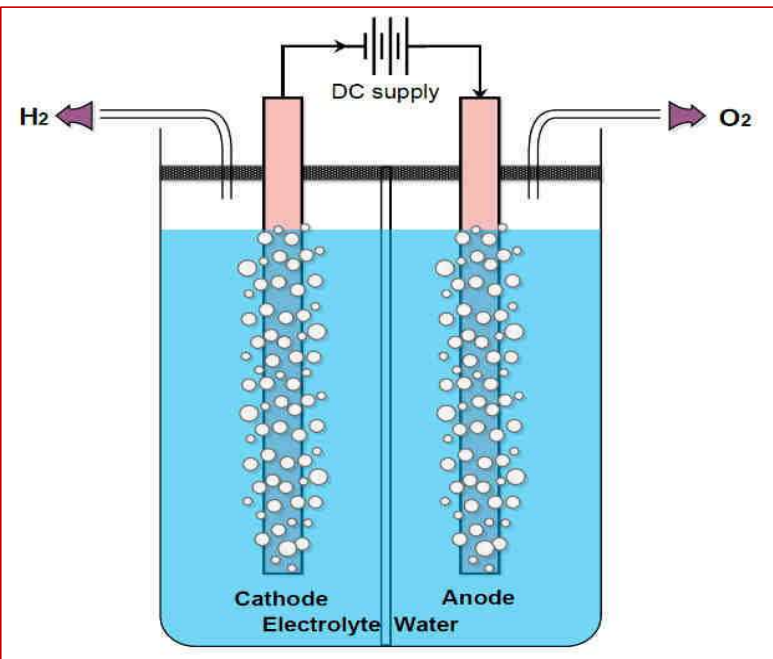


IBC – H-5 Occupancies

- H-5 occupancies
 - Fab rooms
 - HPM rooms
 - Gas cabinets, gas rooms, exhausted enclosures



IBC – Hydrogen Fuel Gas Production Rooms



- Listed for use with hydrogen and any other flammable gases used in the hydrogen fuel gas room.
- Activate when gas exceeds 25 % LFL for gas or mixtures present at their anticipated temperature and pressure.
- Operation and fail-safe design:
 - Distinct audible and visual alarm
 - Deactivation of all heating systems
 - Mechanical ventilation system activation
- Connected to standby power



IMC – Refrigerant Machinery Rooms

- Detector with an audible and visual alarm.
- Design:
 - Detector or sampling tube in area where refrigerant leak will concentrate.
 - Alarm actuated at a value not greater than corresponding TLV-TWA values shown in IMC for refrigerant classification.
 - Detectors and alarms placed in approved locations.
 - Detector shall transmit a signal to an approved location.



IRC - Detection

- R314 Smoke detection
- R315 Carbon monoxide detection



Gas Detection – NFPA I- §3.3.87.9

- Device that detects presence of a specific gas concentration

| Product | Application | Code Section |
|------------------|---|--------------------------------|
| Compressed gases | Corrosive gases – in lieu of treatment system | 63.3.9.3.2.1 |
| | Toxic and highly toxic gases - Unless physiological warning below PEL or TLV | 63.3.9.3.4.3.2 (B) 63.3.9.6 |
| | CO ₂ systems (simple asphyxiant) | 63.9.8.3 |
| LP-Gas | Gas extraction rooms | 38.6.2.4 |
| | Mobile cooking (food trucks) | 50.7.2.3.3 |

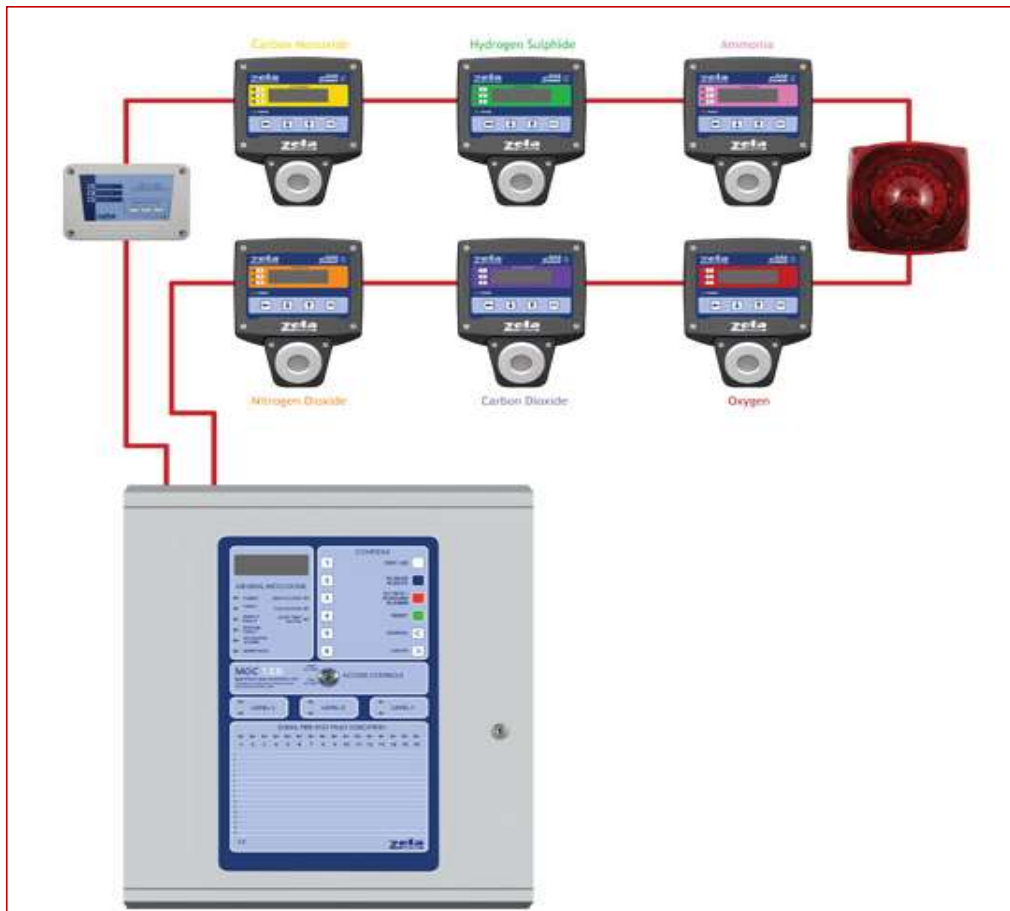


“Single-station” Devices

- CO detector not same as a gas leak detector.
- UL 1484 *Residential Gas Detectors*
- Detection level $\leq 10\%$ of the LEL/LFL for natural gas
- Follow installation instructions carefully.
- Battery-powered with a lifetime battery included



“System Devices”



Installation Guidance - Mounting Heights

| Gas | Molecular Weight | Mounting Height Above Finished Floor (inches) |
|------------------|------------------|---|
| Hydrogen | 2.0 | 48 |
| Helium | 4.0 | |
| Nitrogen | 14.0 | |
| Oxygen | 15.9 | |
| Ammonia | 17.0 | 36 |
| Carbon monoxide | 28.0 | |
| Ethylene | 28.1 | |
| Air | 28.9 | |
| Argon | 39.9 | |
| Nitrous oxide | 44.0 | |
| LP-gas (propane) | 44.0 | 18-24 |
| Carbon dioxide | 44.1 | |
| LP-gas (butane) | 58.1 | |





