

Occupational Health and Safety

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*Environmental Health
and Safety Office and
Department of
Occupational Health*

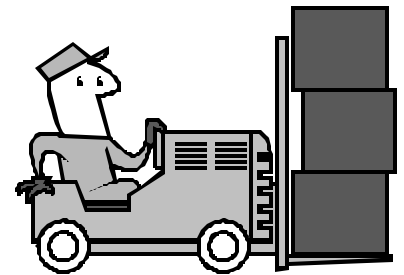
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www.mcgill.ca/ehs

<http://www.mcgill.ca/occh/>



Occupational health and safety includes:

- Occupational Health:
 - Medical management of worker health



- Occupational Hygiene:
 - Recognition, evaluation and control of hazardous materials and agents



www.crboh.ca/

- Occupational Safety:
 - Prevention of unintentional injuries and losses



Occupational Health and Safety

Part 1: Hazard Recognition

the hazard kingdom

Part 2 Hazard Evaluation

energy thresholds

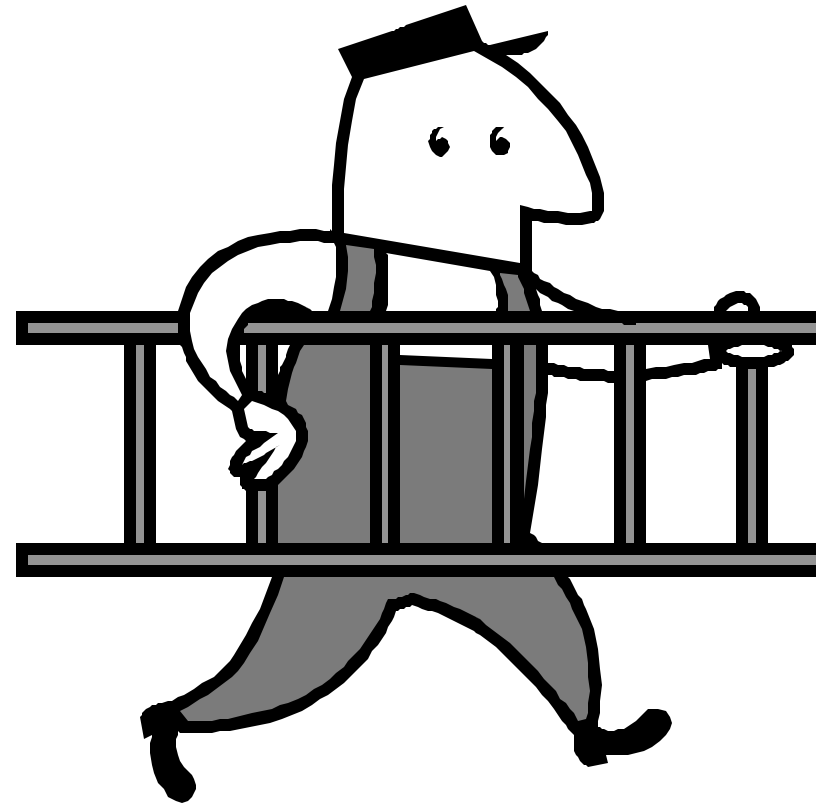
risk assessment

Part 3 Hazard Control

legislation

the controls hierarchy

examples



Part 1 - Hazard Recognition



Classes of Occupational Hazards

- **Chemical**



- **Biological**



- **Physical Agents**



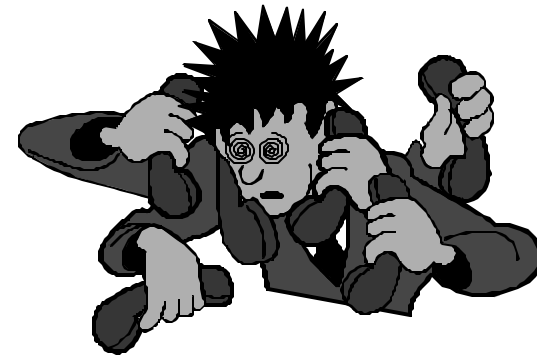
- **Mechanical Hazards**



- **Ergonomics**



- **Stress**

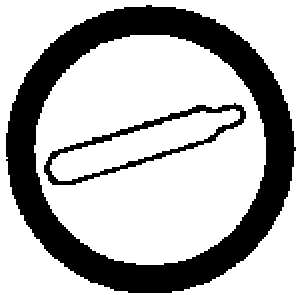


Workplace Hazardous Materials Information System (WHMIS)

- A uniform, pan-Canadian system designed to provide workers information on certain classes of hazardous materials, mostly chemicals, referred to as “Controlled Products”.



What are Controlled Products?



**Class A:
Compressed Gas**



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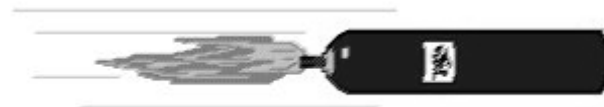




Class A: Compressed Gas



The One That Got Away





Class A: Compressed Gas



What are Controlled Products?



**Class B:
Flammable and
Combustible
Material**



Controlled Products

Class C: Oxidizing Material



9652
Perchloric Acid, 70-72%
HClO₄ FW 100.5

'Baker Analyzed' REAGENT

DANGER!
STRONG OXIDIZER
CONTACT WITH OTHER MATERIAL
MAY CAUSE FIRE OR EXPLOSION,
ESPECIALLY WHEN HEATED
CAUSES SEVERE BURNS

Keep from contact with clothing and other combustible materials. Do not store near combustible materials. Store in tightly closed container. Keep away from heat. Do not get in eyes, on skin, on clothing. Avoid breathing vapor or mist. Use with adequate ventilation. Wash thoroughly after handling. In case of fire, flood with water. In case of spill, flood with water applied quickly to entire area. Neutralize washings with lime or soda ash. **FIRST AID:** In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician. Wash clothing before re-use.

LOT		MEETS A.C.S. SPECIFICATIONS	
Assay (HClO ₄)	70.0 - 72.0 %		
Color (APHA)	10 max.		
Specific Gravity at 25°/25°C.	1.67 - 1.7		
Residue after Ignition	0.003 % max.		
Chloride (Cl)	0.001 % max.		
Nitrogen Compounds (as N)	0.001 % max.		
Sulfate (SO ₄)	0.001 % max.		
Trace Impurities (in ppm):			
Silicate and Phosphate (as SiO ₂)	5	max.	
Heavy Metals (as Pb)	1	max.	
Iron (Fe)	1	max.	

J.T.Baker

Perchloric Acid
VI (12R or 33A)

Manufacturing Chemists Assn. SD-11 Available
402-4308

J. T. BAKER CHEMICAL CO., PHILLIPSBURG, N. J. 08865



Class D Controlled Products

**Division 1:
Materials Causing Immediate
and Serious Toxic Effects**



**Division 2:
Materials Causing Other Toxic
Effects**



**Division 3:
Biohazardous Infectious
Materials**



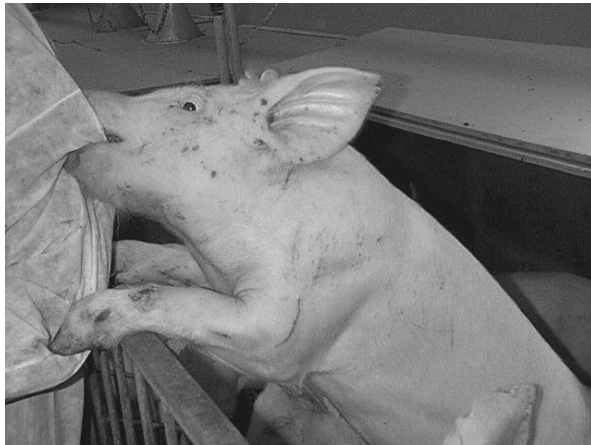
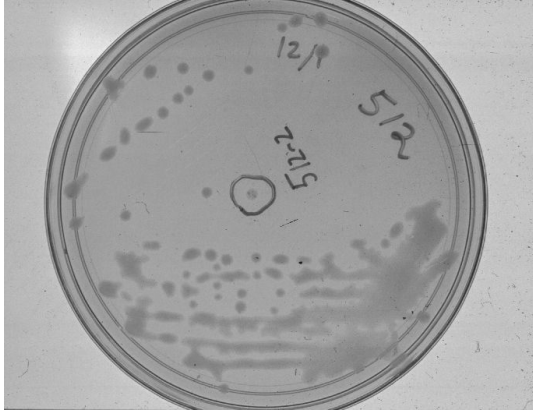
Biohazards



- Bacteria
- Fungi
- Viruses
- Parasites
- Recombinant DNA?



Biohazards assume many forms:



Controlled Products



**Class E:
Corrosive Material**

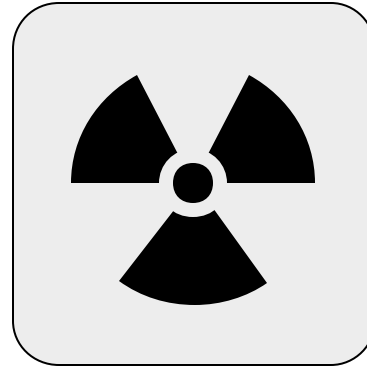


**Class F:
Dangerously Reactive
Material**



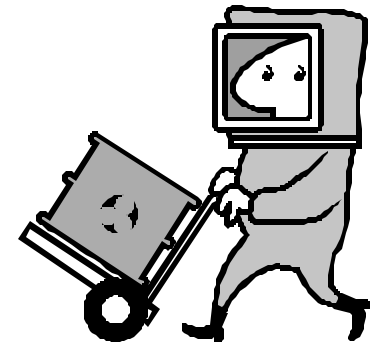
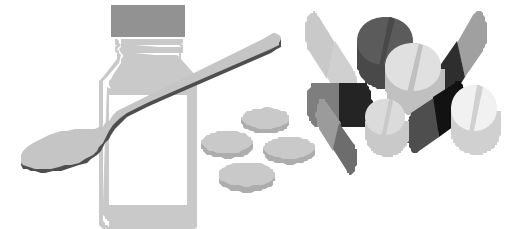
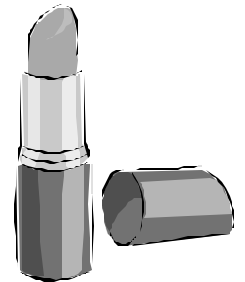
Not Classified as Controlled Products:

radioactive
materials



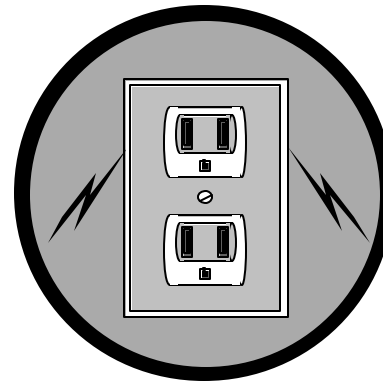
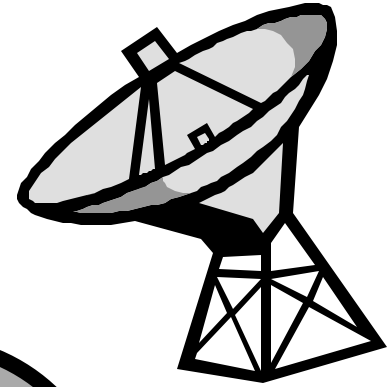
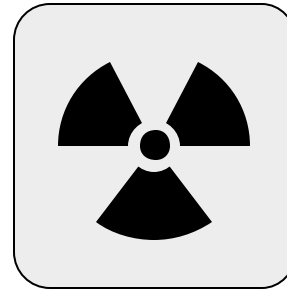
Not Classified as Controlled Products:

- Domestic goods
- Cosmetics
- Food & food additives
- Drugs & diagnostic chemicals
- Pesticides
- Hazardous waste



Physical Agents

- Thermal (heat/cold) stress
- Radiation
 - Ionizing
 - alpha, beta, gamma, x rays
 - Non -ionizing
 - UV, IR, radio and microwave, electric and magnetic fields
- Noise and Vibration
- Hypo and hyperbaric environments
- Electricity



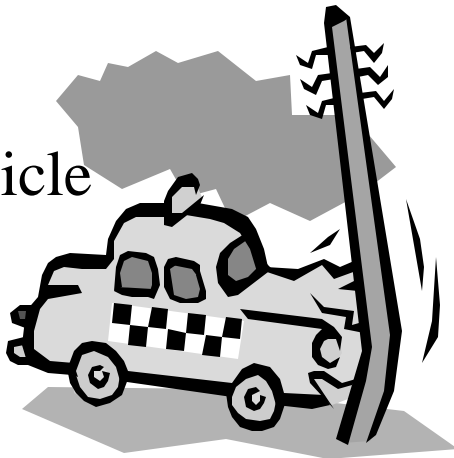
Mechanical Hazards



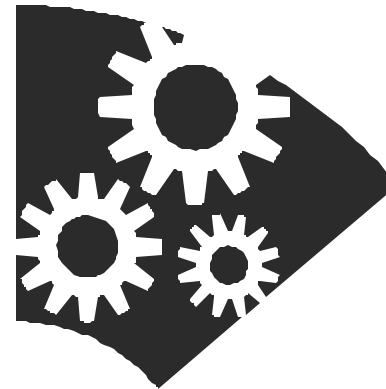
Slips and falls



Falls from heights



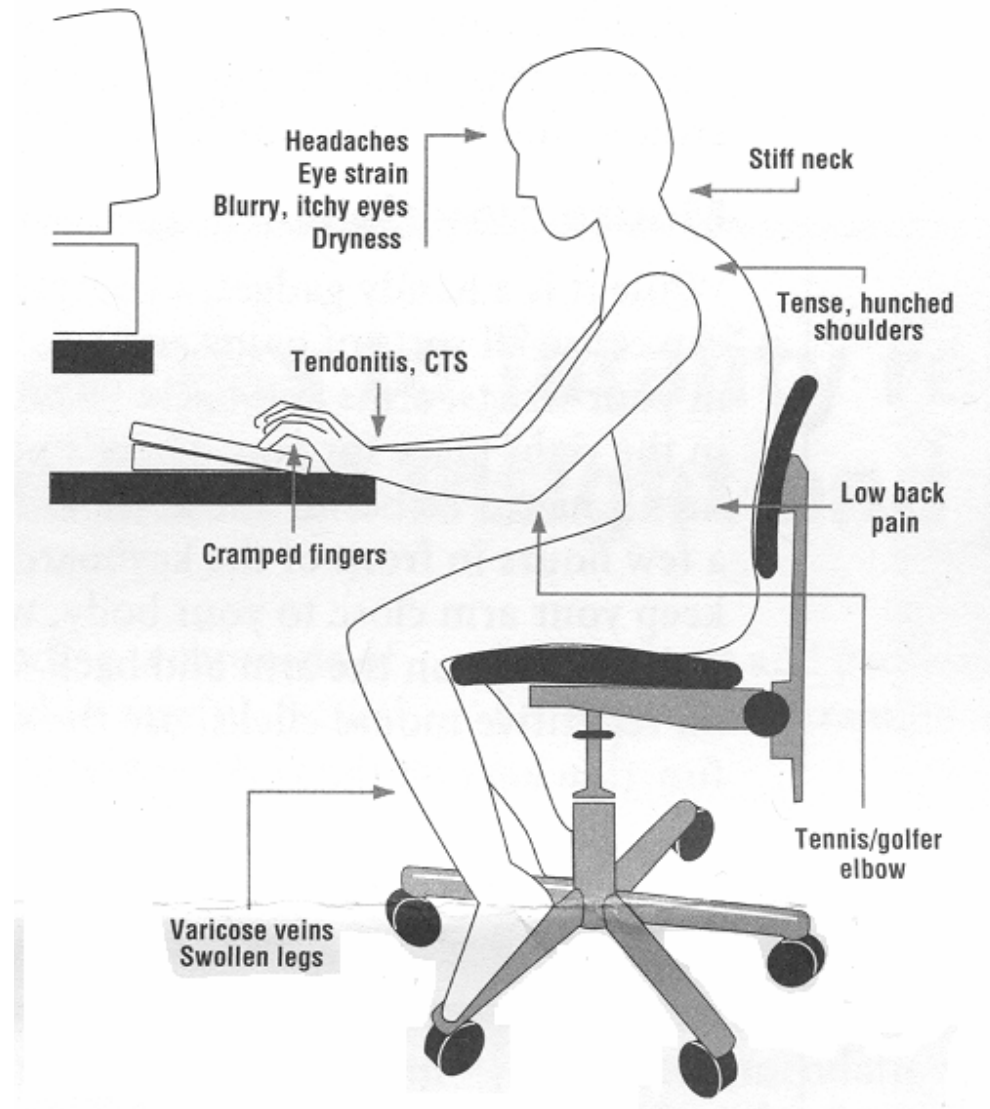
Motor vehicle accidents



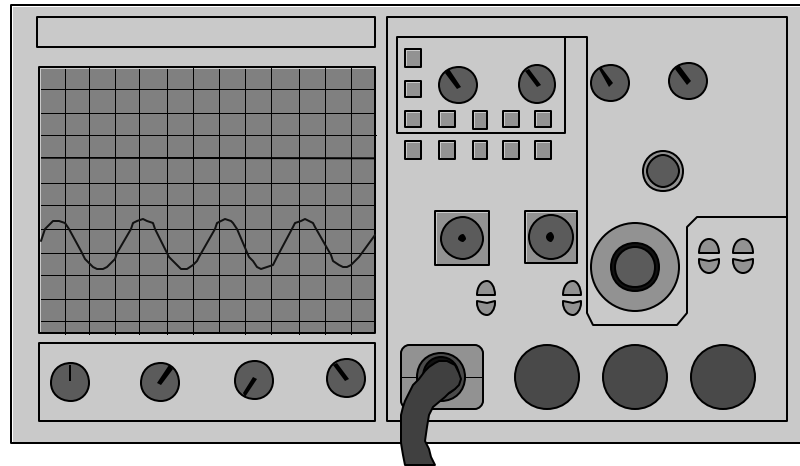
Machine hazards



Ergonomics Related maladies



Part 2- Evaluation of Occupational Hazards



Evaluation of Occupational Hazards

- Energy Thresholds
- Risk Assessment
 - risk equations
 - risk matrix

“Incident” - contact with an energy source above the threshold of the worker.



Examples of Thresholds

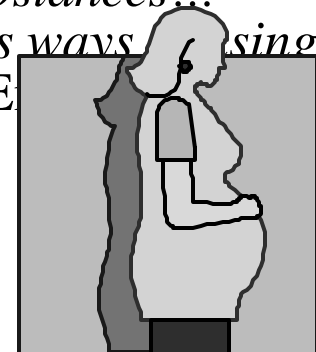


- Chemical “TLV’s”
- Radiation dose
- Thermal stress
- Noise
- Voltage/current
- Ergonomics (# of repetitions)
- Falls (50% from >9 ft. are fatal)



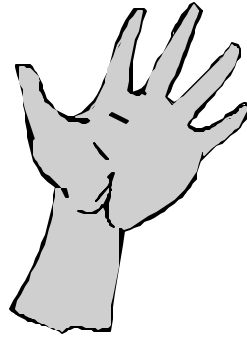
Hazardous Substances: risk considerations

- Physical state (sol, liq, gas, aerosol)
- Physical properties (BP, VP, ...), radionuclear properties.
- Chemical properties i.e., flammability, solubility, reactivity, corrosivity, odour warning ...
- Toxicity (LD50, LC50...)
- Biological properties (species, viability, pathogenicity)
- Toxic effects (carcinogenic, neurotoxic...)
- Amount, duration, frequency timing of exposure
- Amount, duration, frequency timing of exposure
- Route(s) of entry (inhalation, skin absorption, injection, ingestion)
- Interactions (synergistic, antagonistic effects)
- Individual susceptibility (allergies, sensitizations, pregnancy...)
- Handling methods – *“There are no harmless substances... only harmless ways to handle substances”* – E

