TTMI Induction Training

Chemical Safety

Dr Katharine Murray
Head of Safety
November, 2019
Overview

- Main Chemical Legislation
- Chemical hazard classification / symbols
- Chemical risk assessment
- Physico-chemical hazards / properties
- Toxicology
- Safety Data Sheets / OEL’s
- Occupational Hygiene
- Health Surveillance
- Safe handling and storage
- Spills / Contamination
Important Chemical Legislation

- Safety, Health and Welfare at Work Act 2005
- Chemicals Act 2008 / amendment 2010
- Carriage of Dangerous Goods by Road Act 1998
- Waste Management Acts 1996 to 2003
- SHWW (Chemical Agents) Regs 2001/2015
  Code of Practice 2018
- SHWW (Carcinogens) Regs 2001/2015
- SHWW (General Application) Regs 2007
  - Parts 6. Pregnant Employees & 2. PPE & 8. Explosive atmospheres
Chemical Agents Regulations 2001/2015

• Risk assessment (RA): Determine if hazardous chemicals present and assess risks associated with them
• Eliminate risks or reduce them to minimum
• Put prevention and control measures in place following the risk assessment
• Make arrangements to deal with accidents, incidents and emergencies
• Provide information and training
• Make arrangements for consulting with their employees
• Provide appropriate health surveillance
• Provision for lead and its compounds
• Keep exposure records

UK equivalent - COSHH Regulations
Safety Health and Welfare at Work (Carcinogens) Regulations 2001/2015

- General Duties of Employer
  - General measures as per schedule
- General Principles of Prevention
  - Risk Assessments
  - Routes of Exposure
  - Exposures ALATP
  - Special Risk Groups
  - Enclosed Systems
  - Limit access to area
  - Labelling of Containers
Safety Health and Welfare at Work (Carcinogens) Regulations 2001/2015

- Information to HSA, if requested
- Unforeseen exposure
- Foreseeable exposure
- General measures
- PPE
- Information, Training and Consultation
- Health Surveillance
- Exposure records
- Occupational Exposure Limits
SHWW (GA) Regs 2007
Part 6: Sensitive Risk Groups - new and expectant mothers

- Employee must inform employer / manager of pregnancy

- Risk Assessments must be completed -
  - Working Environment
  - Physical Agents – Movement and postures, Visual Display Units, Shift Work, Manual Handling, Shock / Vibration or Movement, Ionising and Non-Ionising Radiation, Noise
  - Biological Hazards
  - Chemical Agents

- Review risk assessments at relevant intervals
Definition

Hazardous Chemical

Any substance, in gas, liquid or solid form, which has the potential to cause harm in the way it is used or is present in the workplace, is referred to as a hazardous substance.

This includes any chemical agent assigned an Occupational Exposure Limit value in the relevant Code of Practice under the Regulations.
Hazardous properties

- **Physical Hazards**
  solid, liquid, gas
  - include flammable, explosive and oxidising

- **Health Hazards**
  - include toxic, carcinogenic, mutagenic, harmful, irritant, corrosive and sensitising

- **Environmental Hazards**
  - persistent, bio-accumulative and toxic (soil, wildlife)
The label is the first and often the only information on the hazards of a chemical that reaches the user.
### Hazard Classes / Categories

#### Physical Hazards
- (solid, liquid, gas)
- eg. Flammable, Explosive and Oxidising

#### Health Hazards
- eg. Toxic, Carcinogenic, Mutagenic, Harmful, Irritant, Corrosive and Sensitising

#### Environmental Hazards
- Persistent, bio-accumulative and toxic
  - (soil, wildlife)

<table>
<thead>
<tr>
<th>Class/Category</th>
<th>Signal Word</th>
<th>Pictogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explosives 1.1-1.3</td>
<td>Danger</td>
<td><img src="image" alt="Danger" /></td>
</tr>
<tr>
<td>Explosives 1.4</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
<tr>
<td>Flammable Liquids 1,2</td>
<td>Danger</td>
<td><img src="image" alt="Danger" /></td>
</tr>
<tr>
<td>Flammable liquids 3</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
<tr>
<td>Oxidising Liquids 1,2</td>
<td>Danger</td>
<td><img src="image" alt="Danger" /></td>
</tr>
<tr>
<td>Oxidising Liquids 3</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
<tr>
<td>Gases under pressure, compressed gases</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
<tr>
<td>Skin Corrosion 1A,1B,1C</td>
<td>Danger</td>
<td><img src="image" alt="Danger" /></td>
</tr>
<tr>
<td>Corrosive to metals 1</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
<tr>
<td>Acute Toxicity 1,2,3</td>
<td>Danger</td>
<td><img src="image" alt="Danger" /></td>
</tr>
<tr>
<td>Acute Toxicity 4</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
<tr>
<td>Skin Irritation 2</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
<tr>
<td>Aspiration hazard</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
<tr>
<td>Respiratory sensitization,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germ cell mutagenicity, Carcinogenicity,</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reproductive toxicity, Specific target</td>
<td></td>
<td></td>
</tr>
<tr>
<td>organ toxicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hazardous to the aquatic environment 1</td>
<td>Warning</td>
<td><img src="image" alt="Warning" /></td>
</tr>
</tbody>
</table>
Physical Hazards - Flammable

- A flammable chemical is one that will ignite spontaneously, on exposure to a high temperature or most commonly on exposure to a spark or open flame.