Flammable Refrigerants

Coming Soon to a System Near You

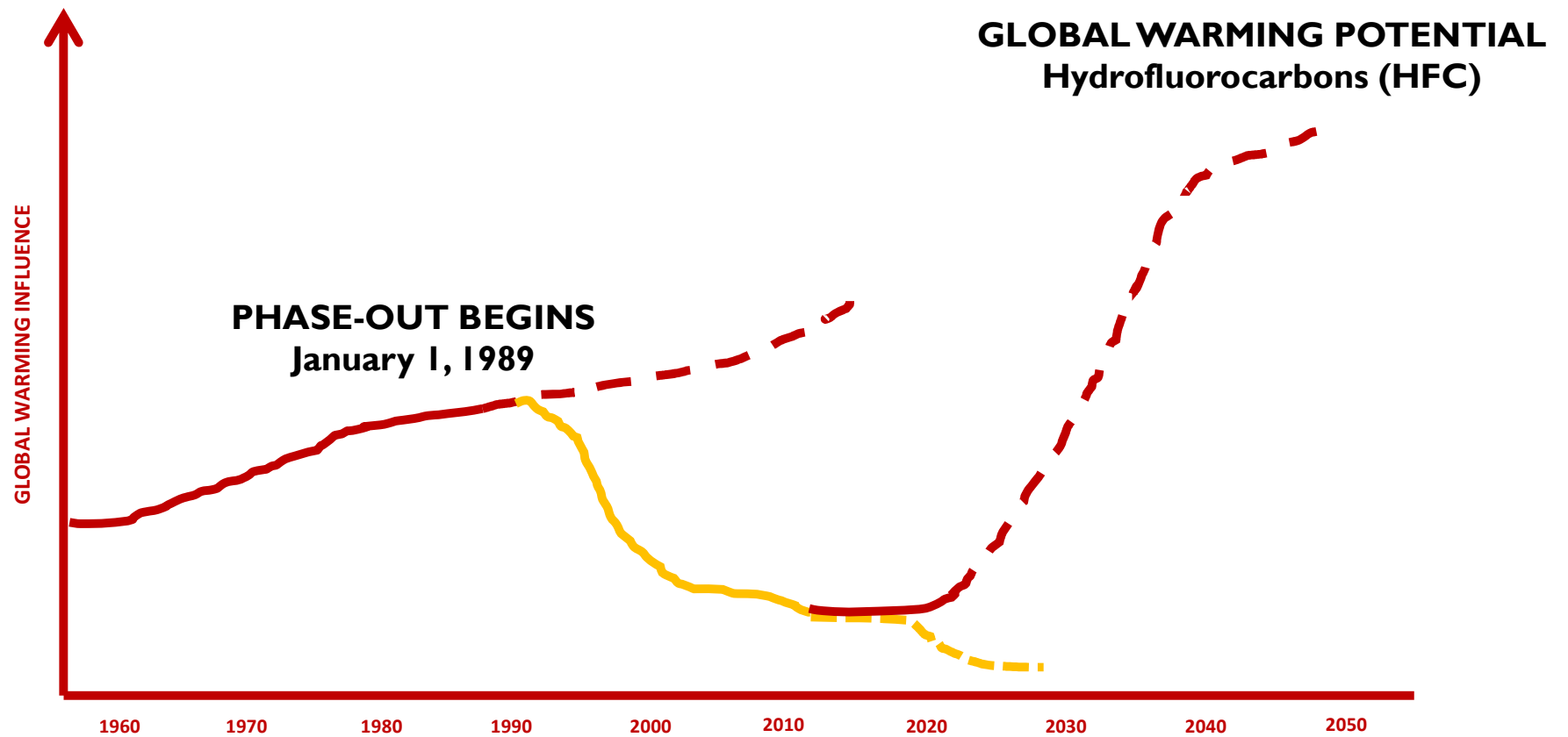


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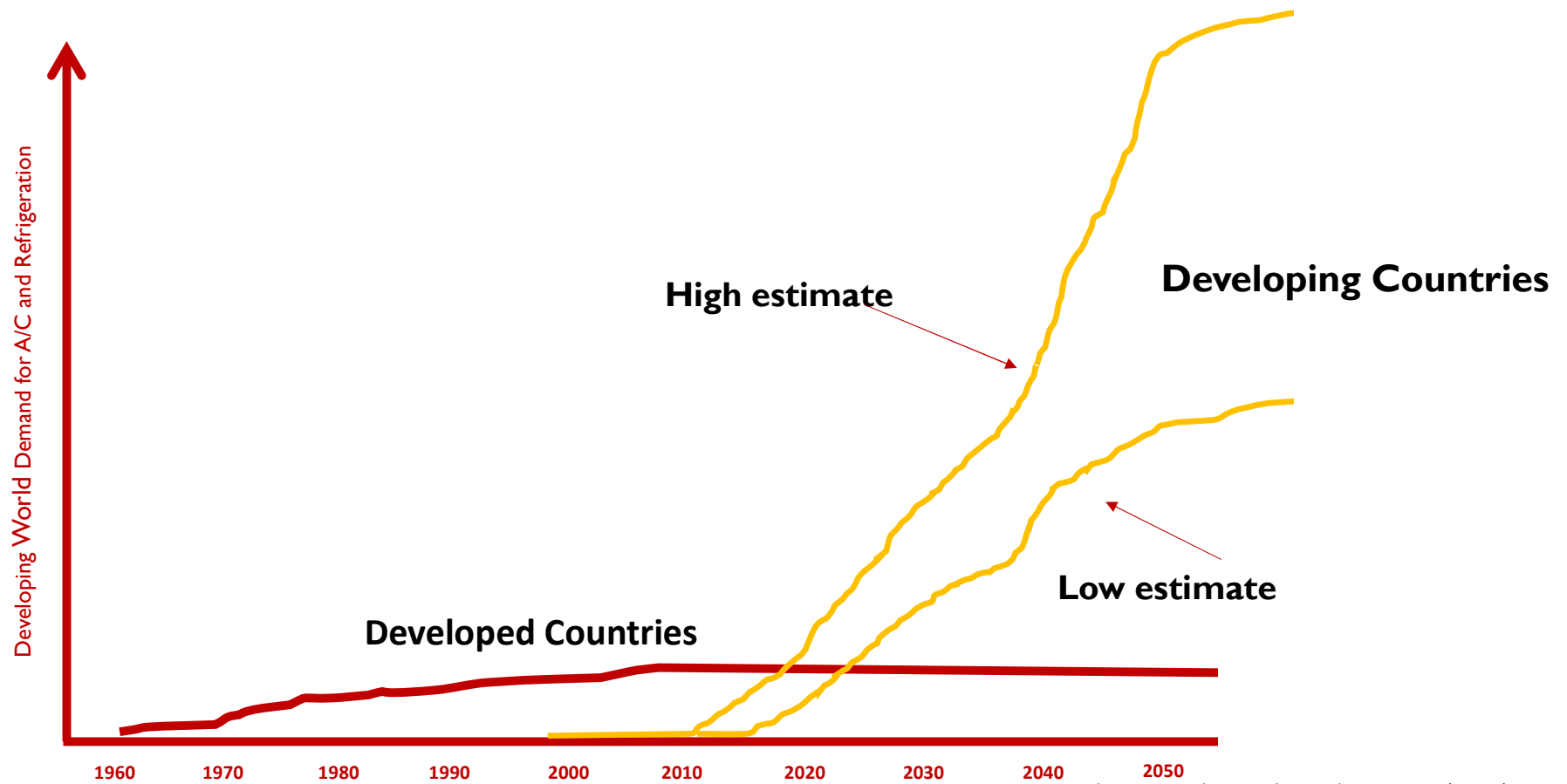
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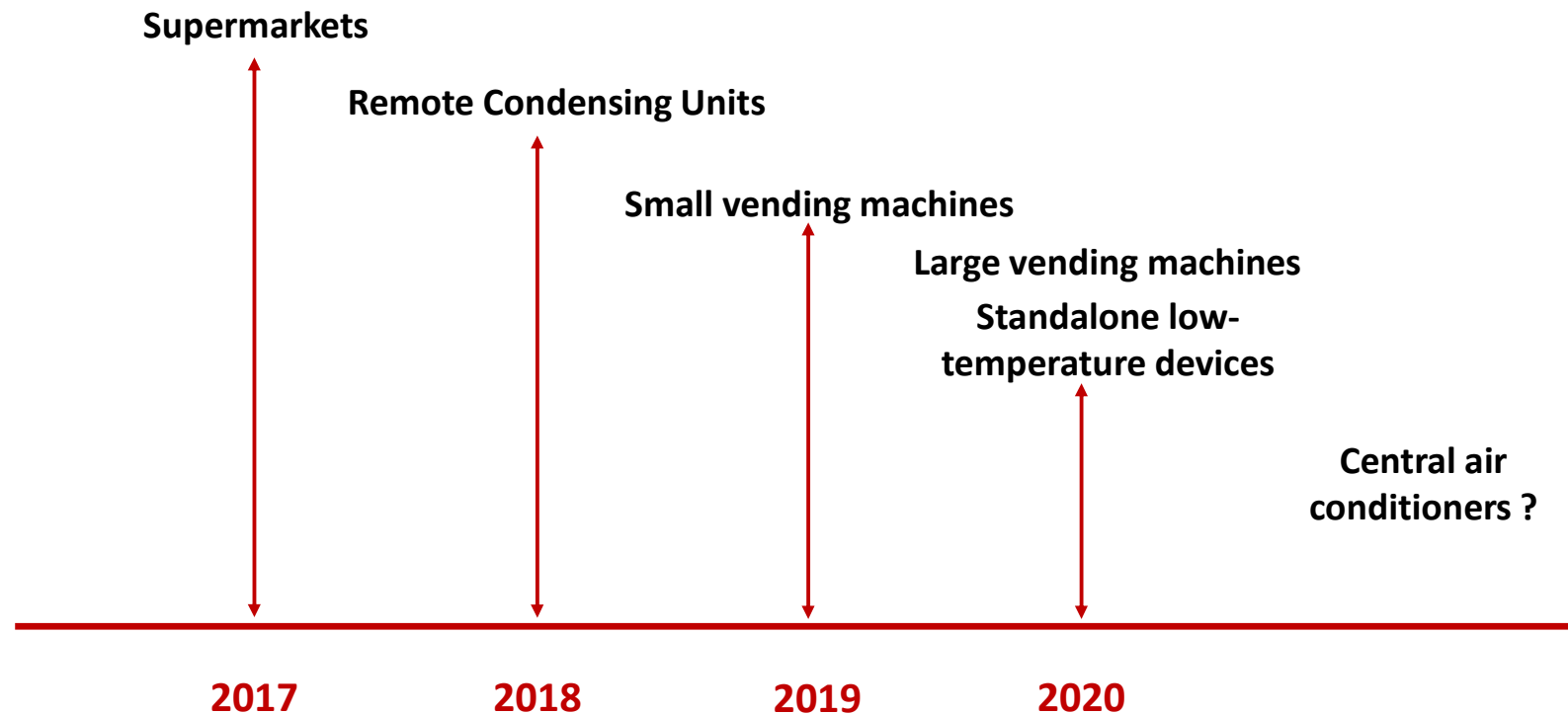
Hydrofluorocarbons



Global Demand



US: GWP Proposed Phaseout (EPA)

