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Qual/quant/WEL/PEL/LOD

.....cutting through the jargon and making sense of IH

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Educational Objectives

This presentation is intended to act as a primer to better understand industrial hygiene, the methods employed, the terms used and the right questions to ask to maximize the value of IH consultants.

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Industrial Hygiene

"the anticipation,
recognition,
evaluation,
control and
prevention
of hazards from work that may result in injury, illness, or affect the well being of workers."

IH Qualifications

- USA
  - Certified Industrial Hygienist (CIH)
- UK
  - Chartered Member of the Faculty (CMFOH)
- Australia, Canada, France, Italy, Netherlands, Norway, Sweden all have national certification schemes

Hazard and Risk

- Hazard: the inherent potential to cause harm or injury
- Risk: the likelihood of harm or injury arising from a hazard

Hazard and Risk

- Hazard is the *potential* to cause harm
- Risk is the *likelihood* of harm occurring

Assessment Tools

- Qualitative primarily addresses *hazard*
- Quantitative primarily addresses *risk*

Qualitative Exposure Assessment (QEA)

- An organized effort to determine if industrial hygiene risks are currently present or potentially present in the workplace

Quantitative Exposure Monitoring

- An exposure assessment that utilizes instrumentation or mathematical modeling to determine numerically the exposure level present to a chemical, physical, or biological hazard.

QEA Elements

- Identify reproductive hazardous, carcinogenic, and endocrine disrupting chemicals
- Rank the hazards
- Update as needed
- Conduct quantitative exposure monitoring when the potential for exposures > 50% of the occupational exposure limit

Quantitative Exposure Monitoring

- based on the QEA
- representative of potential exposures
- Identifies repetitive sampling needs:
  - when required by regulatory agencies
  - when process changes occur
  - annually at a minimum when the chemical airborne exposure levels are > 50% of the occupational exposure limits.

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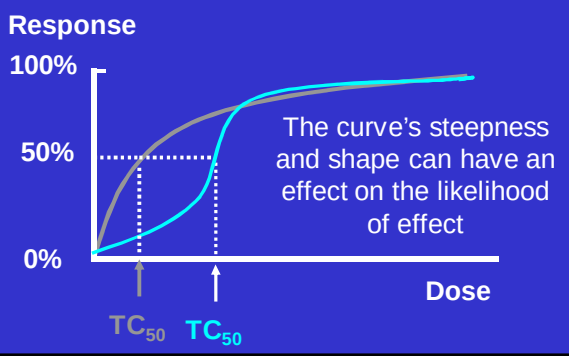
Quantitative Exposure Monitoring Elements

- Who conducted the sampling?
- Who was sampled, for what, why, where, when, what were they doing, for how long, what controls were in place?
- What are the results, what do they mean?
- What is the conclusion and what are the recommendations?

Hazards

- Chemical
  - Solvents, dusts, acids, metals, etc.
- Physical
  - Noise, vibration, lighting, ergonomics
- Biological
  - Animals and by products, mold, endotoxins

Dose-response

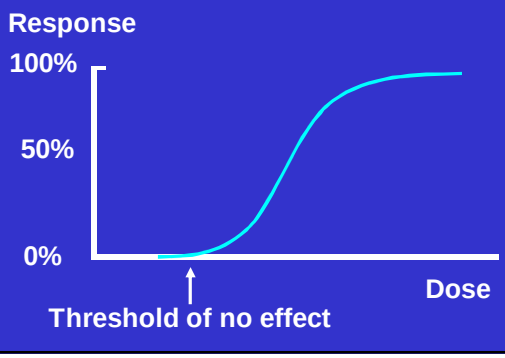


Dose-response

The threshold of no effect is the point below which no effects can be observed.

For some substances, such as carcinogens its presence is debatable.

Dose-response



Routes of Entry

Target Organ vs. Pathway

- Target organ is the system affected
- Pathway is the route of entry

They don't have to be the same!

- Some toxins will affect a particular organ no matter how they enter the body.

Routes of Entry

- Inhalation
- Ingestion
- Skin

Inhalation

Inhalation is a particularly important exposure portal

Inhalation

- At full inspiration your lungs are the size of a tennis court!

Hygiene Standards

- The standards are aimed at inhalation as the primary route of entry, although other routes can contribute to exposure.
- Substances widely known to be absorbed through the skin will have the limit annotated "skin" or "sk"
- Another notation used is "Sen" for sensitizers.