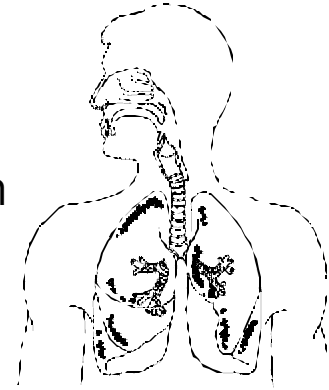


Routes of Entry

Skin Absorption



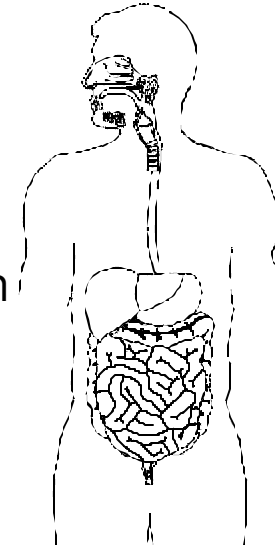
Inhalation



Injection



Ingestion

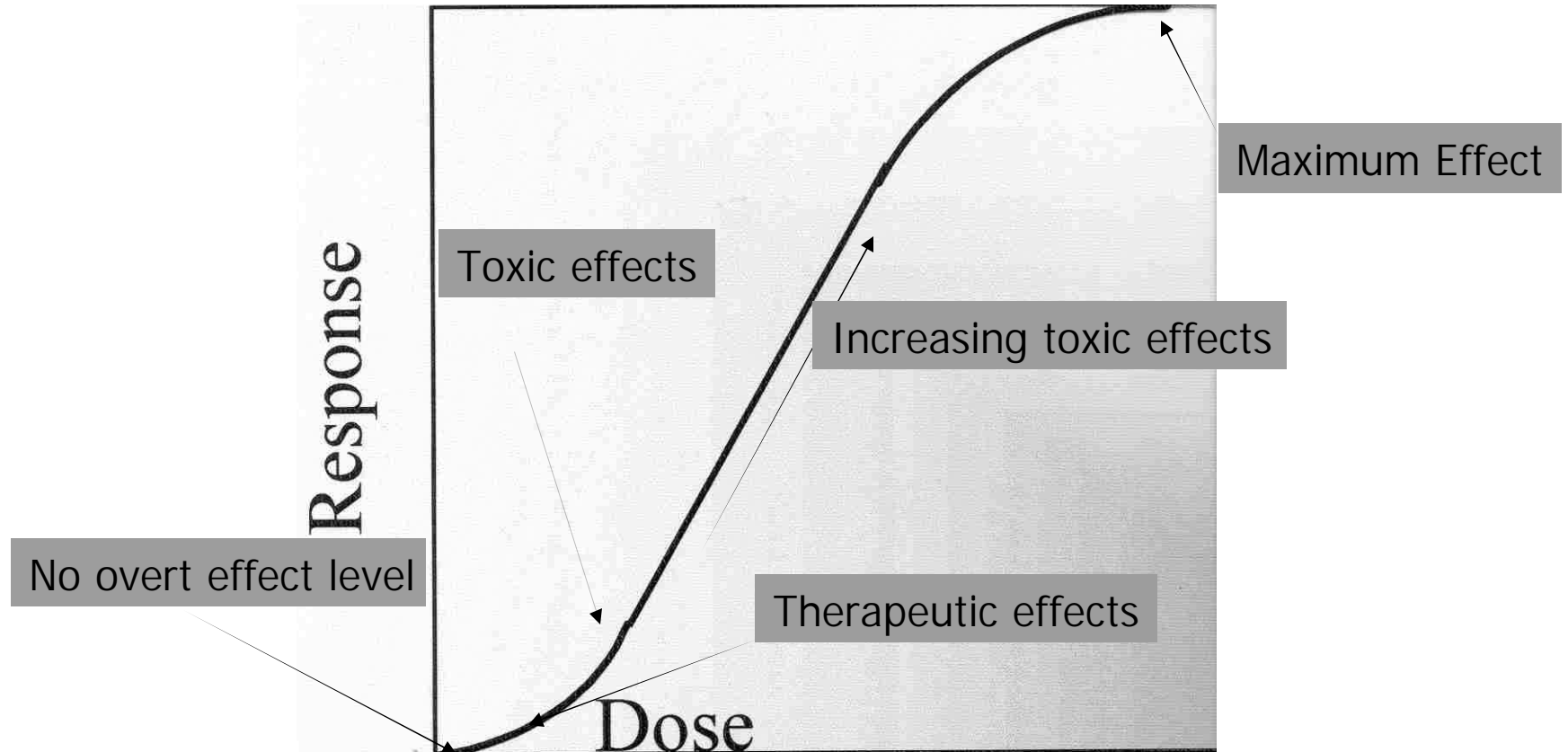


*“All chemicals are
poisons; there is
none which is not a
poison. The right
dose differentiates a
poison and a
remedy.”*

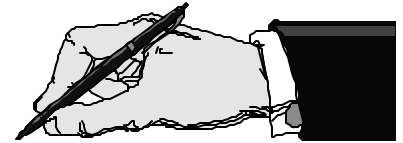
- Paracelsus (1493-1541)



The dose-response curve



TLV Definition



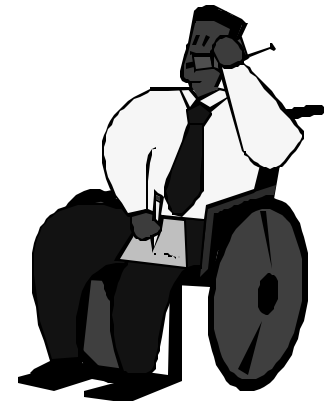
Threshold limit values refer to airborne concentrations of substances and represents conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse effects





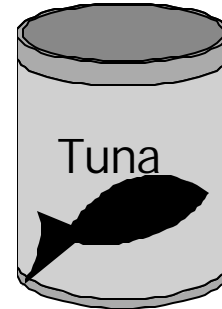
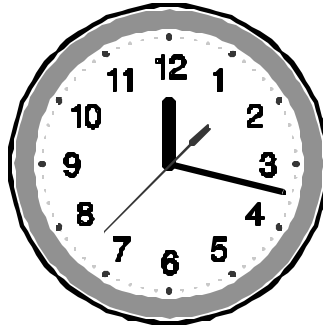
Susceptible Person

- wide variation in individual responses to exposures
- small percentage of workers may experience adverse reactions even at concentrations at or below the threshold limit



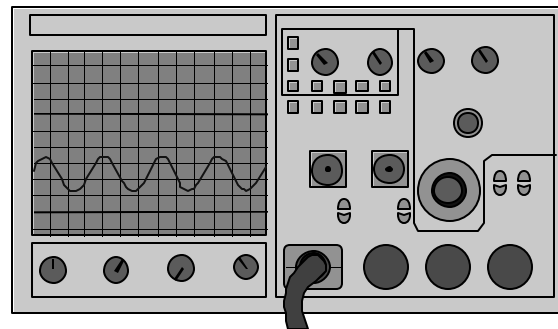
“It’s not only the dose; it’s also the timing”

- Sandra Steingraber, Rachel Carson scholar

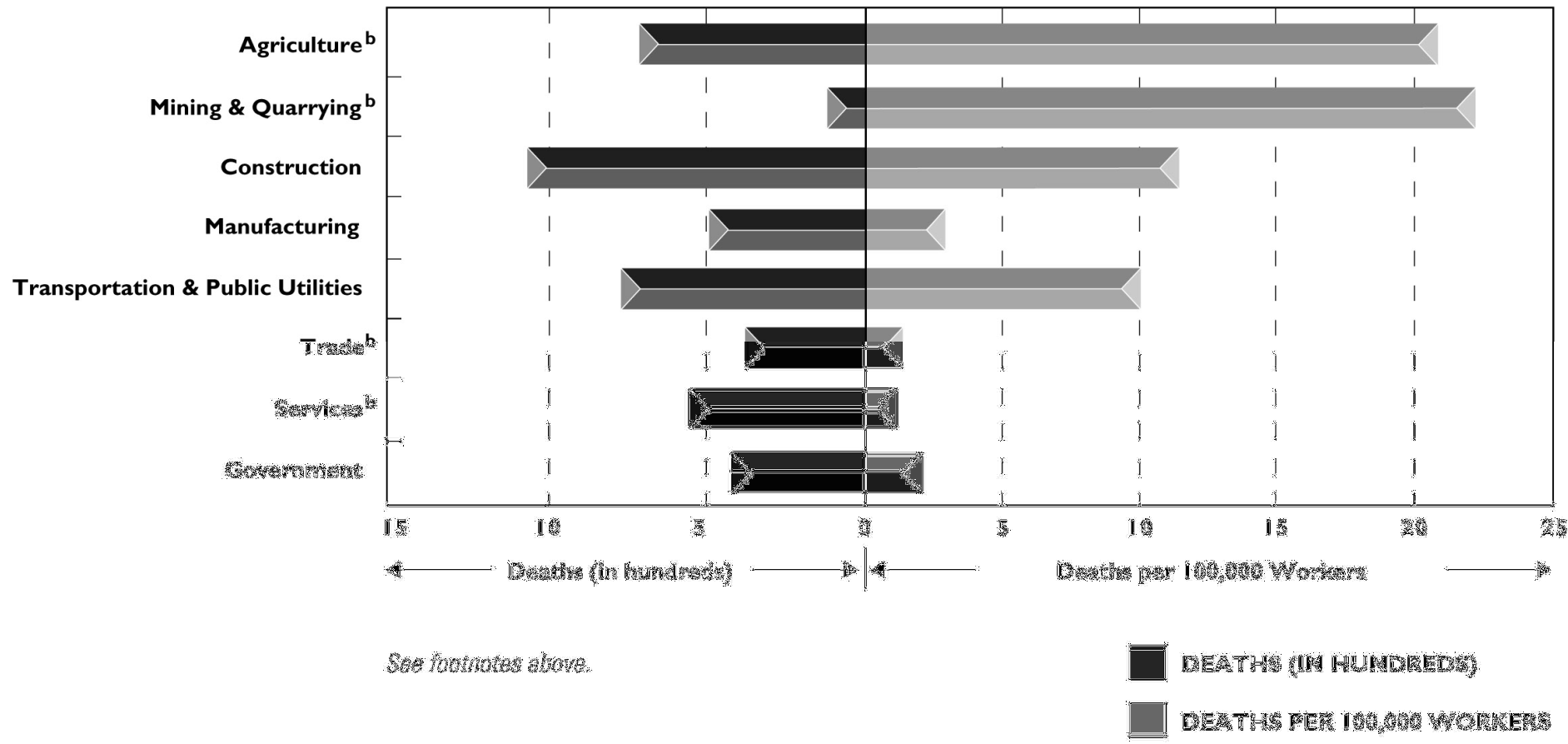


Measurements of Safety

- Recordable injuries, lost time, worker's compensation costs.
- Incidents
- Compliance record
- Occupational hygiene surveys
- Inspections
- Complaints
- Benchmarking
- Auditing
- Behavior
- Worker satisfaction
- \$\$\$



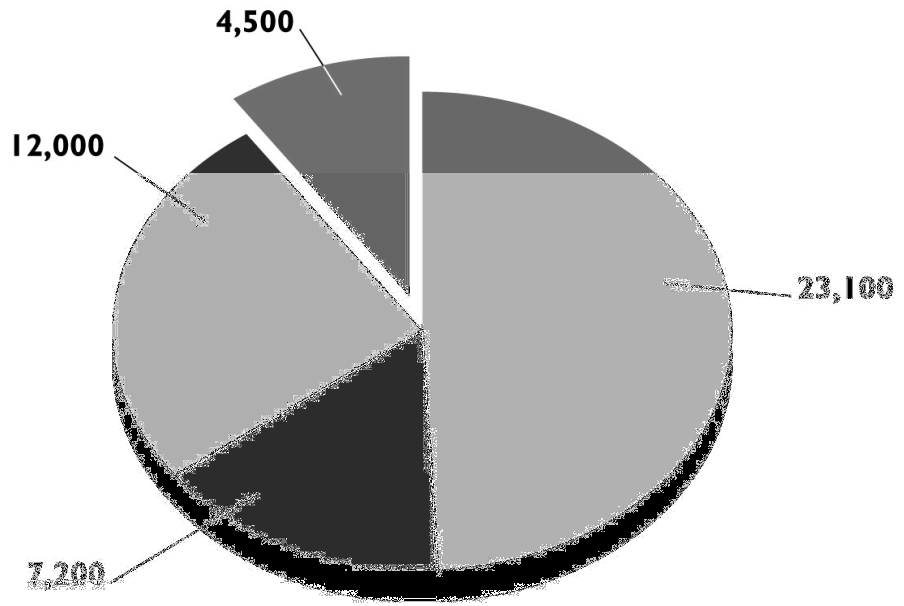
OCCUPATIONAL UNINTENTIONAL-INJURY DEATHS AND DEATH RATES BY INDUSTRY, UNITED STATES, 2003



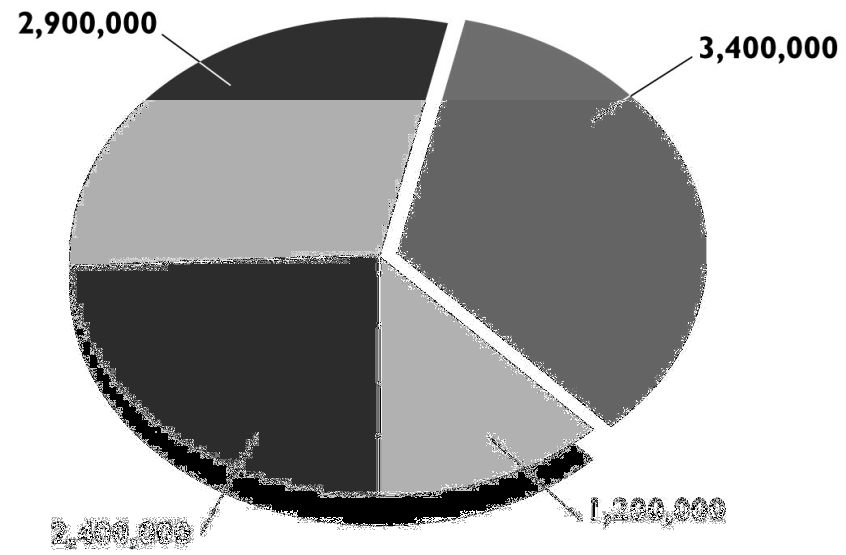
Source: National Safety Council Accident Facts, 2004 edition