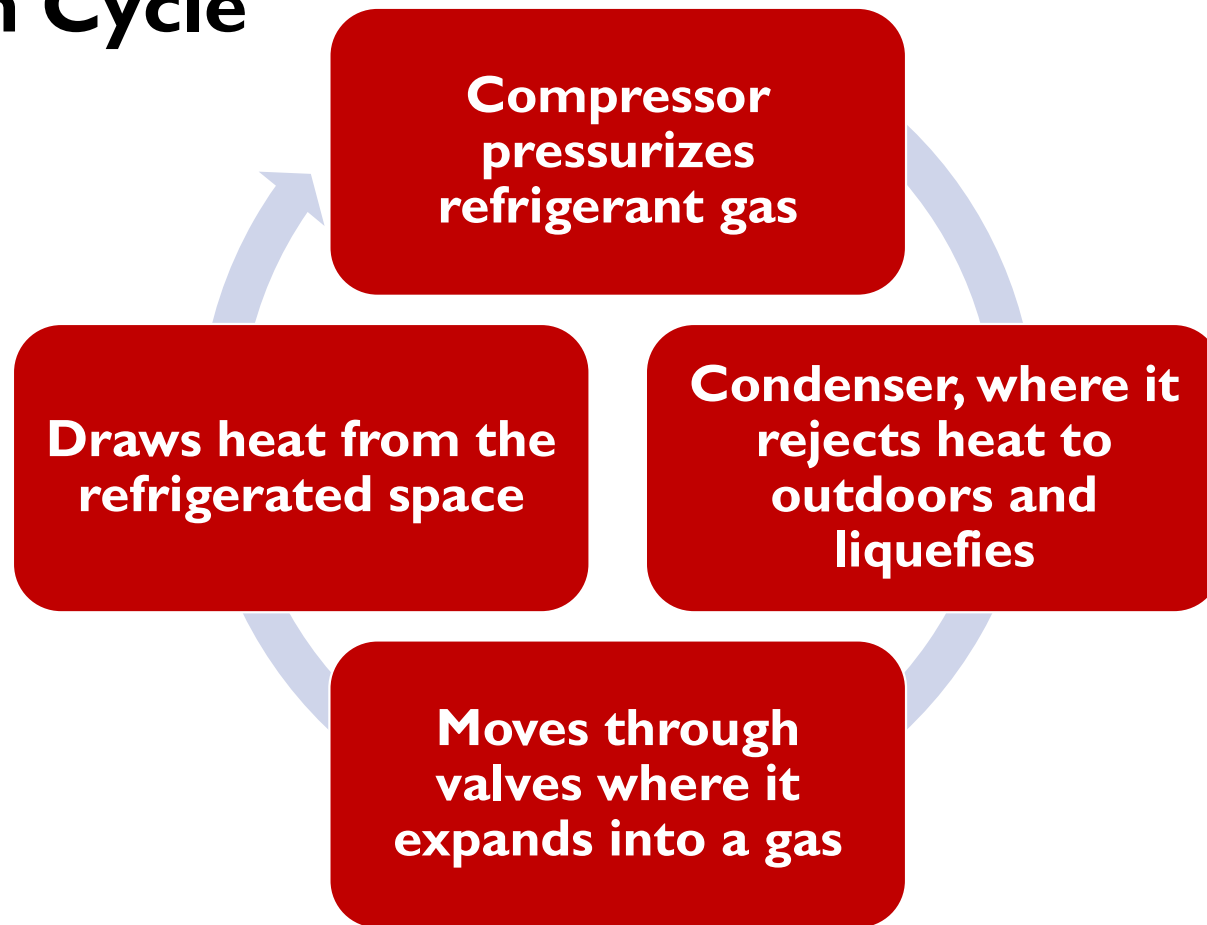


Refrigeration Principles: Heat Properties





- Always moves from warmer to cooler surface
 - Moves by radiation, convection or conduction
- When a refrigerant boils it absorbs heat
- When a refrigerant condenses, it releases heat
- *Heat by a fluid (refrigerant) – as it changes from a liquid to a gas – lowers the temperature of the objects around it.*

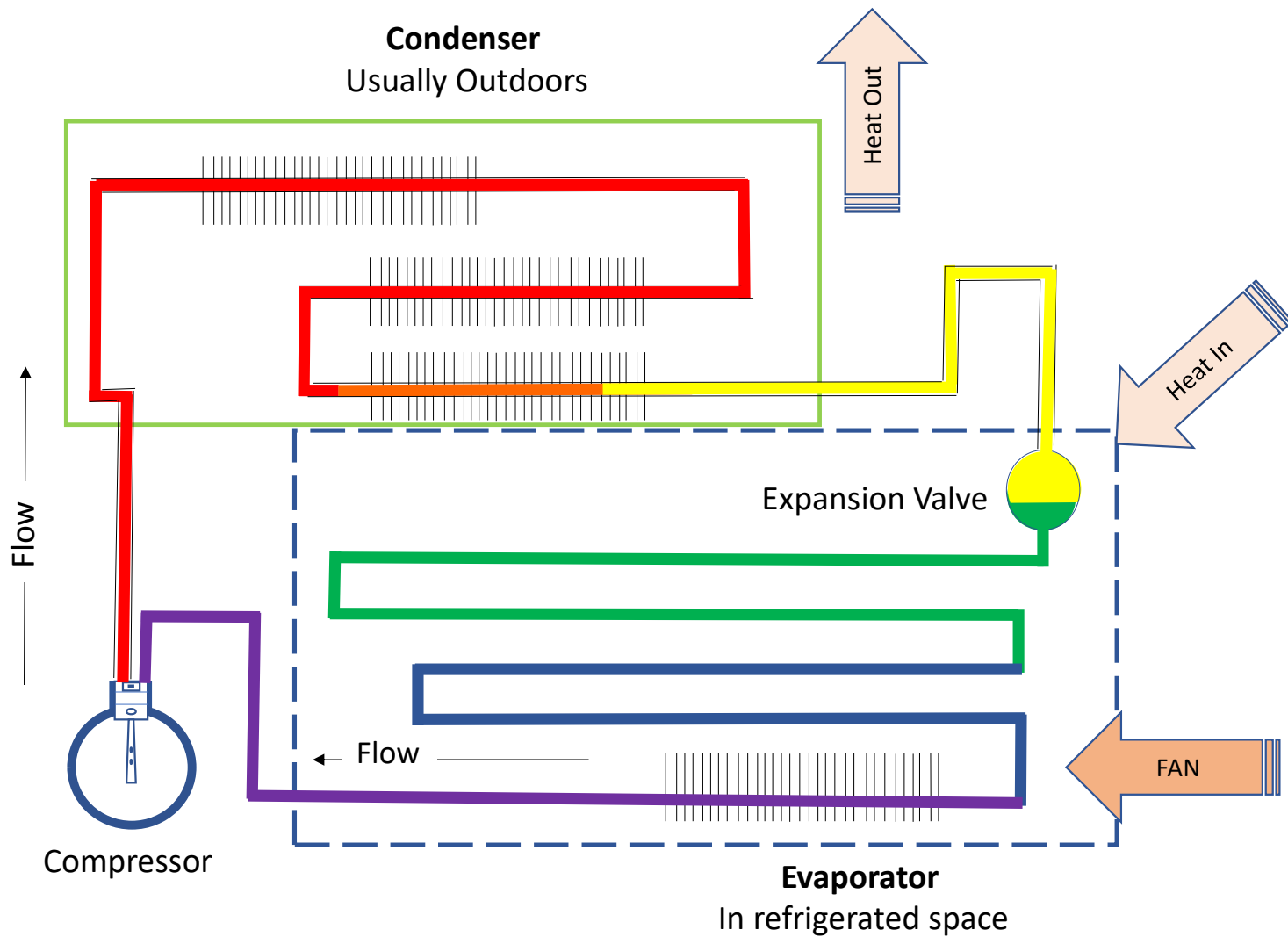


Refrigeration Cycle



**Schematic Only
Not To Scale**

-  High Pressure Gas
-  High Pressure Liquid
-  Low Pressure Gas/Liquid
-  Low Pressure Vapor



Refrigerant Units



- Refrigerant ton
 - Measure of *cooling capacity* -- not refrigerant.
 - Energy removal rate that will freeze one short ton of water at 32 °F in one day.
 - Historically defined as approximately 11,958 Btu/hr, and now conventionally redefined as exactly 12,000 Btu/hr.



Refrigerant Capacities

- Residential A/C equipment



| Tons | kW | Btu/Hour |
|------|-----------|-----------------|
| 1-5 | 3.5.-17.5 | 12,000 – 60,000 |

- Commercial industrial chiller systems



| Tons | kW | Btu/Hour |
|-----------|-------|-----------|
| Up to 800 | 2,800 | 9,600,000 |