Hygiene Standards

- Short-term limits are created for substances that can cause their effect in a short time, such as irritants, or for substances that can have very serious effects.
- Long term limits assume an 8 hour work shift, so longer periods should have the limit lowered proportionately.

Hygiene Standards

- Limits are usually in parts per million (ppm) or milligrams per cubic meter of air (mg/m^3).
- Not safe/unsafe limits but concentrations aimed at protecting most workers.
- Some people could still be affected.

Occupational Exposure Limits (OELs)

- European Union - Indicative Occupational Exposure Values (IOELVs)
- UK Workplace Exposure Limits (WELs)
- US Occupational Health and Safety Administration (OSHA) - Permissible Exposure Limits (PELs)
- American Conference of Governmental Industrial Hygienists (ACGIH) - Threshold Limit Values (TLVs®)

Other OELs

- American Industrial Hygiene Association (AIHA) – Workplace Environmental Exposure Levels (WEELs)
- Bundesministerium für Arbeit (BMA) Maximale Arbeitsplatzkonzentration (MAKs)
- NIOSH Recommended Exposure Limits (RELs)

Biological Monitoring

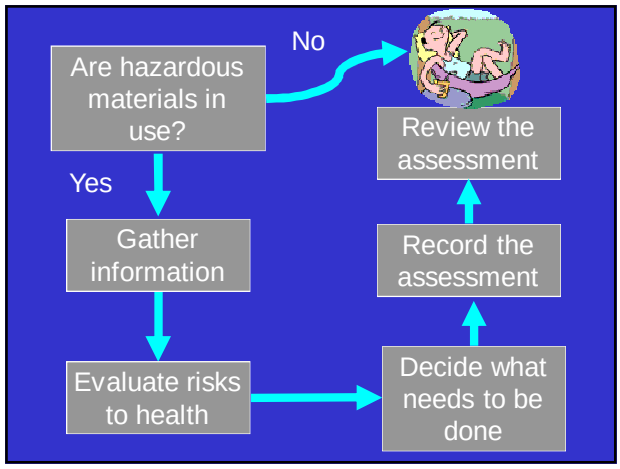
- Personal absorption can be assessed by biological monitoring or biological effect monitoring.
- This can be the substance itself or a metabolite formed in the body measured in a bodily fluid or exhaled breath.

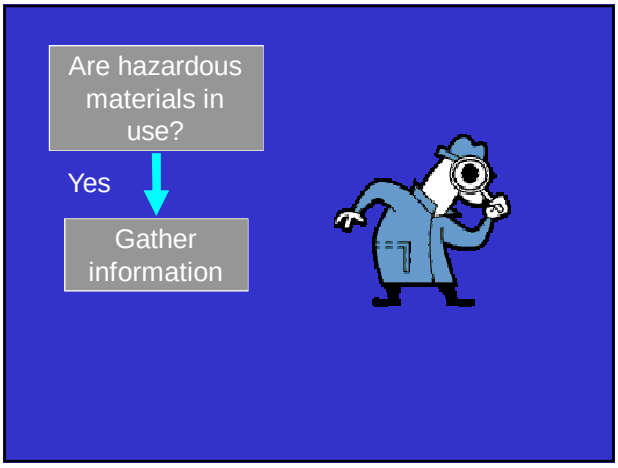
Biological Monitoring

- Biological monitoring can be useful in assessing exposure from all routes of entry.
- Limited in that there are few substances that have guidance available.
- Another limitation is possible interferences, especially in regards to metabolite formation.

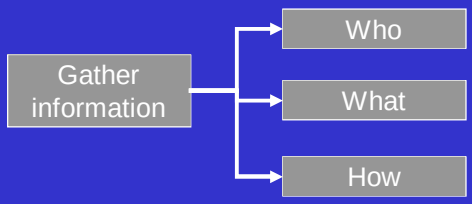
Sample Validity

- Established calibration procedures of equipment are needed
- Use of accredited laboratories
- Sufficient sample size to have limit of detection (LOD) < OEL
- Manufacturer and laboratory statements of accuracy provide useful information.