WORKERS' ON- AND OFF-THE-JOB INJURIES, 2003

DEATHS



INJURIES

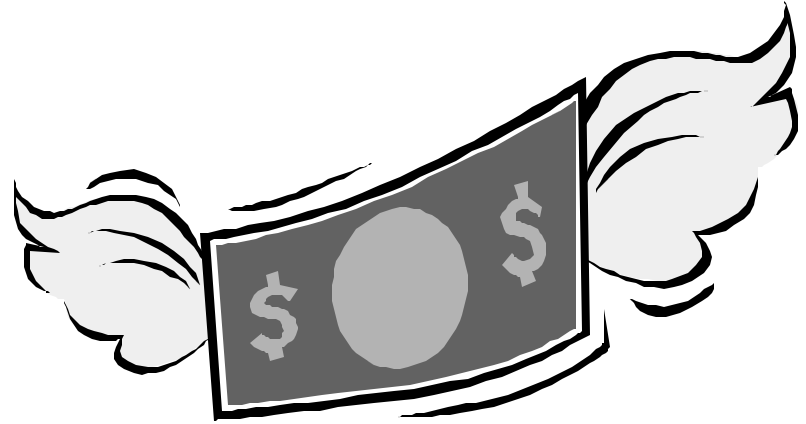


-  ON-THE-JOB
-  OFF-THE-JOB MOTOR-VEHICLE
-  OFF-THE-JOB PUBLIC
-  OFF-THE-JOB HOME



Major Areas of Loss

- Harm to employees
- Property loss
- Harm to public
- Production Loss
- Loss of revenues
- liabilities
- Security losses
- Damage to reputation



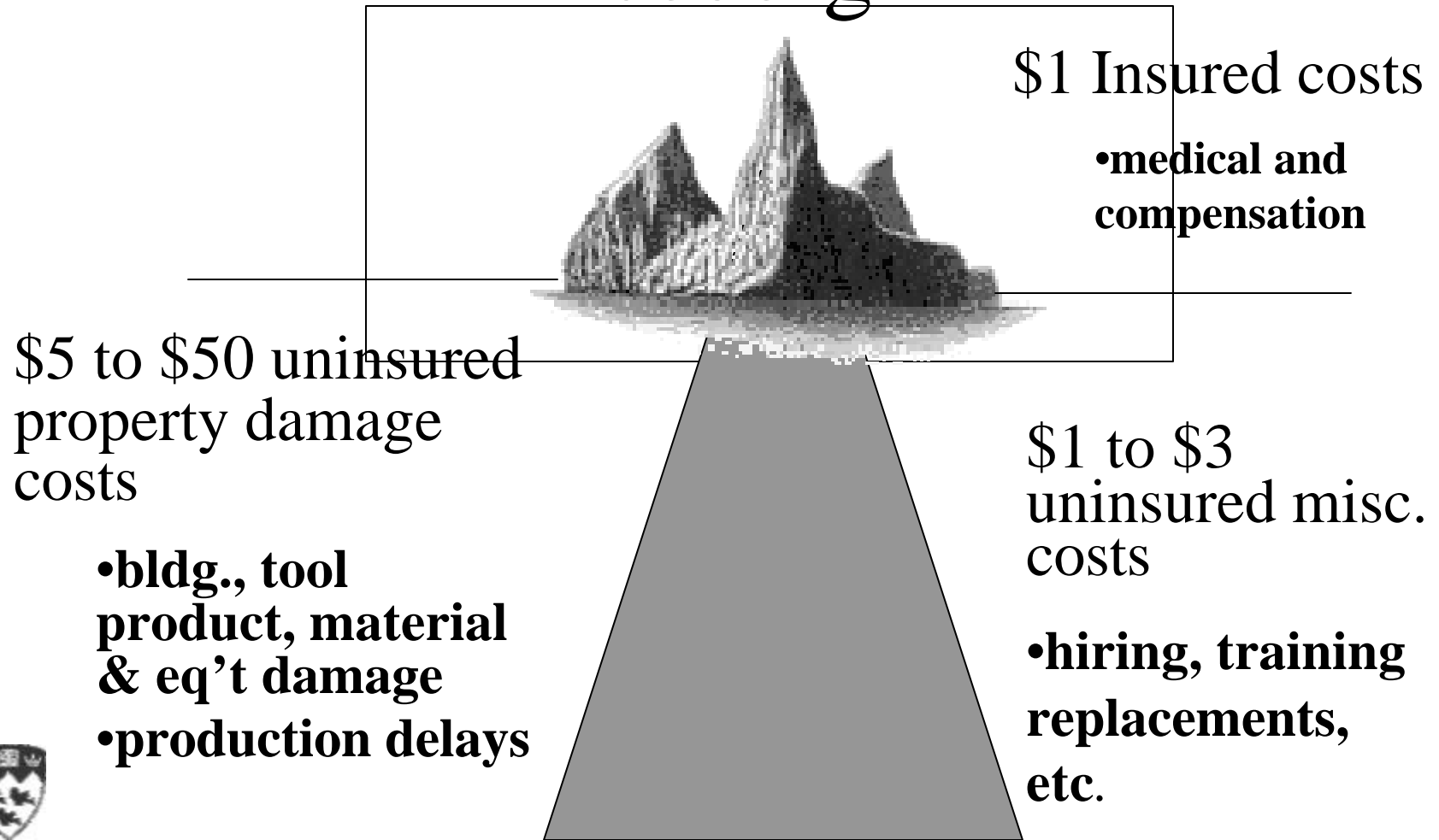
Sales Required to Cover Losses

Costs of Losses	1% Profit Margin	3% Profit Margin	5% Profit Margin
\$1000	100,000	33,000	20,000
5000	500,000	167,000	100,000
10,000	1,000,000	333,000	200,000
50000	5,000,000	1,667,000	1,000,000
100,000	10,000,000	3,333,000	2,000,000

In times of keen competition, low profit margins and waning budgets, controlling losses may contribute more to profits than the organization's best salesperson.



Direct Costs- The tip of the Iceberg



Assessing Risk

Traditional risk equations:

Risk = Likelihood x Exposure x
Consequences



Or

Risk = Probability x Magnitude



Risk Matrix

CONSEQUENCES ↓	LIKELIHOOD →				
How Seriously Can it Hurt Someone?	How Likely is it to Hurt Someone?				
	VERY LIKELY	LIKELY	OCCASIONAL	UNLIKELY	VERY UNLIKELY
EXTREME	HIGH	HIGH	HIGH	MEDIUM	MEDIUM
MAJOR	HIGH	HIGH	MEDIUM	MEDIUM	LOW
MODERATE	HIGH	MEDIUM	MEDIUM	LOW	NEGLIGIBLE
MINOR	MEDIUM	MEDIUM	LOW	NEGLIGIBLE	NEGLIGIBLE

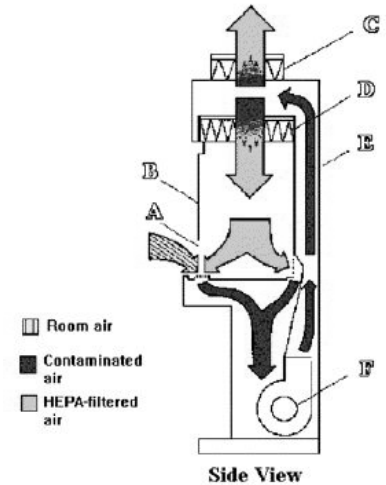


Risk management options

- Terminate
- Tolerate
- Transfer
- Treat

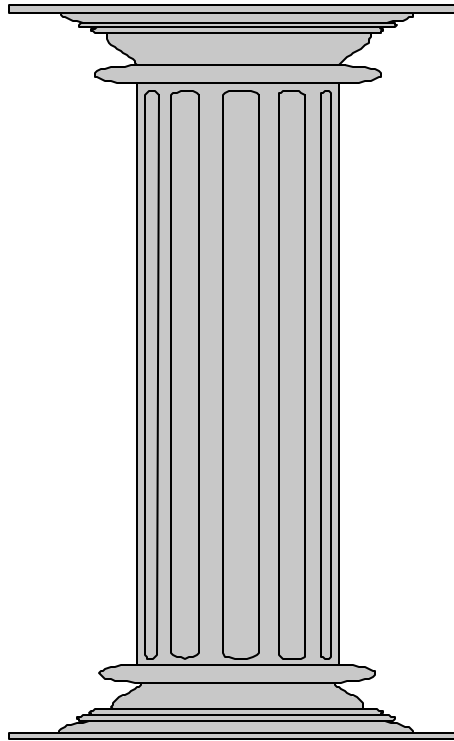


Part 3- Control of Occupational Hazards

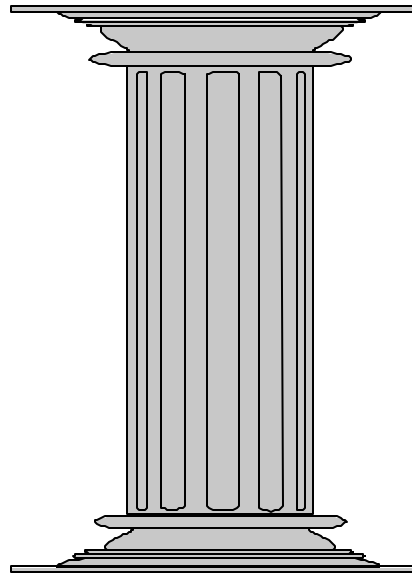


The Hierarchy of Controls

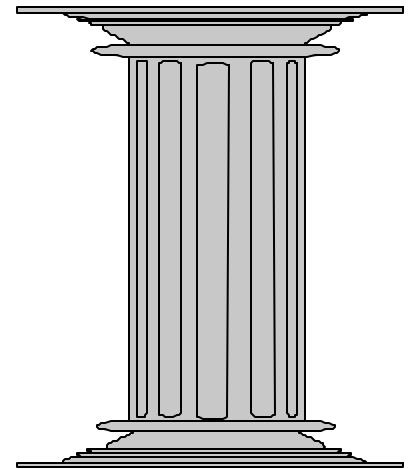
Engineering



Administrative



Personal and
Procedural



Engineering Controls

*“Safety by Design,
not by Accident”*

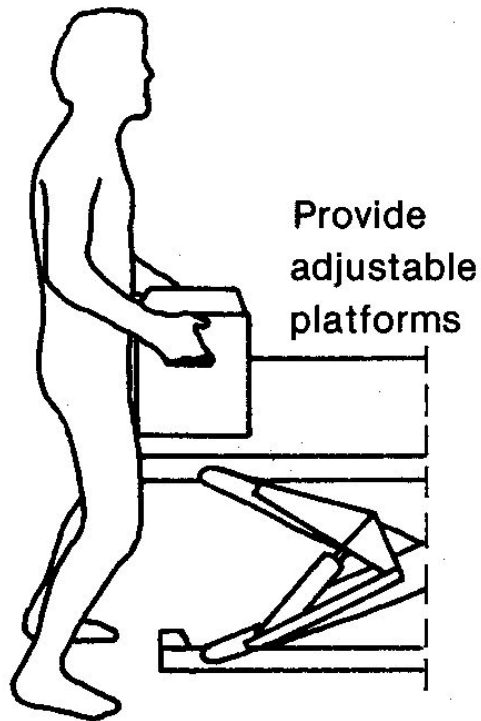
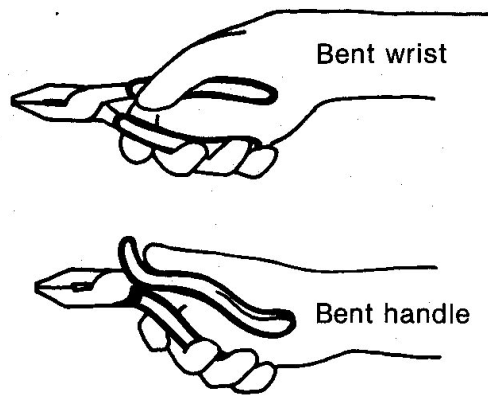