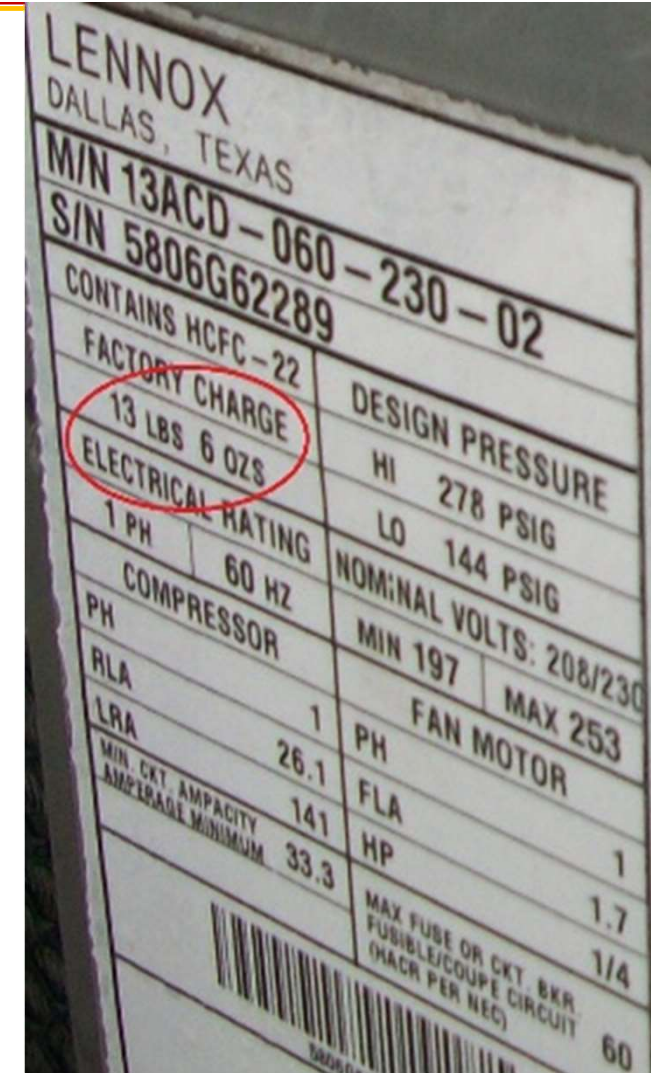
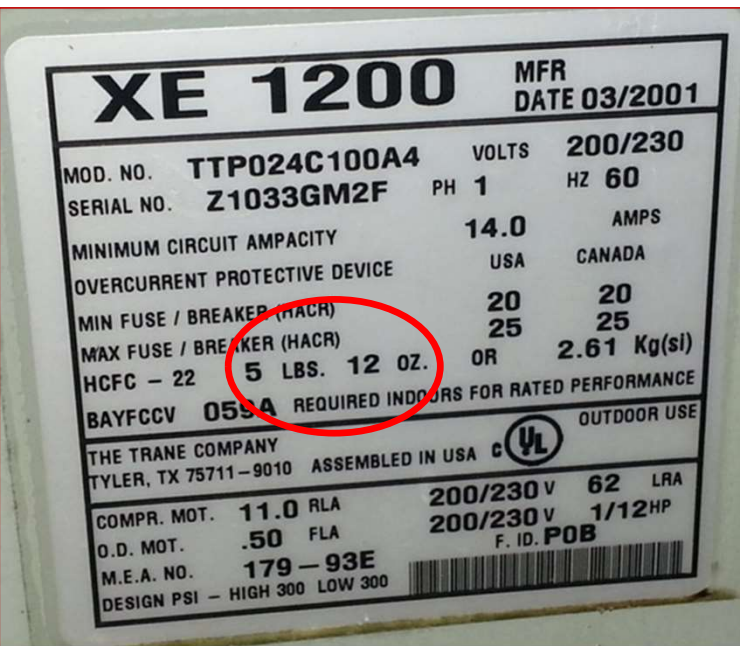


Refrigerant Pounds

- For *code* purposes, refrigerants are measured in pounds
 - Liquid weight unit
 - Refrigerants typically have density > 1
 - Heavier than water
 - Densities lessen at higher temperatures
 - Based on internal volume of the refrigeration system
 - Volume x liquid density at specific temperature = pounds in system
 - Check the system label.



Refrigerant Labels



Sidebar: Note to First Responders

- For *response* purposes, vapor density should be considered
 - Most refrigerant leaks occur as vapor
 - Vapor density > 1 = vapor sinks
 - Vapor density < 1 = vapor rises



Code Triggers

- When system refrigerant exceeds:
 - 220 pounds A1, or,
 - 30 pounds any other refrigerant



Refrigerant Composition


| Prefix | Represents | Examples |
|--------|-------------|------------------|
| R | Refrigerant | R22, R134a, R717 |


May include:

| | | |
|---|----------|-------------------------------------|
| C | Chlorine | RC317: Chloroheptafluorocyclobutane |
| B | Bromine | R22B1: Bromodifluoromethane |
| F | Fluorine | RFE-36: Hexafluoropropane |
| H | Hydrogen | R134a: 1,1,2,2-Tetrafluoroethane |
| C | Carbon | RC318: Octafluorocyclobutane |
| E | Ether | RE170: Dimethylether |




NEW:ASHRAE Safety Groups

|  Increasing Flammability | Flammability Classification | | Toxicity Group | |
|--|-----------------------------|--|----------------|-----------------|
| | | | Group A | Group B |
| | | | Lower Toxicity | Higher Toxicity |
| | | | | |
| | Higher Flammability | | A3 | B3 |
| | Lower Flammability | | A2 | B2 |
| | Low Flammability | | A2L | B2L |
| | No Flame Propagation | | A1 | B1 |


 Increasing Toxicity



NEW:ASHRAE Safety Groups -- *Flammability*

|  Increasing Flammability | Flammability Classification | | Test | |
|--|-----------------------------|----------------------|---|------------------------------|
| | | | At 70F and 14.7 psi | Examples |
| | A3 | Higher Flammability | LFL < 0.00624 lb/ft ³ Latent heat > 8172 Btu/lb | Methane Propane Butane |
| | A2 | Lower Flammability | LFL > 0.00624 lb/ft ³ Latent heat < 8172 Btu/lb | HCFC-142b HFC-152b |
| | A2L | | Difficult to ignite Flame speed < 3.94"/sec | R-32 R1234yf |
| | A1 | No Flame Propagation | No flame propagation in air | CFC-11 CFC-113 R-500 |



ASHRAE Safety Groups -- Toxicity

| Toxicity Groups | | | |
|---|------------------|---|--------------|
| Group A | Examples | Group B | Examples |
| Lower Toxicity | | Higher Toxicity | |
| No toxicity identified at concentrations ≤ 400 ppm | | Evidence of toxicity at concentrations <400 ppm | |
| A1 | CFC, HCFC, | B1 | Seldom used |
| A2 | R152a | B2 | Seldom used |
| A2L | Most Low-GWP HFC | B2L | Ammonia |
| A3 | Hydrocarbons | B3 | Hydrocarbons |



ASHRAE 15 and 34/IIAR 2 and 7

American Society of Heating, Refrigeration and Air-conditioning Engineers

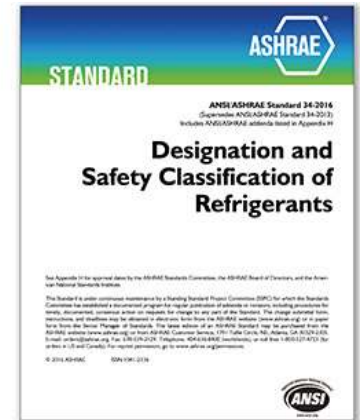
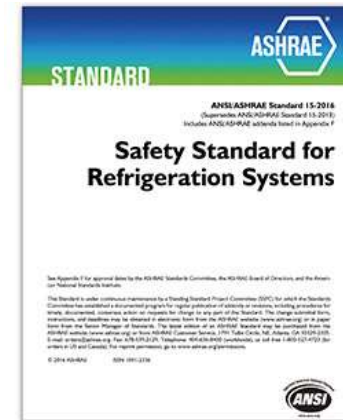
- ASHRAE 15 – Safety Standards for Refrigeration Systems
- ASHRAE 34 – Designation and Safety Classification of Refrigerants

International Institute of Ammonia Refrigeration

- IIAR 2 – Safe Design of Closed-Circuit Ammonia Refrigeration Systems
- IIAR 7 – Developing Operating Procedures for Closed-Circuit Ammonia Refrigeration Systems



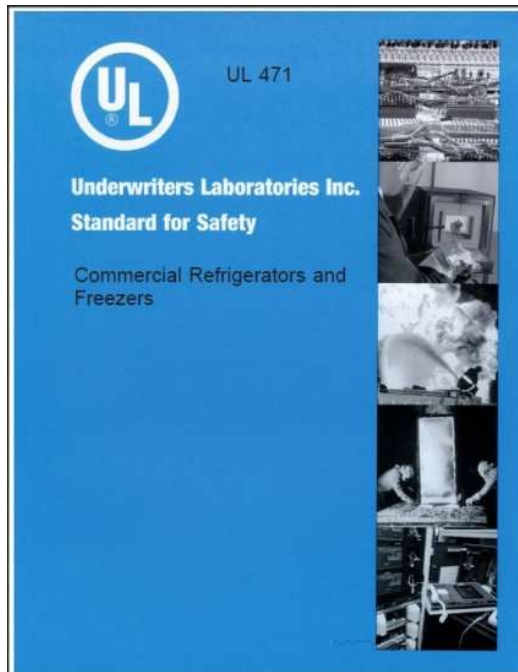
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Additional Reference Standards



- UL 207
 - *Standard for Refrigerant-Containing Components and Accessories, Nonelectrical*
- UL 412
 - *Standard for Refrigeration Unit Coolers*
- UL 471
 - *Standard for Commercial Refrigerators and Freezers*
- UL 1995
 - *Heating and Cooling Equipment*