Gathering Information



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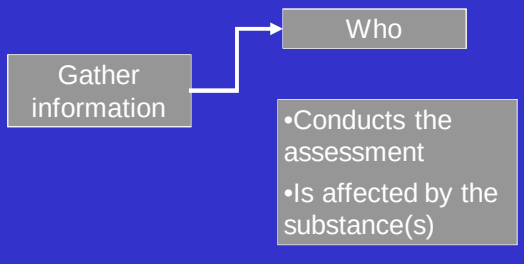

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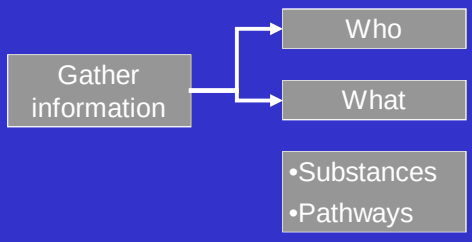

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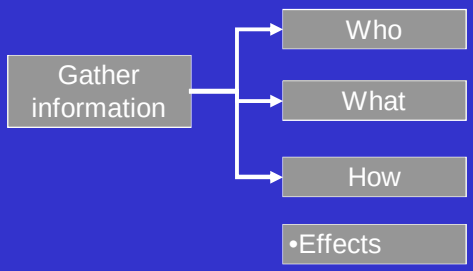
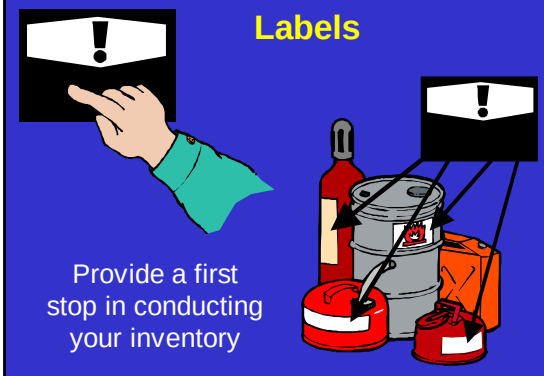


Gathering Information

- A process and substance inventory is the first step, what, how much and where.
- Relevant hazardous substances including intermediate products must be identified.
- Workers and work areas that can be affected are important.

Labels



Provide a first stop in conducting your inventory

Identification

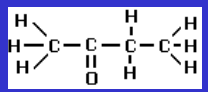
- A single substance can have several names making identification difficult.
- To circumvent this problem there are a couple of identification schemes, EINECS and CAS, that provide a unique identifier and the IUPAC naming scheme.

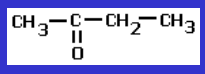
Identification

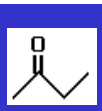
- Here's an example of a chemical that has a half dozen names, yet only a single IUPAC name, CAS # and EINECS #

Identification

MEK, C_4H_8O
= methyl ethyl ketone
= 2 butanone
= methylacetone
= ethyl methyl ketone
butan-2-one (IUPAC)
CAS No: 78-93-3
EINECS No: 201-159-0

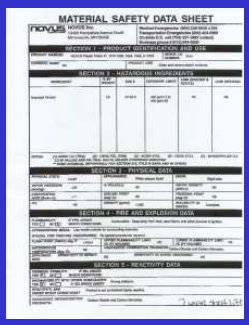






Safety Data Sheets

- Safety Data Sheets (called Material Safety Data Sheets in the US)
- Provide the main source of information for a given substance.


MATERIAL SAFETY DATA SHEET

Safety Data Sheets

- Safety Data Sheets are changing in response to the United Nations Globally Harmonised System of Classification and Labeling of Chemicals (GHS).

Information Needed

The types of job carried out, (task inventory) - in particular the elements of the jobs for which higher exposures might occur, including when and why.

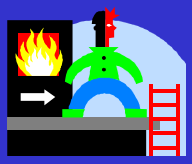
Work / shift pattern can make a difference.

Information Needed

Recommended operating practices and precautionary measures.

Engineering controls.

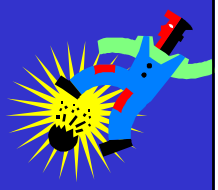
Personal protective equipment.



Information Needed

Past experience, with occupational health complaints, incidents, ill-health, compensation cases.

Foreseeable mishaps or emergencies.