- Process/hazard isolation or containment
- Machine safeguarding
- Ventilation
- Facility design
- Equipment design e.g. safety interlocks
- Automation

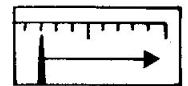


Designing Safety Features

Shape



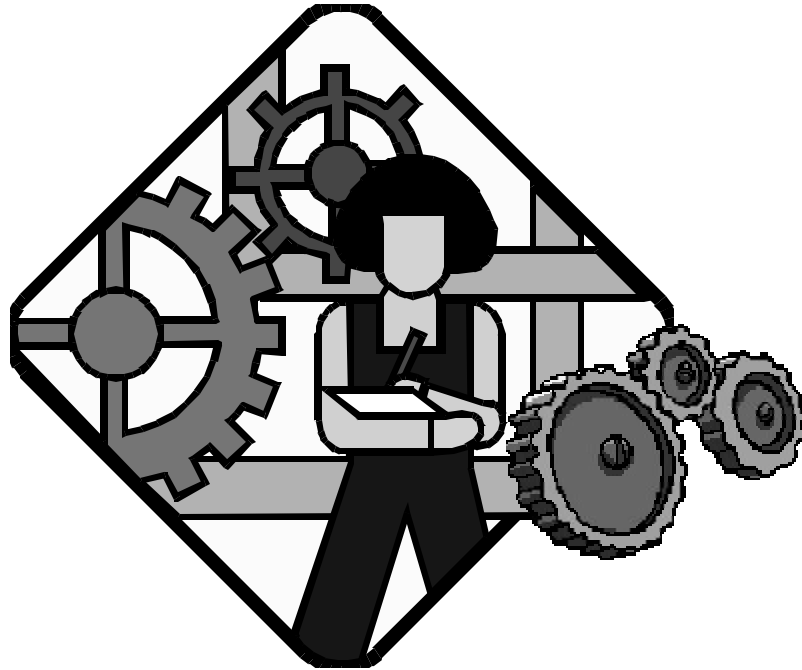
Control-Display Relationships



Follow usual expectations.

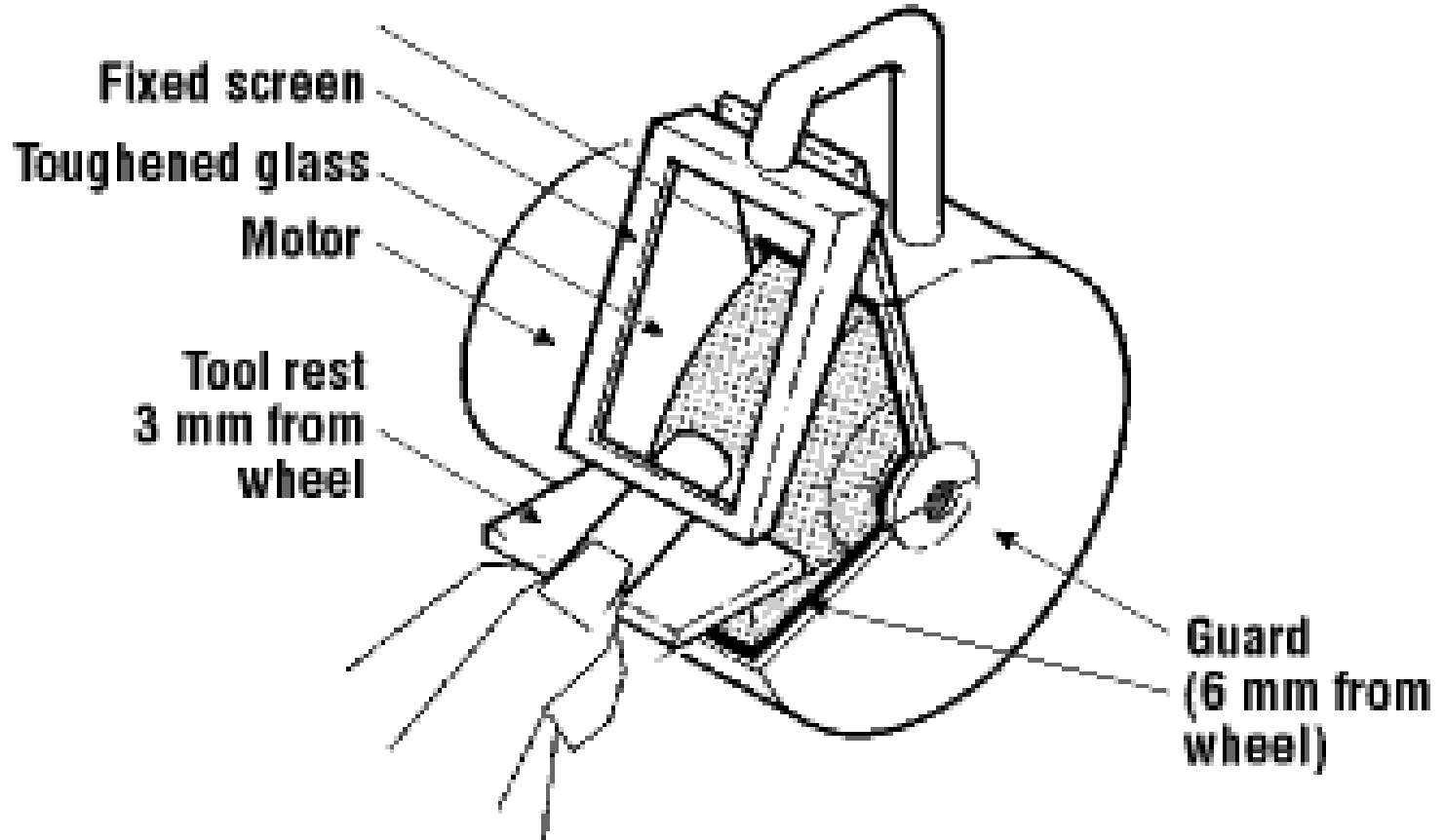


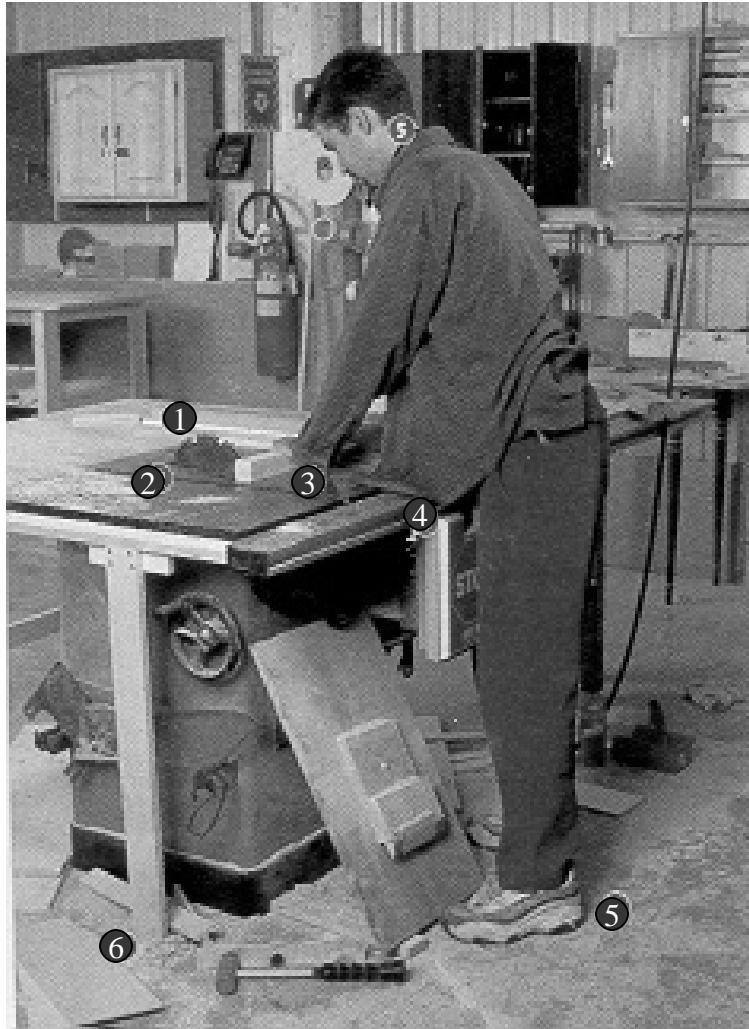
Machine Safeguarding



http://www.osha-slc.gov/Publications/Mach_SafeGuard/

Machine Safeguarding





1. No guard on saw blade
2. Debris on table surface
3. No push stick
4. Loose clothing
5. No safety shoes or glasses
6. Tripping hazards



Administrative Controls



- Substitution
- Work scheduling
- Purchasing standards
- Training, supervision
- Inspections & audits
- Occupational health and hygiene programs
- Incident reporting and investigation
- Emergency and disaster planning
- Safety management systems
e.g. OHSAS 18001



Personal and Procedural Controls



- Eye protection
- Skin protection
- Foot protection
- Respirators
- Safe work policies and procedures e.g. Lock-out/Tagouts, confined space entry procedures



Legislation

- Due Diligence
- Types of Law
- Rights, Obligations and General Duties



Introducing...

Knowledge of legislation is important, but there's more to OH&S than that. Exercise critical thinking - be a McGill engineer, not just another Checklist Charlie!