International Mechanical Code

- Design, installation, construction and repair
- Six-step design protocol



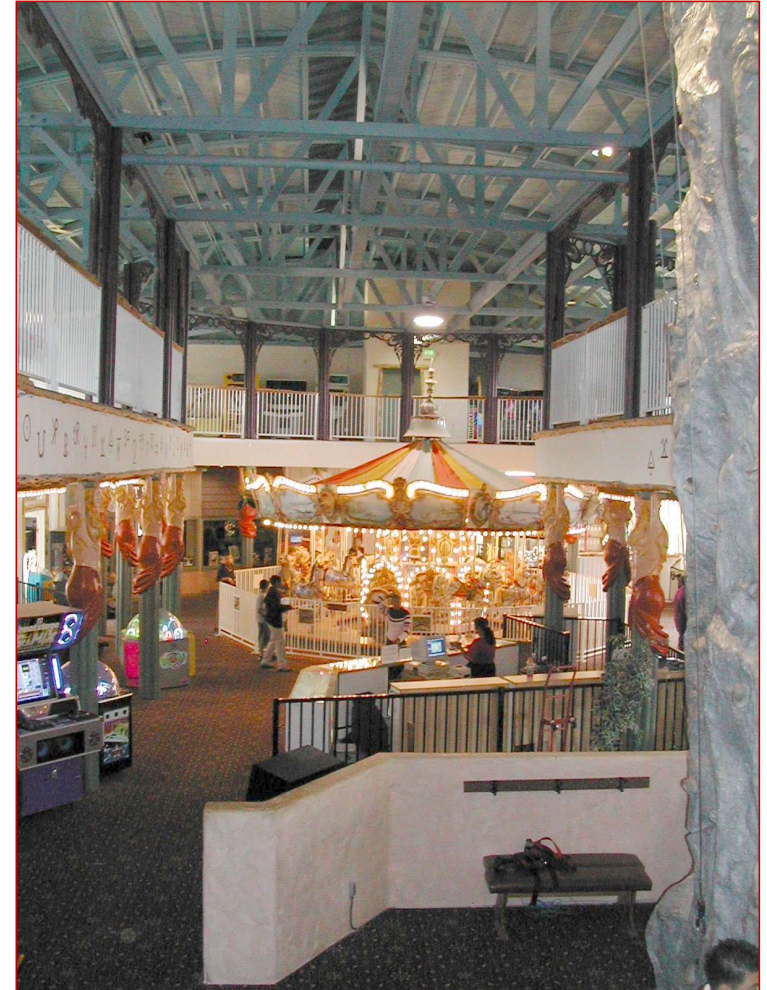
IMC Design Protocol

I. Occupancy classifications

- Institutional
- Public assembly
- Residential
- Commercial
- Large mercantile (O.L. > 100)
- Industrial
- Mixed occupancies



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IMC Design Protocol (cont'd)

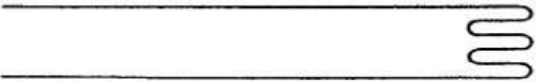
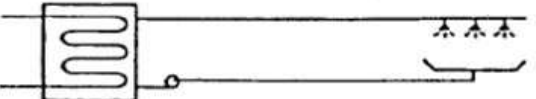
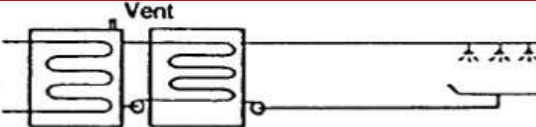
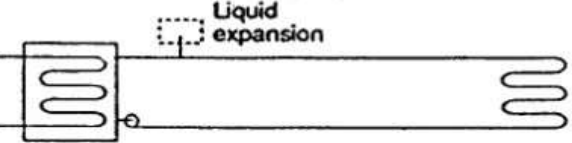
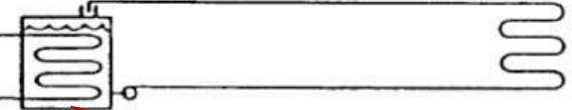
- Refrigeration system's *classification* based on likelihood leaks entering occupied area
 - Low or High probability
 - Low probability:
 - Double-indirect open spray
 - Indirect closed
 - Indirect-vented closed
 - High probability
 - Direct
 - Indirect open spray



System Classifications

High Leak
Probability

Low Leak
Probability

| Designation | Cooling or Heating Source | Air or Substance to be Cooled or Heated |
|-----------------------------------|---|---|
| Direct system |  | |
| Indirect open spray system |  | |
| Double indirect open spray system |  | |
| Indirect closed system |  | |
| Indirect vented closed system |  | |

Liquid-to-liquid exchangers



IMC Design Protocol (cont'd)

2. Refrigerant classification (A1-B3)
3. Maximum refrigerant quantity per refrigerant, system classification and occupancy
4. System enclosure requirements
5. Refrigeration and application location and installation
6. Non-factory tested, field erected equipment and appliances



IMC System Application

- Machinery rooms
 - Outdoor applications
 - Small quantity listed equipment
- Institutional applications
 - 50% limit on refrigerants
- Industrial occupancies and refrigerated rooms
 - Exceptions for manufacturing, food and beverage prep, meat cutting and storage



Courtesy: Texas Glacier.com



IMC Machinery Rooms



- Design and construction
- Ventilation requirements
 - Normal/emergency
- Continuous ventilation for NH_3
- Emergency ventilation for A2L
- Remote emergency shutoffs



Refrigerant Piping

- Height above floor
- Limited building envelope penetrations
- Material limits
 - Steel, copper, brass, aluminum
- Valve identification



Courtesy: Stellar.net



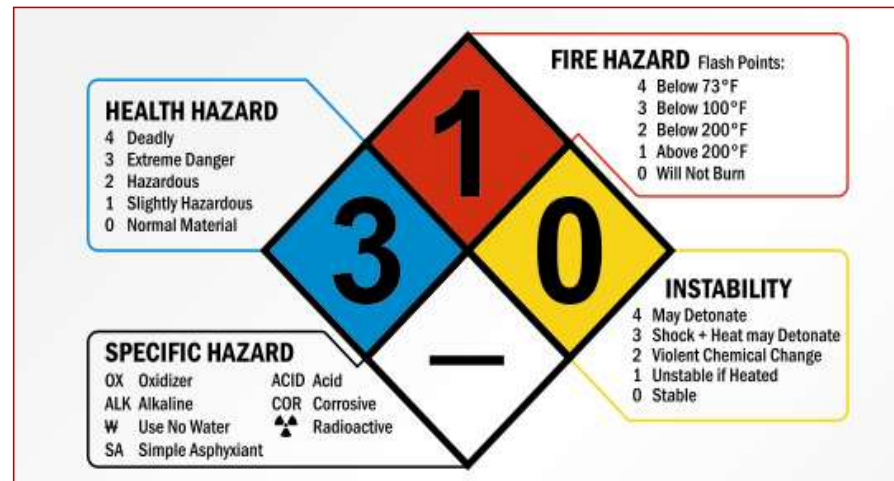
Detection

- Refrigerants other than ammonia
 - Detector or sampling tube where refrigerant may accumulate
 - Audible/visual alarms in room, outside room and report to approved location, when detection senses *lesser of*:
 - TLV-TWA values found in IMC[®], or,
 - 25% of the refrigerant LFL.



Warning Signs

- Exceed:
 - 220 pounds A1, or,
 - 30 pounds any other refrigerant
- Suitable for refrigerant
- Comply with NFPA 704



Carbon Monoxide: The Quiet Killer

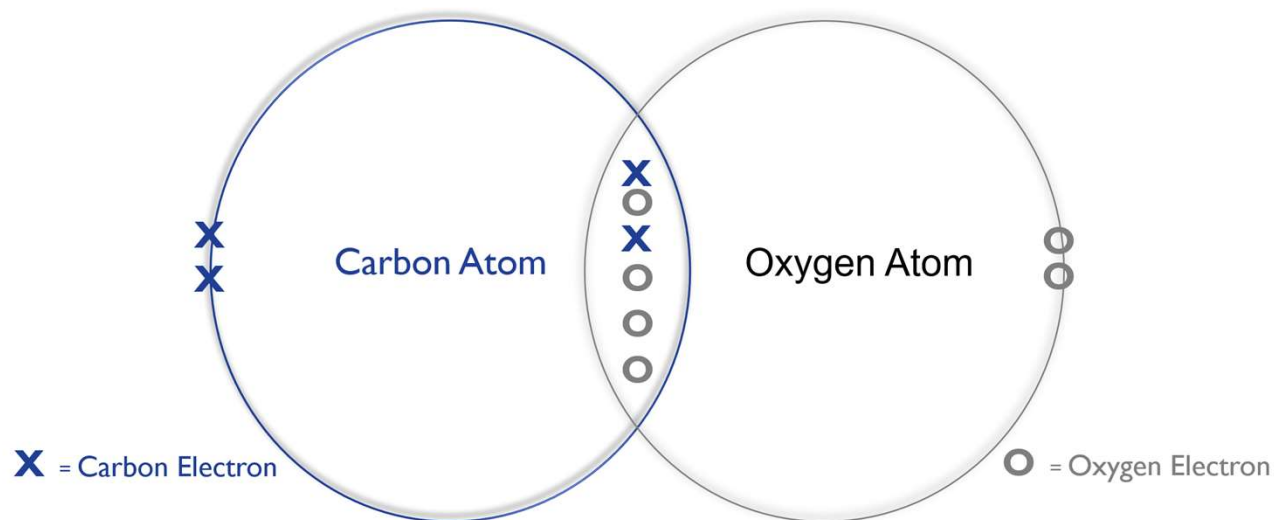
Chemistry, Pathology and Sources



Carbon Monoxide

Why is it called “The Quiet Killer?”

- Colorless.
- Tasteless.
- Odorless.
- Red blood cell affinity.