Monitoring Reasons

- Emergencies, high risk situations
- Regulatory Compliance
- Determine effectiveness of controls
- Investigate complaints
- For "research" purposes - basis of setting or modifying standards

Emergency situations

- Usually accurate data cannot be obtained
- Event has passed
- At best only an estimate of event can or need be made

High risk (Known hazard)

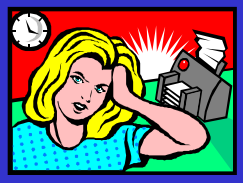
- Examples: Tank entry, rescue work
  - Hazard existence is assumed
- Sample for pre-entry or for the record

Compliance sampling

- Compliance with regulation or exposure guidelines
  - WEL
  - Corporate standard
- Check control efficiency

Complaints

- To assure or re-assure employees regarding magnitude of risk



Research

- For setting or modifying standards

Workplace Sampling Strategies

- A common approach is to do “worst case sampling” on the maximum risk employee to see if an exposure problem exists.
- Statistically representative sampling of Similarly Exposed Groups (SEGs), also called Homogeneous Exposed Groups (HEGs) is then conducted for compliance and to determine the exposure levels.

Sample Methods

Two main sources are from the UK Health and Safety Laboratory (HSL) and the US National Institute for Occupational Safety and Health (NIOSH)

HSL - Methods for the Determination of Hazardous Substances (MDHS)

NIOSH - NIOSH Manual of Analytical Methods (NMAM®)

Sample Types

1. Personal, breathing zone (BZ), from an imaginary box around a persons head, nominally from a sampler on their lapel.

   (non-personal BZ can also used, where a sample probe is held by a researcher in the workers breathing zone).

2. General Air (Area), from the work area, not representative of a particular worker

Personal Sampling

Personal, breathing zone – samplers are directly attached to employee and worn continuously during all work/ rest operations

Area Sampling

- For general or background measurements, to show spread of contaminant; entry to a confined space; for breathing air quality.

Surface and Other Measurements

- Non-airborne sampling by surface wipe tests is sometimes conducted to establish the spread of contamination and the likelihood of ingestion.
- Bulk sampling can be performed to determine identity of substances in the workplace if there is any question.

Whom to Evaluate

- Workers directly exposed
  - Maximum risk employee
  - Homogenous Exposure Group
- B.Z. of nearby workers
- Workers remote from exposure
  - In answer to complaint
  - To set base-line record

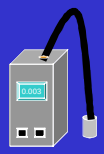
Sample Period Length

There are two general types

- Grab Samples
- Integrated Samples

Grab Sample

A sample taken over so short a time period that atmospheric concentration is assumed to be constant throughout the sample period. Usually by some form of direct reading instrument.



Integrated Sample

A sample taken over a sufficiently long period so that cyclic variations are averaged by the sample procedure. Usually by some form of pumped sampler.

Sampling

Measurements for 8 hour standard:

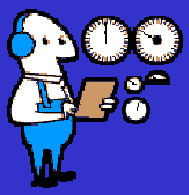
- sampled portion must cover majority of the work-shift
- un-sampled portion usually assumed to be the same as sampled portion unless proven otherwise

Assess the health risk(s)

Gather information

↓

Evaluate risks to health



Assess the health risk(s)

Evaluate risks to health →

- Chance
- Frequency
- Duration
- Concentration

Statistical Analysis

There are
lies,
damn lies,
& statistics!

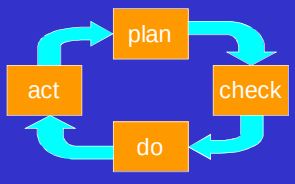
Record the Risk Assessment

Gather information → Evaluate risks to health → Decide what needs to be done → Record the assessment

Review the Risk Assessment

Gather information → Evaluate risks to health → Decide what needs to be done → Record the assessment → Review the assessment

Review the Risk Assessment



The review is part of a continuous improvement process.

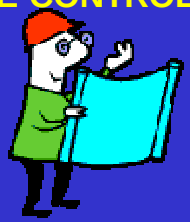
Are hazardous materials in use?

No

Yes

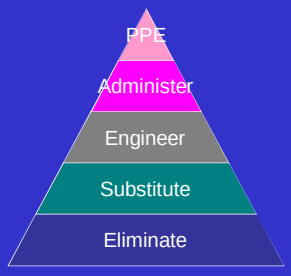
Gather information → Evaluate risks to health → Decide what needs to be done → Record the assessment → Review the assessment

WORKPLACE CONTROL



Gather information → Evaluate risks to health → Decide what needs to be done

Hierarchy of Control



Elimination

- Sometimes a step in a process is not needed and can be eliminated.
- Understanding the process is the only way this can be done
- Most effective in the design stage of a process.

Substitution

- The use of one substance may present less hazards than another.
- Many uses of solvents such as xylene have been replaced by aqueous citrus based solutions, resulting in benefits to both worker health and the environment.