Checklist Charlie



Types of Law



Criminal

Civil



Regulatory

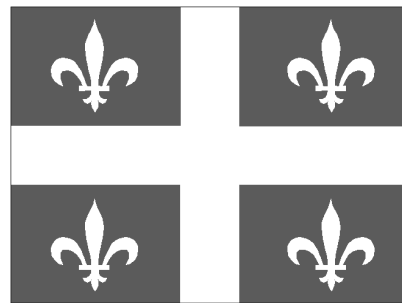


Jurisdictions

Federal

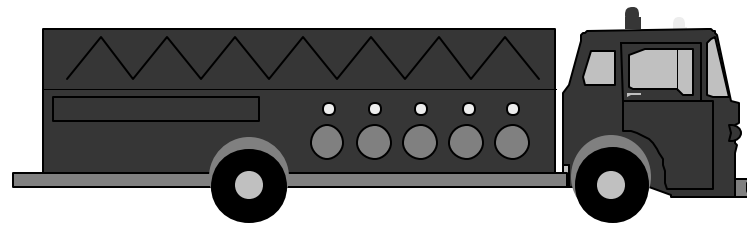


Provincial



QUEBEC

Municipal



Key Federal H&S Legislation

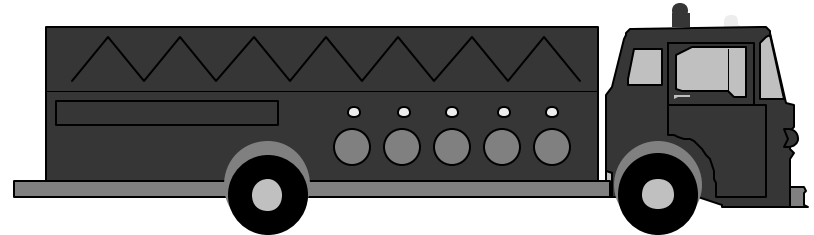


- Canada Labour Code
 - Canadian Nuclear Safety Act
 - Transport of Dangerous Goods Act
 - Hazardous Products Act
 - Pest Control Products Act
- Bill C-45 → Canada Criminal Code

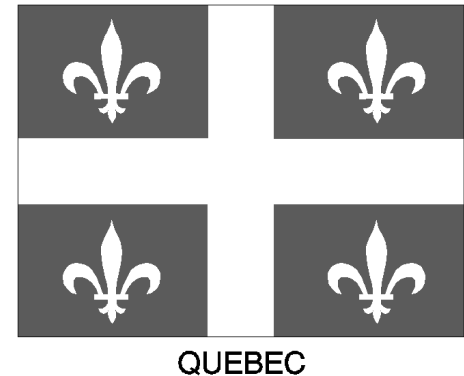


Municipal H&S Legislation

- Fire prevention
- Building permits and zoning
- Some ventilation and building codes
- Water and air emissions



Provincial Legislation



- Act and regulations respecting occupational health and safety
- Regulation respecting industrial accidents and occupational diseases (aka worker's compensation regs)
- Public building safety act
- Construction safety code



Laws (acts) and Regulations



The Act Respecting Occupational Health and Safety

(and many more) →

Regulation
Respecting
Occupational
Health & Safety

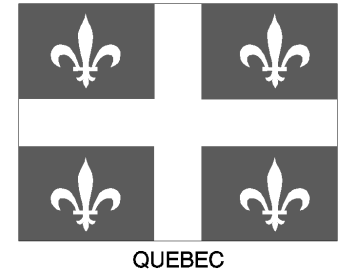
First Aid
Minimum
Standards
Regulation

Controlled
Products
(WHMIS)
Regulation



<http://www.ccohs.ca/legislation/>

Workers' Rights¹

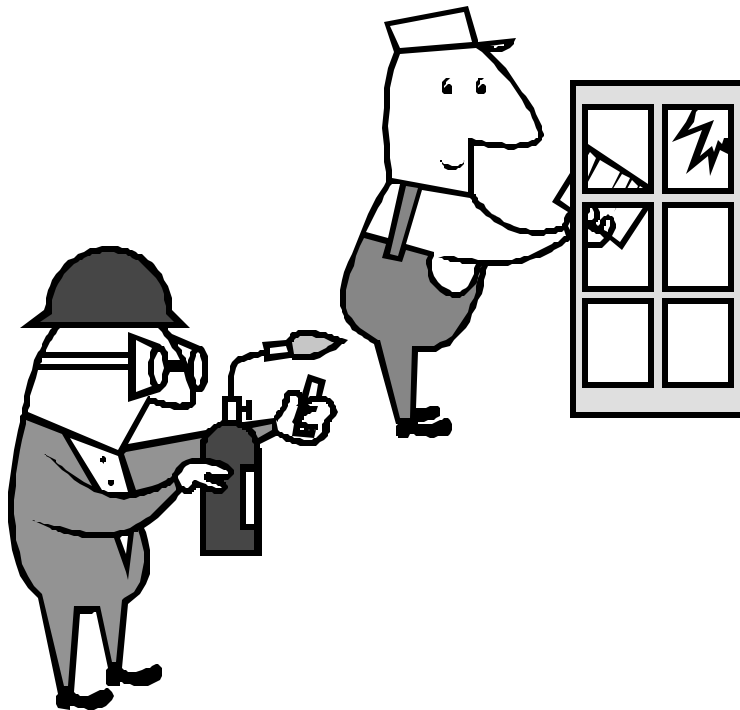
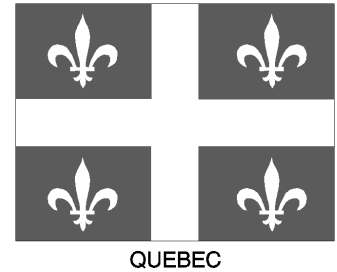


- Safe and healthful conditions
- Supervision, training, and info on safety
- Right to refuse dangerous work
- Right to a safety rep
- Protective reassignment



¹Quebec Act respecting occupational health and safety

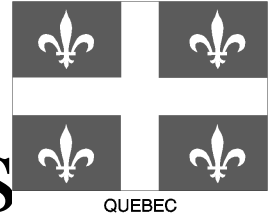
Workers' Obligations



- Be familiar with “prevention program” i.e., safety policies and procedures
- Take measures to protect self and others
- Participate in the ID of risks
- Cooperate with H&S committee



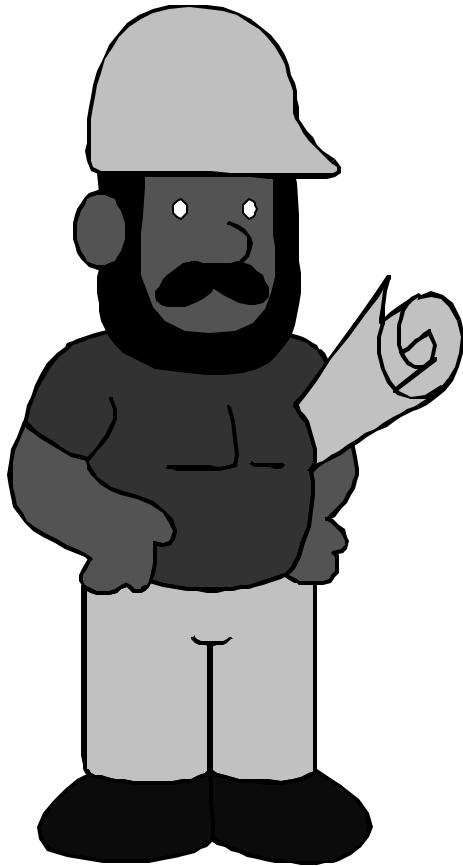
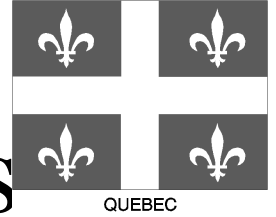
Employers' Obligations and General Duty Clauses



- Facility **design**, layout, maintenance, sanitation, environmental conditions
- Work **organization**, **procedures**, and techniques
- Methods to **identify**, **control**, and **eliminate risks**



Employers' Obligations and General Duty Clauses



- **Fire protection**
- **Control of dangerous substances** used or emitted
- **Train, supervise and advise** workers about risks and prevention measures.
- Provide safety **devices and equipment**

And more...



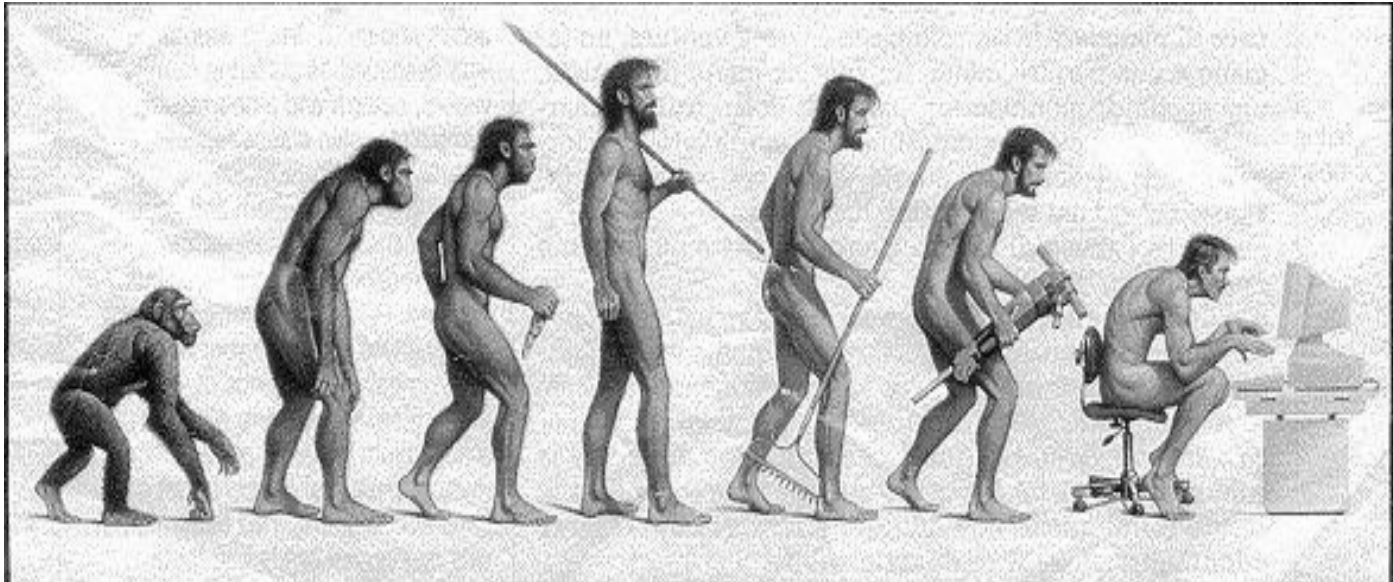
Some typical contents of H&S regulations:

- Confined space entry
- Exposure limits (chemicals, radiation, noise, thermal stress, vibration, etc.)
- Ventilation requirements
- Comfort (T,H) criteria
- Lighting
- Fall protection
 - scaffolds
 - ladders
 - guardrails,
 - fall arrest, fall restraint
- Fire Protection
- Ergonomics
- Sanitation criteria
- Machine guarding specs
- Lock-out/Tag-out procedures
- Protective equipment specs
- Storage and handling specs



Ergonomics – the risk factors

- Force
- Posture
- Repetitiveness
- Duration



Basic precautions and solutions



The ideal ergonomic keyboard!