Carbon Monoxide – By the Numbers

| | |
|---------------------------------------|------------------------------------|
| CAS Number | 630-08-0 |
| Number of Carbon Atoms | One |
| Number of oxygen atoms | One |
| Molecular weight | 28.101 |
| Vapor density (Air = 1) | 0.9667 |
| Annual US fatalities | 430 |
| Annual non-fire hospital visits | 50,000 |
| Total fatalities 1999-2010 | 5,149 |
| Death rate for males | 0.22 per 100,000 |
| Death rate for females | 0.07 per 100,000 |
| Death rate for senior males ≥ 65 | 0.42 per 100,000 |
| Death rate for senior female | 0.18 per 100,000 |
| Deadliest month | January (3 times more than summer) |

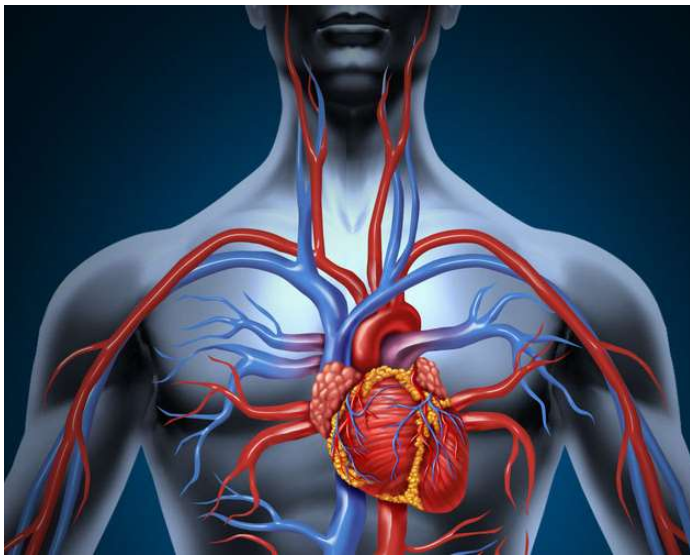
Source: CDC.gov



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CO: Physiopathology

What Is the Danger to Humans and Animals?



- Cellular hypoxia (oxygen deficiency).
 - Binds to hemoglobin to block oxygen delivery to tissues.
 - Binds 230-270 times more avidly than oxygen
 - Small concentrations result in significant levels of carboxyhemoglobin (HbCO).



CO: Physiopathology

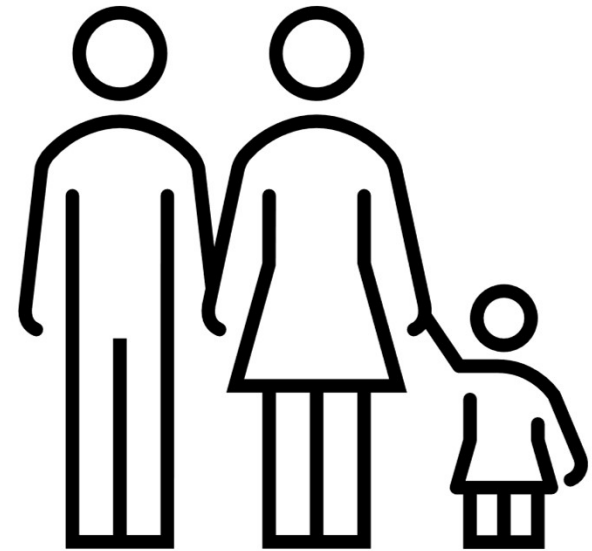
More Danger to Humans and Animals

- Ambient CO level of 100 ppm produces HbCO of 16%
 - Increases respiratory and cardiac rate
- CO is eliminated through the lungs.
 - Half-life of CO at room air temperature is 3-4 hours.
 - One hundred percent oxygen reduces the half-life to 30-90 minutes



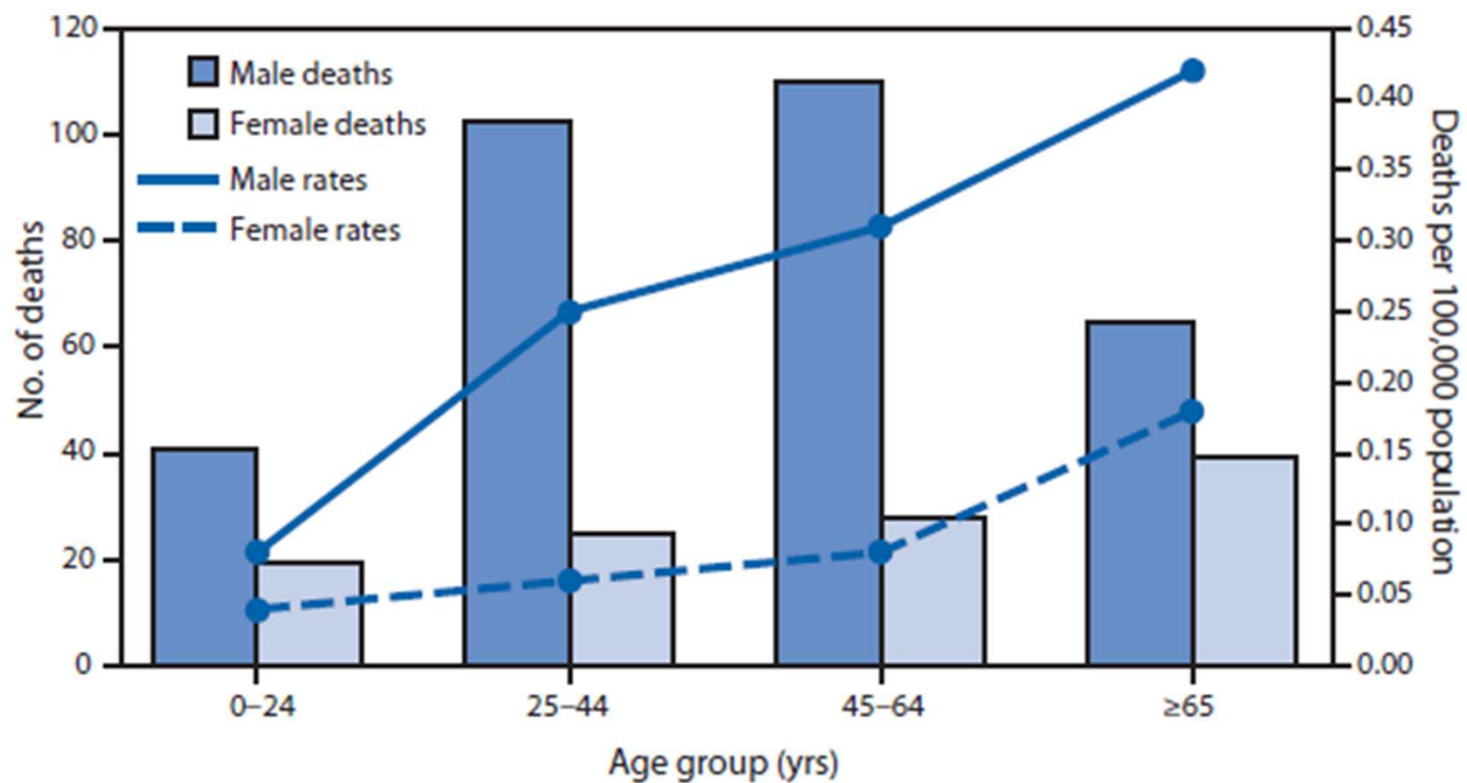
Exposure Limits

| | | PPM | |
|-------------------|----------|--------|--|
| Acute poisoning | 1.28% | 12,800 | Death in 1 to 3 minutes |
| | 0.5% | 5,000 | Death in 20 minutes |
| | 0.2% | 2,000 | Death in 4-5 hours |
| | 0.1% | 1,000 | Coma, convulsions in 1 hour |
| | 0.05% | 500 | Lost consciousness, tachypnea, tachycardia |
| Chronic poisoning | 0.02% | 200 | Headache, fatigue, nausea, vomiting, dizziness |
| | 0.01% | 100 | Headache, asthenia (weakness) |
| | 0.003% | 30 | Some physiological response |
| | 0.0025% | 25 | CO detector/alarm threshold |
| | 0.0005% | 5 | Normal residential background |
| | % in air | | |



U.S. Death Rates By Age Group

Males Outnumber Females in All Age Categories



Source: U.S. Centers for Disease Control



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CO Poisoning

Most Common Signs and Symptoms

- Flush or pink skin
- Headache
- Dizziness
- Weakness
- Nausea
- Vomiting
- Chest pain
- Confusion

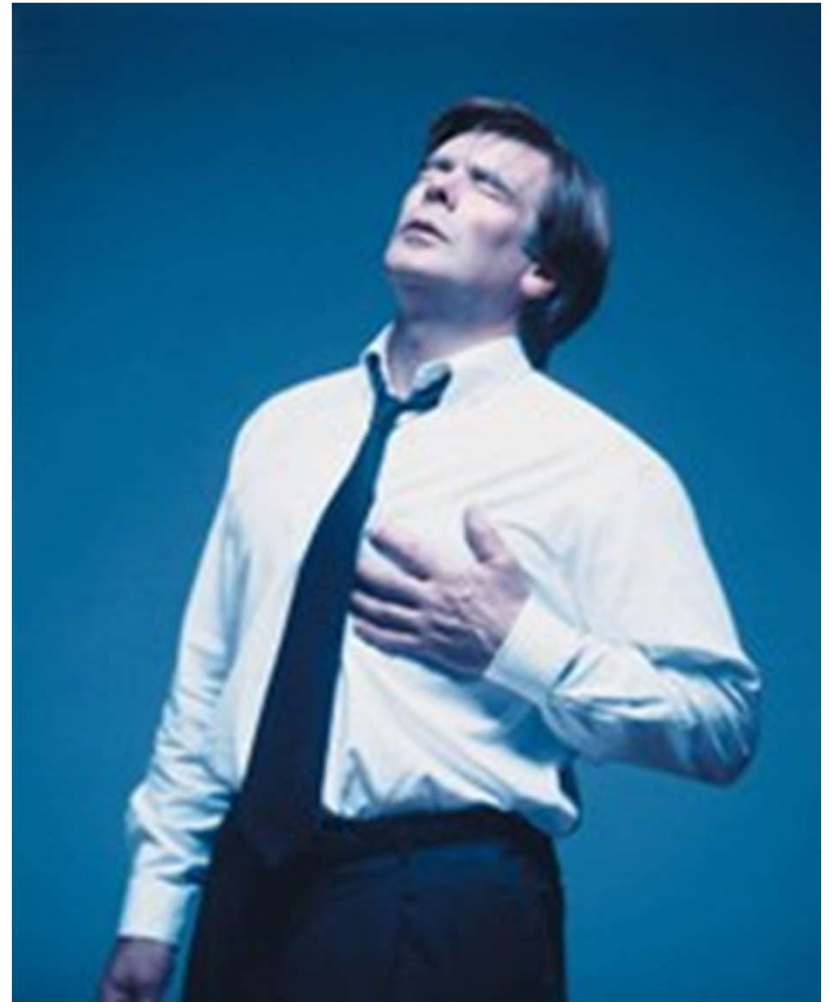


Image courtesy of U.S. National Library of Medicine

CO: Flammable Gas

As Percentage in Air

| Gas/Vapor | Lower Explosive or Flammable Limit (LEL/LFL) | Upper Explosive or Flammable Limit (UEL/UFL) |
|-----------------|--|--|
| Carbon Monoxide | 12 | 75 |
| Acetylene | 2.5 | 81 |
| Ethyl Alcohol | 3.3 | 19 |
| Gasoline | 1.4 | 7.6 |