Engineering Controls

- The design and use of appropriate work processes, with an emphasis on the control of exposure at source.
- Usual focus on local exhaust ventilation systems. Other options, usually paired with ventilation include containment.

Administrative Controls

- Reducing periods of exposure.
- Exclusion of non-essential personnel.
- Personal hygiene arrangements.
- Control of access to hazardous areas.

Personal Protective Equipment

- Only intended to be used where adequate control of exposure cannot be achieved by other means.
- Must be compatible with other controls.



Respirator Program Elements

- Used if substitution or engineering changes are not feasible, while they are being installed, or in emergencies.
- A written program is required.
- Medical Surveillance needed to determine suitability with the exception of voluntary filtering face piece respirators (i.e. dust mask).

Respirator Program Elements

- No respirator to be issued to any employee with conditions which prevents a good face seal. (Beards, facial scars, and temple bars of glasses that may interfere, etc)

Respiratory Protective Equipment Types

- Air Purifying
  - Clean the air the worker is in
- Supplied Air (Atmosphere Supplying)
  - Provide air from elsewhere

Breathing Air Quality

The air being supplied must be quality tested to ensure that it is safe to breath

- Carbon dioxide < 500 ppm
- Carbon monoxide < 5 ppm
- Oil mist < 0.5 mg/m^3

The air must be free from odour and particles and toxic or irritating ingredients. It should also be at a comfortable temperature.

Respirator Fit Testing

There are two types of fit testing:

- Qualitative fit testing (QLFT)
- Quantitative fit testing (QNFT)

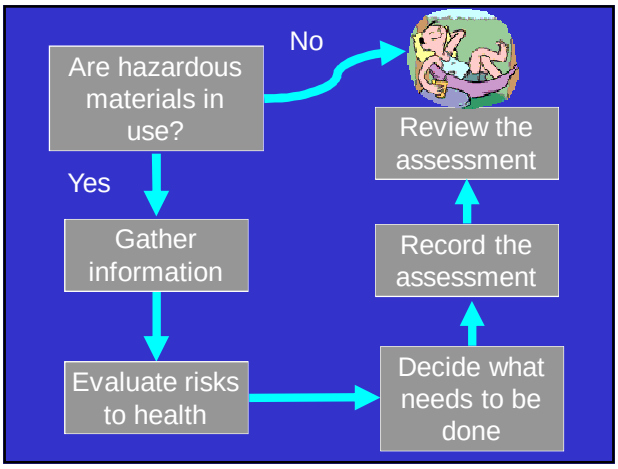
Both types require subjects to perform a series of motions and speak while wearing the respirator.

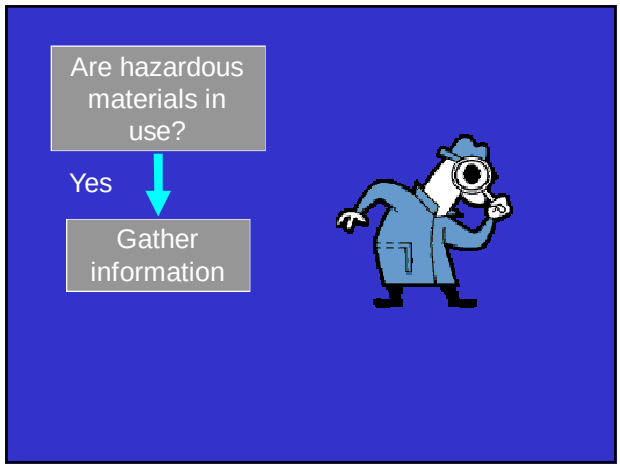
With either method the user must perform **fit checking** each time the respirator is donned to ensure a proper fit.

Respirator Fit Testing

Quantitative fit testing compares the measured concentration of a test agent inside the face mask with that outside to calculate a fit factor.

Qualitative fit testing uses a user response (smell, taste or irritation) to detect the test agent and a fit factor is assigned.