- Neutral position
- Minimize reaching, bending, twisting
- Intersperse repetitive with other tasks
- Adjustability, adjustability, adjustability
- Lighting, glare control
- Health and fitness
- Medical intervention for chronic symptoms



Key Adjustments

Backrest at slightly $> 90^\circ$

Top of monitor at eye level or lower

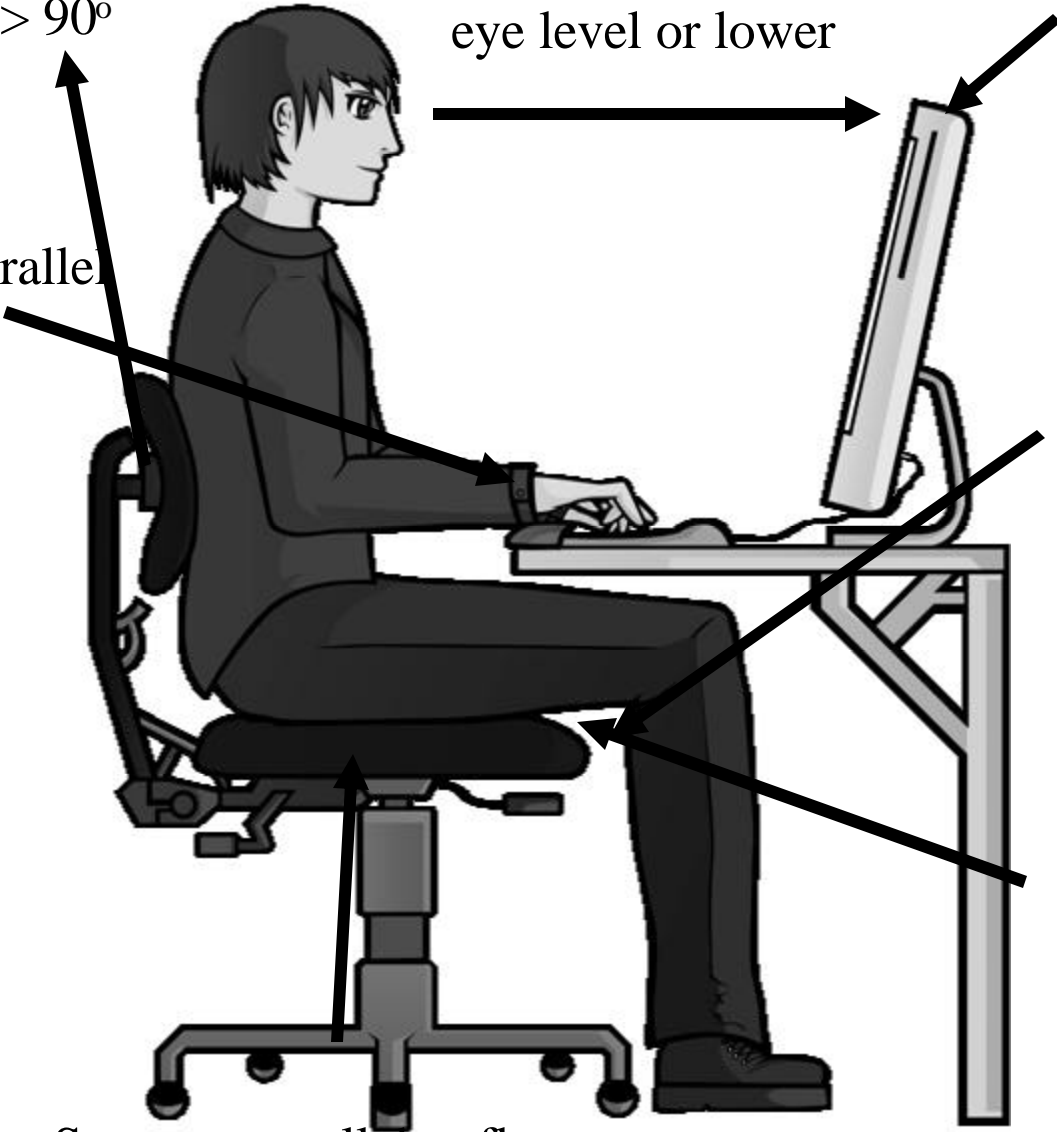
Monitor at arm's length, 90° rel. to windows

Forearms parallel to floor, wrists in "neutral" position

Space between seat pan and back of knees

Space between seat pan and lower thigh.

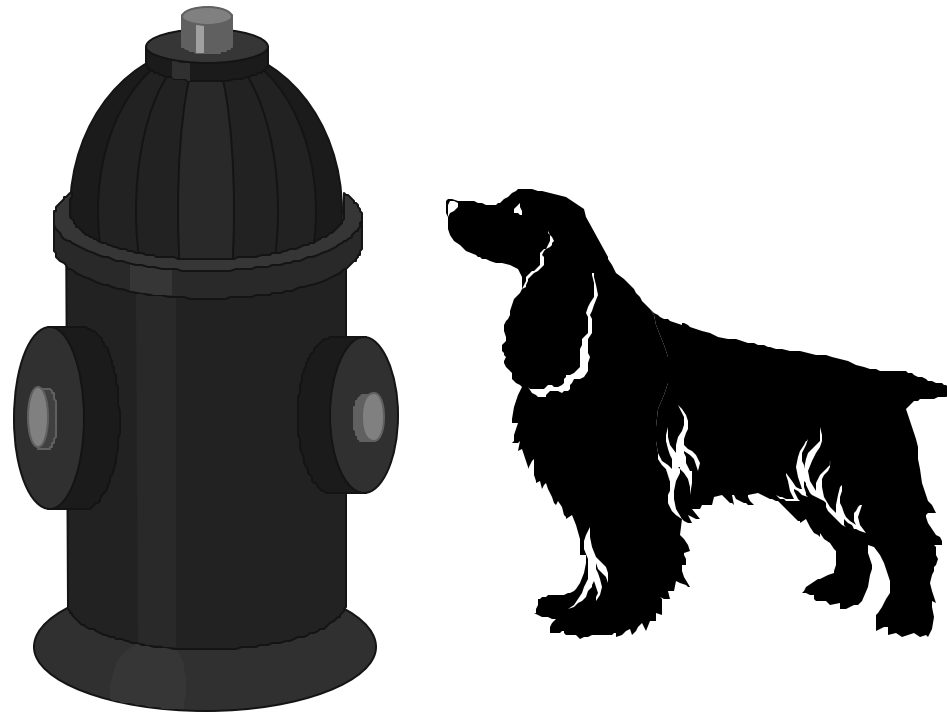
Seat pan parallel to floor



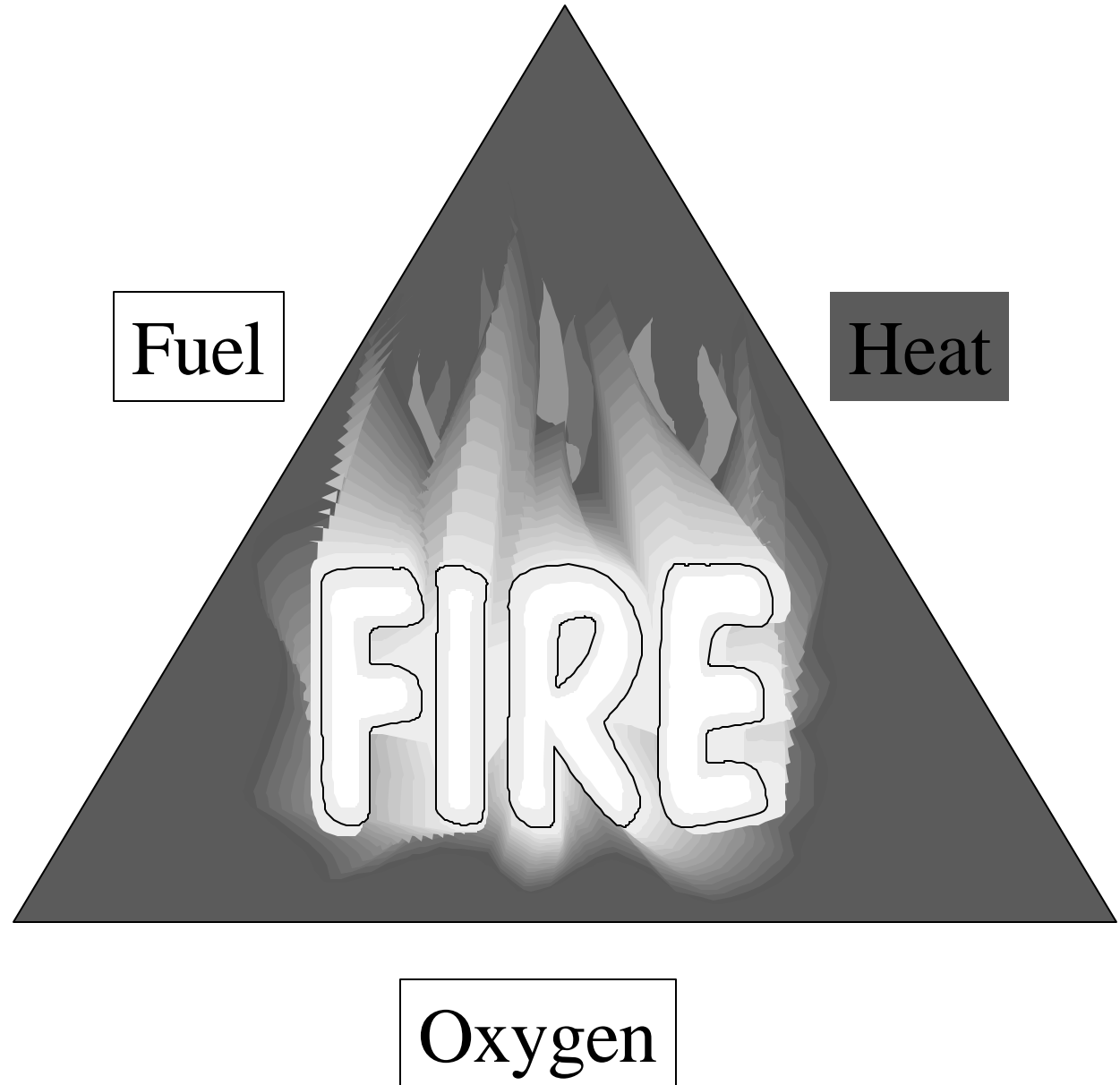
Arm Abduction with a conventional keyboard/mouse tray



Fire Protection



The Fire Triangle:





Class A Fires (combustibles)

- **wood**
- **paper**
- **cloth**





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Class B Fires (liquid fuels)

- **solvents**
- **oil**
- **gasoline**





Class C (electrical equipment)

- **motors**
- **transformers**
- **relay and fuse boxes**
- **appliances**





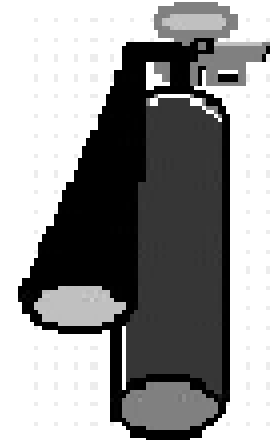
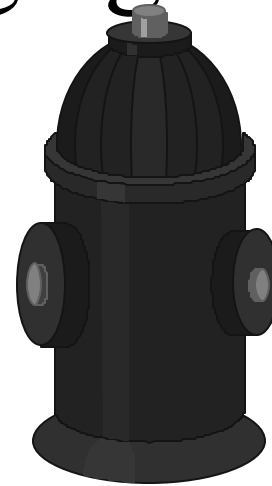
Class D (combustible metals)

- **sodium**
- **potassium**
- **phosphorus**
- **magnesium**



Extinguishing agents

- Water (A)
- Carbon dioxide (B,C)
- (Multipurpose) dry chemical (A,B,C)
- ~~Halogenated compounds (B,C)~~
- Dry chemical for combustible metals (D)
- Foam (varies by formulation)



Fire Facts

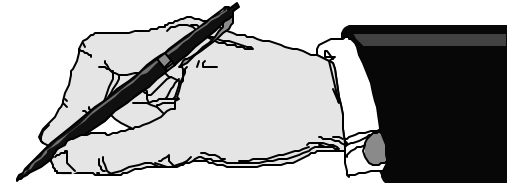


- Fires occur in gaseous phase
- Flammable materials burn at room T
- Combustibles burn if heated
- Fire intensity proportional to fuel surface area
- Smoke and gas kill (>75 % of fatalities)
- Flash point = best indicator of fire potential

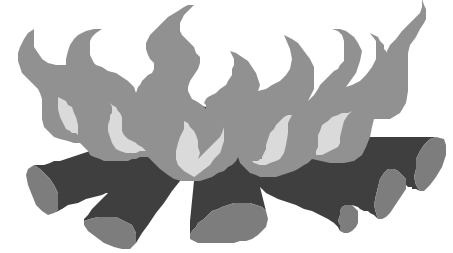


Definition: Flash Point

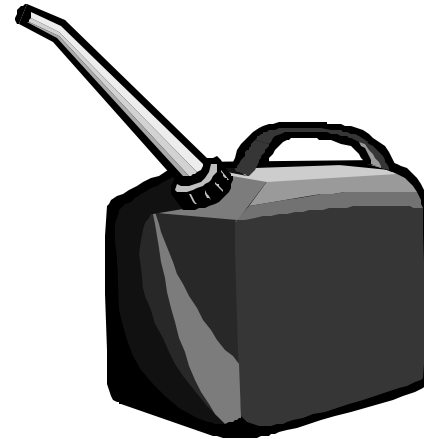
- The flash point is the lowest temperature at which a liquid produces enough vapour to ignite in the presence of a source of ignition.
- The lower the flash point, the greater the risk of fire.