CO: Industrial Uses



- Energy and reducing agent:
 - Mixed with hydrogen for industrial and domestic heating.
 - Manufacture of acids, esters.
 - Catalyst for nickel carbonyl.
 - Toxic by skin contact, inhalation or ingestion
- Electronic and semiconductor applications.
- Pharmaceutical manufacture.
- Instrument calibration.



CO: Common Sources

Incomplete Combustion



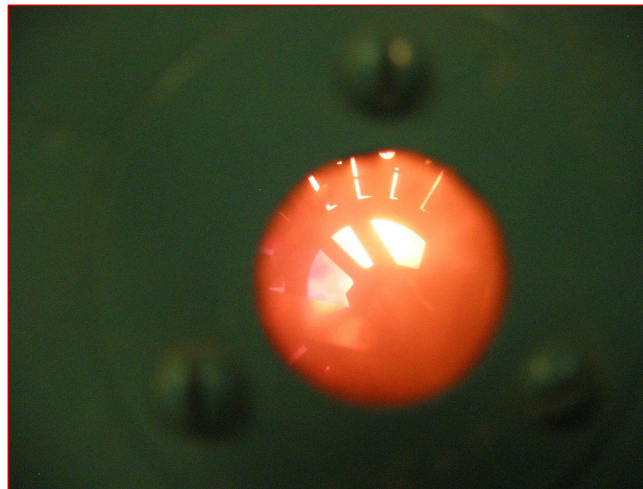
- Unvented kerosene and gas space heaters
- Leaking chimneys and furnaces
- Back-drafting from furnaces, gas water heaters, wood stoves and fireplaces



Fuel-burning Appliances

Household Appliances

Common household fuel-burning appliances include oil-, natural gas- or LP-gas-fired furnaces, gas-fired hot water tanks and gas- or wood-fueled fireplaces and heaters.



CO: Common Sources

Incomplete Combustion



- Incomplete oxidation during combustion in gas ranges
- Generators and other gasoline powered equipment
- Internal combustion engine exhaust confined spaces
- Tobacco smoke



CO: Common Sources

- **Inadequate Ventilation**

- Internal combustion engine exhaust from attached garages, nearby roads or parking areas
- Solid fuel appliances
 - Barbecues
 - Wood and coal-fired appliances
- Worn or poorly adjusted and maintained combustion devices (e.g., boilers, furnaces)
 - If flue is improperly sized, blocked or disconnected, or,
 - If vent/chimney/flue is leaking.



Reducing CO Exposure

- **Identify Common Sources and Potential Exposures**



- Operate fuel-powered equipment outdoors.
- Assure that combustion equipment is maintained and properly adjusted.
- Manage vehicular use adjacent to buildings and in work spaces.



Reducing CO Exposure

- **Mechanical Ventilation**



- Additional ventilation can be used temporarily when high CO levels are expected for short periods of time.
 - Enclosed parking garages.
 - Gas transfer operations.
 - Industrial applications.



Minimum Ventilation Rates

| Space | cfm/sq. ft. |
|-------------------------------------|-------------|
| Parking garages | 0.75 |
| Auto repair garages | 0.75 |
| School science labs | 1.0 |
| Educational science labs | 1.0 |
| Automobile fuel dispensing stations | 1.5 |
| When CO in storage exceeds MAQ | 1.0 |
| Toilet rooms | 25/50 |





Occupancy Detection Requirements

The Code Approach



May 13, 2022



CO Detection

Provide Early Warning for Vulnerable Occupants

- Dwelling Units and Sleeping Units in:
 - Group I-1: 24-hour supervision for more than 16 persons
 - Group I-2: Hospitals, nursing homes, psychiatric facilities
 - Group I-4: Adult and child day care
- Group E: Classrooms

IRC/IBC/FPA I Residential Applications

Protecting Those Who May be Sleep-Impaired

- Group R:
 - One- and two- family dwellings
 - Townhouses

[A] DWELLING UNIT. A single unit providing complete, independent living facilities for one or more persons, including permanent provisions for living, sleeping, eating, cooking and sanitation.

IRC § 202

[BG] SLEEPING UNIT. A single unit providing rooms or spaces for one or more persons that includes permanent provisions for sleeping and can include provisions for living, eating and either sanitation or kitchen facilities but not both. Such rooms and spaces that are also part of a *dwelling unit* are not *sleeping units*.

IRC § 202



IBC Educational Applications

Protecting The Young

- Group E:
 - Classrooms for students through the 12th grade.
 - On-site alarm reporting to staffed location.

[BG] Group E, Educational. Educational Group E occupancy includes, among others, the use of a building or structure, or a portion thereof, by six or more persons at any one time for educational purposes through the 12th grade.



IBC Institutional Occupancies

Care for Impaired or Restrained

[BG] Group I, Institutional. Institutional Group I occupancy includes, among others, the use of a building or structure, or a portion thereof, in which care or supervision is provided to persons who are or are not capable of self-preservation without physical assistance or in which persons are detained for penal or correctional purposes or in which the liberty of the occupants is restricted. Institutional occupancies shall be classified as Group I-1, I-2, I-3 or I-4.

IFC § 202

- Congregate care/Board and care (I-1)
 - More than 16 occupants
 - 24-hour care
- Hospitals/Nursing homes/Detox (I-2)
- Prisons/Detention centers (I-3)
- Adult/Child day care (I-4)



IBC Enclosed Parking Garages

- Continuous mechanical ventilation
 - ≥ 0.75 cfm/sq. ft
- Carbon monoxide/nitrogen dioxide detection.
 - Ventilation cycles
 - Full on ≥ 0.75 cfm/sq. ft
 - Standby ≥ 0.05 cfm/sq. ft



Detection Requirements

Dwelling units, sleeping units and classrooms with:

- Fuel-burning appliances
- Fuel-burning fireplaces
- Fuel-burning forced-air furnaces
- Attached private garages



IBC/IRC Attached Private Garage

Primarily Individual Occupant(s)

- Used by on-premise tenants
- Vehicles are stored or kept
- No repairs for profit
- No more than 1,000 sq. ft. each
 - Multiple if separated by one-hour fire barrier

[BG] PRIVATE GARAGE. A building or portion of a building in which motor vehicles used by the *owner* or tenants of the building or buildings on the premises are stored or kept, without provisions for repairing or servicing such vehicles for profit.

IFC §202



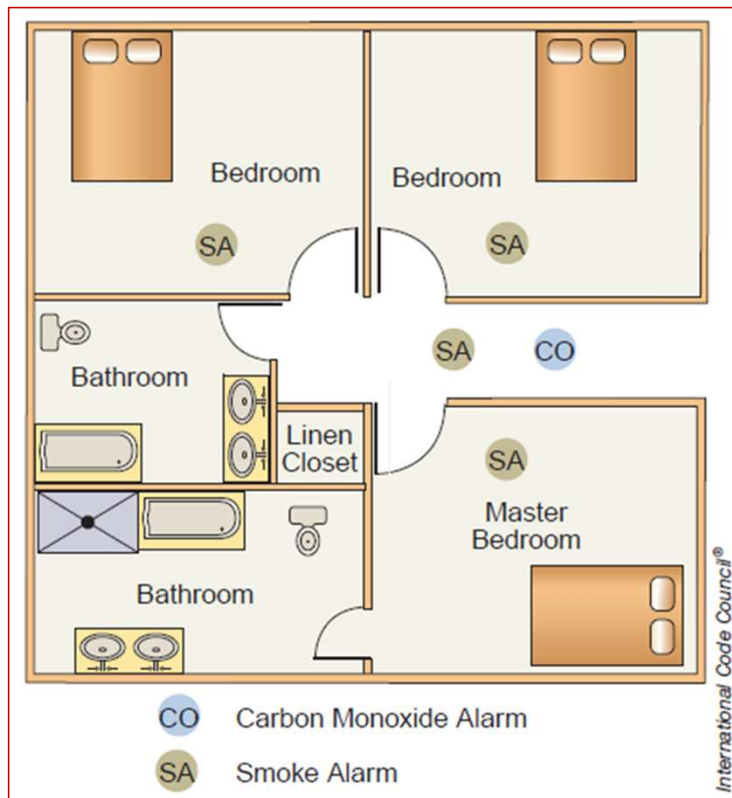
Location Requirements

Detection Must be Provided Between Source and Potential Victims

- Outside sleeping areas
- Inside classrooms
- Installed in accordance with code, standard and manufacturers' installation instructions



Dwelling Units



- Outside each separate sleeping area in the immediate vicinity of the bedrooms.
- In bedroom with fuel-burning appliances.