Are hazardous materials in use?
No
Yes
Gather information
Evaluate risks to health
Decide what needs to be done
Record the assessment
Review the assessment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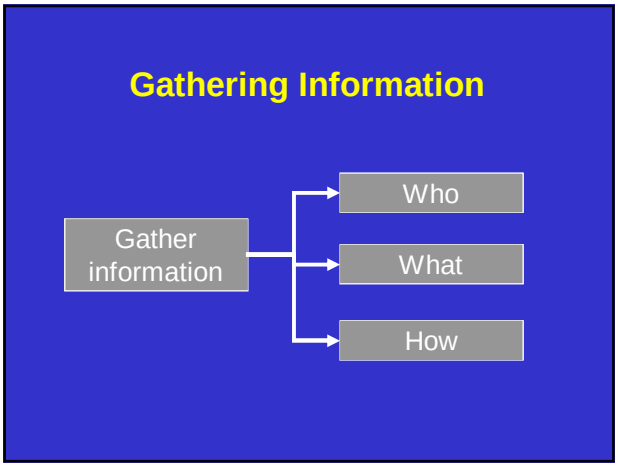
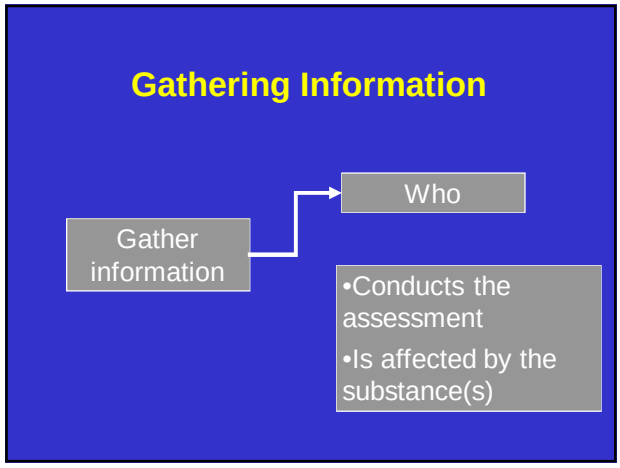
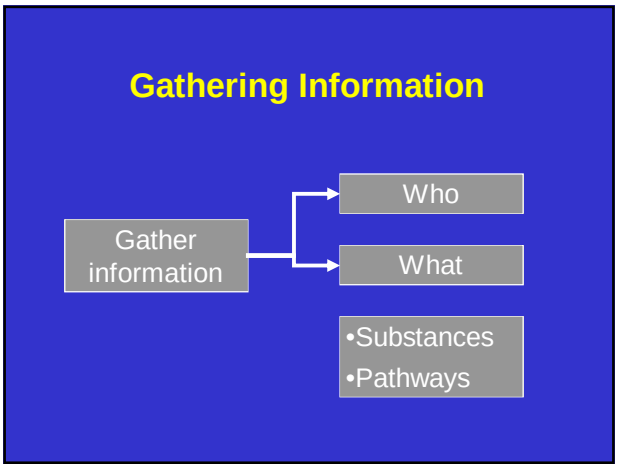
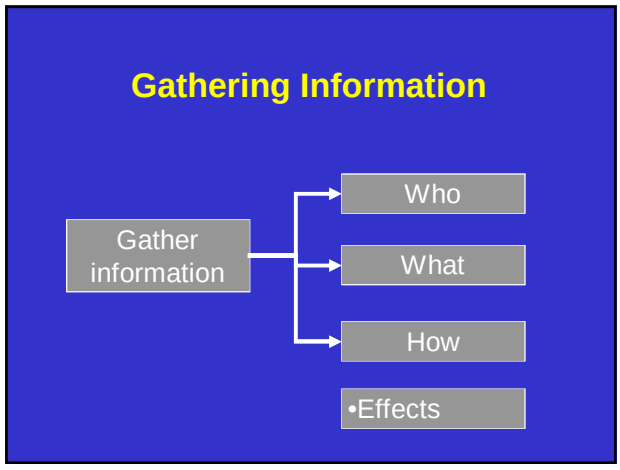
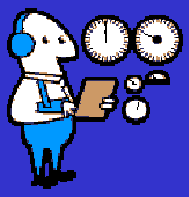

Gathering Information
Gather information
Who
What
How


Gathering Information
Gather information
Who
•Conducts the assessment
•Is affected by the substance(s)


Gathering Information
Gather information
Who
What
•Substances
•Pathways


Gathering Information
Gather information
Who
What
How
•Effects

Assess the health risk(s)



Gather information

Evaluate risks to health

Assess the health risk(s)

Gather information

Evaluate risks to health

- Chance
- Frequency
- Duration
- Concentration

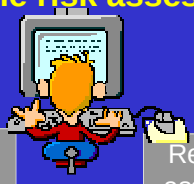
Decide what need to be done

Gather information

Evaluate risks to health

Decide what needs to be done

Record the risk assessment



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