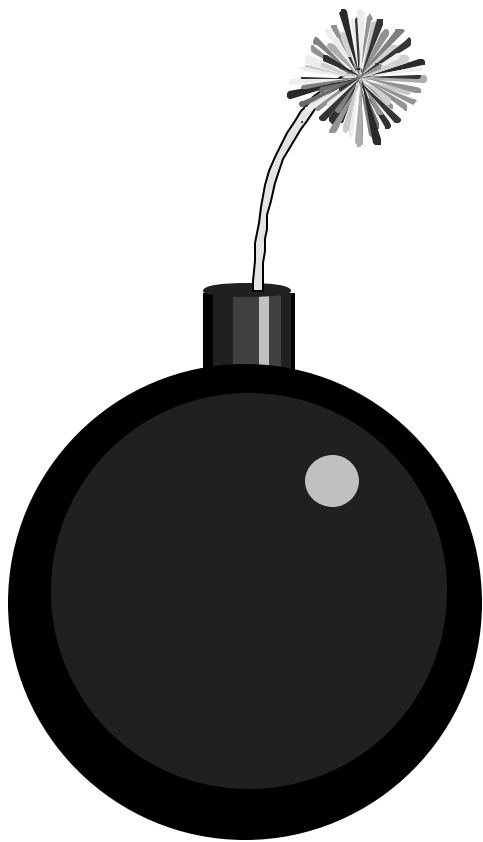
Flash Points °C



acetone	-18
ether (diethyl)	-45
natural gas	- 88
ethyl alcohol	13
methyl alcohol	11
gasoline	-43
varsol	40



Explosives



- Explosive atmospheres
- Explosive compounds



Gases, vapours AND combustible solids (as aerosols) can present explosive atmospheres.

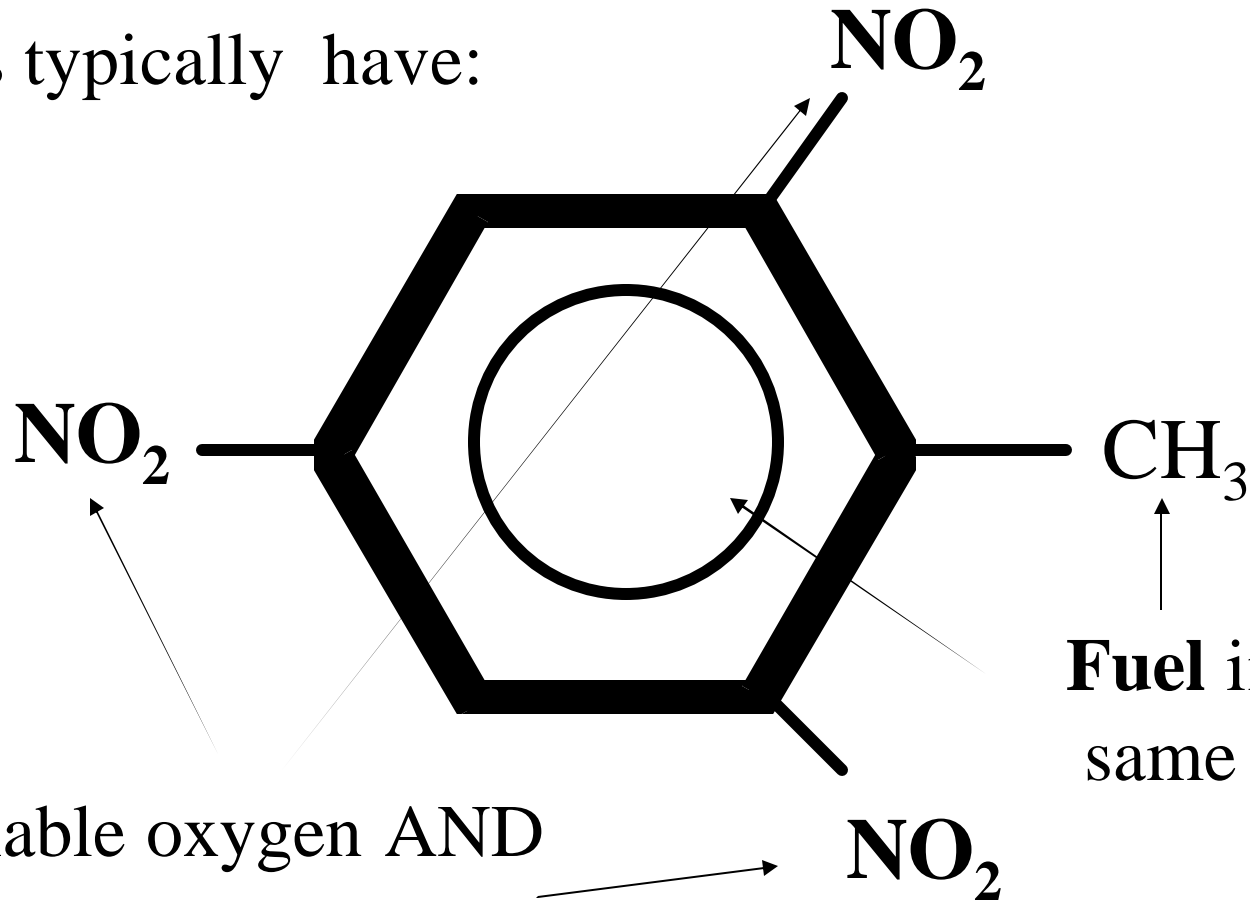


- Carbon
- Fertilizers
- Grain and other foods
- Metal powders
- Resin, wax, soap
- Drugs
- Insecticides
- Wood, paper

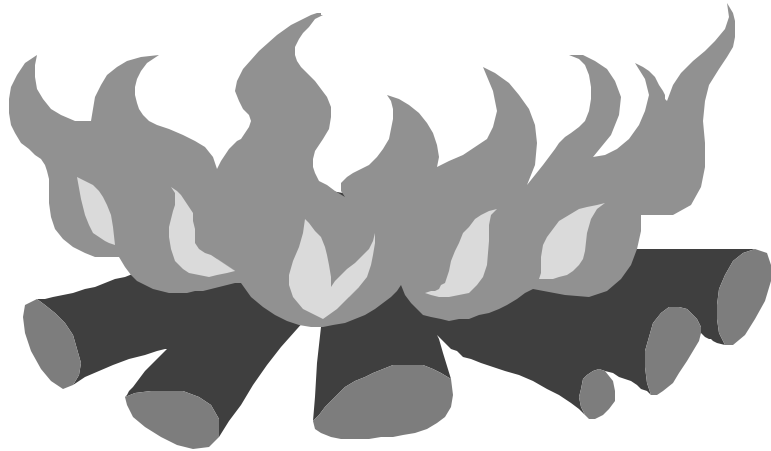


Trinitrotoluene (TNT)

Explosives typically have:



Stages of a Fire

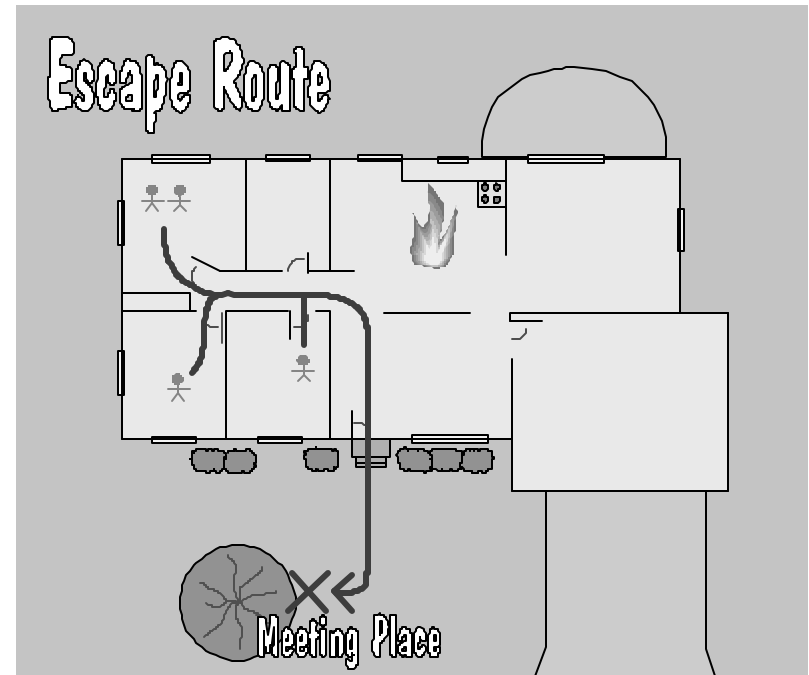


- Incipient - release of combustion particles
- Smoldering - smoke, but no flame and little heat
- Flame - visible flame, less smoke
- Heat stage - fire heats surroundings, spreads rapidly



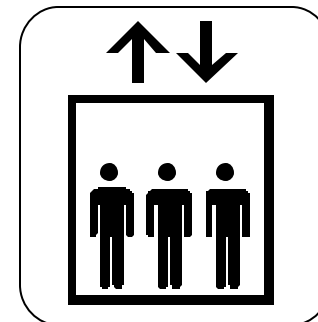
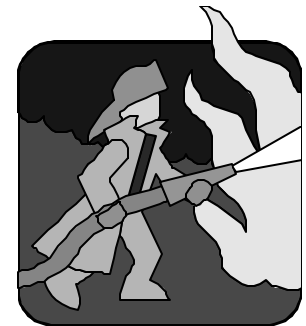
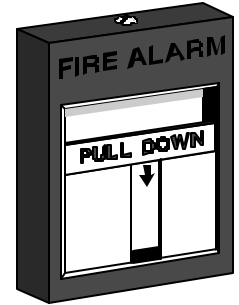
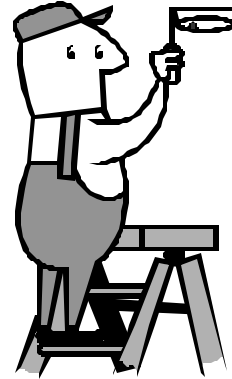
Fire Protection Engineering Considerations

- Usage i.e., residential, industrial, commercial, institutional, etc.
- Size of facilities, age of building, materials of construction
- Location, occupancy
- Activities, fuel content



Engineering Features

- Detection systems
- Fire alarms
- Suppression systems
- Water supply, booster pumps, headers, standpipes, sprinklers
- Building system controls
- Fire separation, ratings, compartmentalization
- Egress (exit) routes, hardware
- Signage
- Certification and Maintenance



Source for Fire Protection Codes:



National Fire Protection Association