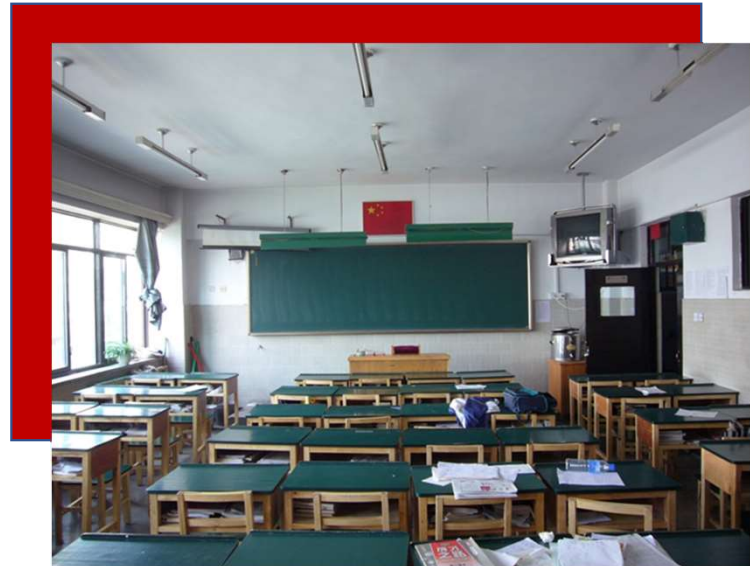
Sleeping Units

- Installed in sleeping units.
- Exception:
 - Detection outside room allowed where the sleeping unit or its attached bathroom does not:
 - contain a fuel-burning appliance, and,
 - is not served by a forced air furnace.



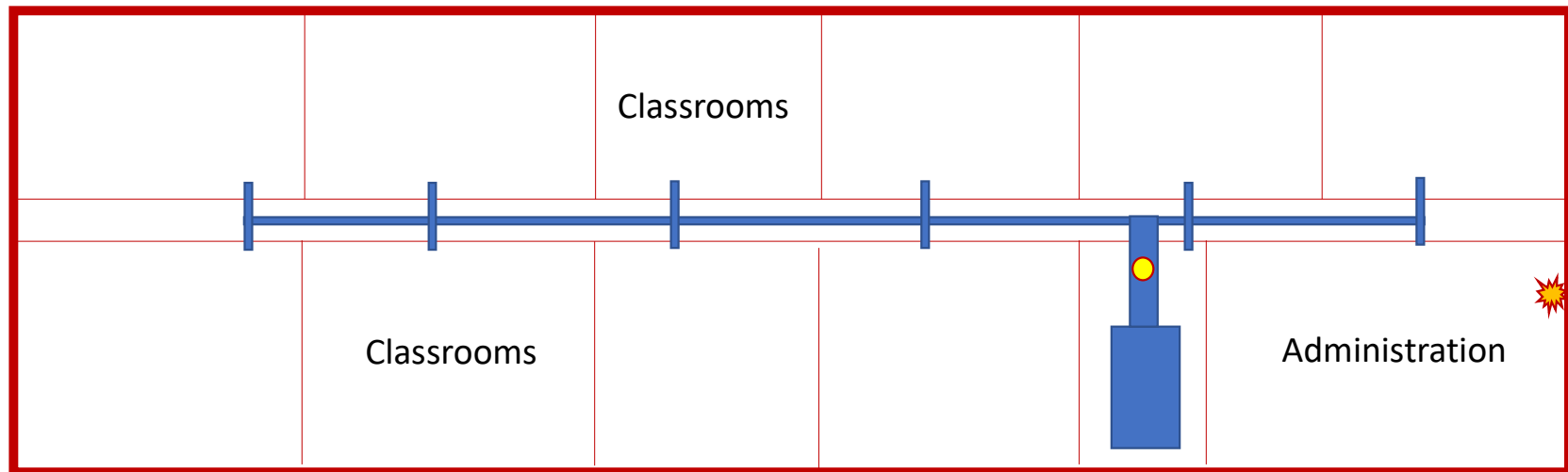
Group E Occupancies

- In classrooms
 - Alarm signals automatically transmitted to an on-site location that is staffed by school personnel.
 - Exception for Group E with 30 or fewer occupants



Room Detection Exceptions

- Fuel-burning forced-air furnaces
 - Detection installed in main supply ducts
 - First room or area leaving furnace
 - Alarm reports to an approved location



Plan View



Detection Exceptions



- Fuel-burning appliances outside of:
 - Dwelling units, sleeping units, classrooms
 - Where:
 - No communicating openings occur, or,
 - Detection installed in approved location
 - Between appliances, or,
 - On ceiling in room where appliance is installed



Detection Exceptions



- Attached private garages
 - Dwelling units, sleeping units, classrooms
 - Where:
 - No communicating openings
 - Living accommodations or classrooms more than one story above or below
 - Garage connected to building through open-ended corridor
 - Detector installed in approved location between garage openings and exposures



Detection Exceptions

- Exempt garages:
 - Open parking garage
 - Enclosed parking garage
 - Mechanically ventilated



Detection Technology



Photo courtesy of Integra Code Consultants.

- Sensing technology
 - Biometric
 - Metal-oxide semiconductor
 - Electrochemical
- Power sources
 - 120-volt alternating current
 - 9-volt battery
 - Fire alarm/CO detection control unit
 - Combination



Performance Standards

- UL 217 – Single and Multiple Station Smoke Alarms
- UL 268 – Smoke Detectors for Fire Alarm Systems
- UL 864 – Control Units and Accessories for Fire Alarm Systems
- UL 2034 – Single and Multiple Station Carbon Monoxide Alarms
- UL 2075 – Gas and Vapor Detectors and Sensors



Carbon Monoxide Alarms

- Single and multiple station devices
 - Primary power from the building wiring
 - Battery backup
- UL 2034 “Standard for Single and Multiple Station Carbon Monoxide Alarms”
- Combination CO/smoke alarms are acceptable alternative
 - If smoke alarm listed to UL 217



CO Detection Systems

- Comply with NFPA 720
 - “Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment”
- Code-based detector placement locations supersede NFPA 720
- Detectors listed to UL 2075
 - “Standard for Gas and Vapor Detectors and Sensors”



Co Detection And Warning Equipment

NFPA 720 (2015 Edition)

- Requirements for performance, installation, operation, inspection, testing and maintenance.
- Addresses installations of:
 - commercial systems and components
 - single- and multiple-station CO alarms, and,
 - household CO detection systems.
- Will move to NFPA 72 Chapter 17 in 2022 Edition



NFPA 720 – Design Criteria

- Qualified design, installation and service personnel
 - Factory trained or certified
 - State- or locally-licensed
- Primary power from building
 - Secondary power supply
 - Battery or generator
- 24-hour standby and 12 hours of operation and of alarm
 - May be reduced to five minutes where supervised



Gas Detectors

UL 2075

- Toxic and combustible gas and vapor detectors and sensors
- Portable or employed in indoor or outdoor locations in accordance with the *National Electrical Code*®, NFPA 70.
- Detectors for toxic and/or combustible gases or vapors:
 - assembly of electrical components with a sensing means inside a chamber, or,
 - by separate components.
 - includes provision for connection to a power source and signaling circuits.





Inspection, Testing, and Maintenance

Maintaining Performance



May 13, 2022

NFPA 720 - Inspection Frequency (Extract)

| Components | Visual Inspection Frequency |
|---|-----------------------------|
| CO detectors | Semiannual |
| Notification appliances | Semiannual |
| Supervisory signal devices | Quarterly |
| Control panel (non monitored) <ul style="list-style-type: none">• Fuses, lamps, main power supply | Weekly |
| Control panel (monitored) <ul style="list-style-type: none">• Fuses, lamps, main power supply | Annually |
| Batteries (Lead acid and dry cell) | Monthly |



NFPA 720 - Testing Requirements

- Testing
 - Initial acceptance
 - System or device alterations or repairs
 - Software changes
- Single- and multiple-station devices
 - Inspected and tested monthly
- Household devices
 - Tested per manufacturer's recommendations
 - Checked by qualified technician every three years



Free Resources

Available on the Web



- U.S. National Library of Medicine
 - Chemical and toxicological information
 - www.nih.gov
 - Search on “carbon monoxide”
 - ToxTown interactive game
- U.S. Fire Administration
 - Free safety handout materials
 - www.usfa.dhs.gov
 - Search on “carbon monoxide”



Additional Free Resources

Available on the Web



- U.S. Consumer Products Safety Commission
- Carbon Monoxide Information Center
- Bi-lingual videos and safety tips
- www.cpsc.gov





Review

You should be able to:

1. Identify Maine Title 25 §2469, the International Building and Residential Codes, and NFPA I gas detection requirements.
2. Provide examples of common sources of physical and health hazard gases.
3. Demonstrate how these regulations apply to new and existing construction.





References



International Building Code (2021 Edition)



International Residential Code (2021 Edition)



Maine Title 25, §2469 “Fuel Gas Detectors”



NFPA 1 Fire Code (2021 Edition)



NFPA 720 Carbon Monoxide Detection (



NFPA 72 National Fire Alarm and Signaling Code





References

- American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE)
www.ashrae.org
- ASHRAE Refrigerant Designations
<https://www.ashrae.org/technical-resources/standards-and-guidelines/ashrae-refrigerant-designations>
- International Institute of Refrigeration
www.iifiir.org
- Global Refrigerant Management Initiative
 - Alliance for Responsible Atmospheric Policy
www.arap.org
- Air-Conditioning, Heating and Refrigeration Institute
www.ahrinet.org
- Brazilian Association for HVAC-R
www.abrava.com.br



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