- The flammability of a liquid is defined by its *flash-point*
  - The lowest temperature at which a fuel-air mixture present above the surface of a liquid will ignite if an ignition source is introduced.

  21-55 °C ~ Flammable

  < 21 °C ~ Highly flammable (Alcohol 13 °C)

  < 0 °C ~ Extremely flammable (Petrol < −40 °C)
Physical Hazards - Explosive

- An explosive substance or mixture is a solid or liquid substance or mixture which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings
Physical Hazards - Oxidisers

• An oxidising chemical is one that evolves oxygen spontaneously either at room temperature or on heating slightly

• In practical terms, oxidisers are chemicals that permit other chemicals to burn

• Examples are peroxides and permanganates
Physical Hazards – Gases under pressure

- Compressed gases
  - Liquefied gases
  - (ammonia, chlorine, methane, propane)
  - Refrigerated liquefied gases
    (cryogenic gases, liquid nitrogen)
  - Dissolved gases
    (acetylene)
## Health Hazards: exposure to Chemicals

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute toxicity</td>
<td>A chemical that causes an adverse health effect following a single exposure (e.g. skin contact with insecticides, accidental ingestion of a chemical)</td>
<td><img src="https://via.placeholder.com/15" alt="Safety Data Sheet" /> <img src="https://via.placeholder.com/15" alt="Exclamation" /></td>
</tr>
<tr>
<td>Chronic toxicity</td>
<td>A chemical that causes an adverse health effect following repeated exposure which can occur following a relatively short exposure (weeks) or longer term exposure (years)</td>
<td><img src="https://via.placeholder.com/15" alt="Safety Data Sheet" /> <img src="https://via.placeholder.com/15" alt="Exclamation" /></td>
</tr>
<tr>
<td>Irritant</td>
<td>A chemical that causes reversible damage to skin, eyes or airways (e.g. detergents or soaps)</td>
<td><img src="https://via.placeholder.com/15" alt="Exclamation" /></td>
</tr>
<tr>
<td>Skin sensitiser</td>
<td>A chemical that can cause an allergic reaction of the skin following skin contact (e.g. wood dust or adhesives)</td>
<td><img src="https://via.placeholder.com/15" alt="Exclamation" /></td>
</tr>
</tbody>
</table>
### Health Hazards: exposure to Chemicals

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory sensitisr</td>
<td>A chemical that can cause an allergic reaction in the airways following inhalation of the chemical (e.g. isocyanate)</td>
<td><img src="image" alt="Label" /></td>
</tr>
<tr>
<td>Corrosive</td>
<td>A chemical that causes irreversible damage to skin, eyes or airways (e.g. strong acids and strong bases such as concentrated hydrochloric acid or concentrated hydroxides)</td>
<td><img src="image" alt="Label" /></td>
</tr>
<tr>
<td>Carcinogen</td>
<td>A chemical that causes or can potentially cause cancer (e.g. breathing in asbestos fibres, skin contact with used motor oils)</td>
<td><img src="image" alt="Label" /></td>
</tr>
<tr>
<td>Mutagen</td>
<td>A chemical that can cause permanent damage to genetic material in cells, which can possibly lead to heritable genetic damage or cancer (e.g. UV rays from the sun, benzene).</td>
<td><img src="image" alt="Label" /></td>
</tr>
</tbody>
</table>
# Health Hazards: exposure to Chemicals

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teratogen</td>
<td>A chemical that causes birth defects (e.g. thalidomide / relief from morning sickness in the 50’s)</td>
<td>![Label]</td>
</tr>
<tr>
<td>Reproductive toxin</td>
<td>A chemical that can affect adult male or female reproductive systems, their ability to reproduce and/or that can lead to birth defects (e.g. lead, carbon monoxide, organic solvents)</td>
<td>![Label]</td>
</tr>
</tbody>
</table>

![Periods of Fetal Development](image)
Chemical Information

- Hazard labels

- Safety Data Sheets
Sodium dichromate dihydrate
GR for analysis

Index-No: 024-004-01-4
Fa. Muster KG, Musterdorf, Germany, www.mcwustermann.de
Tel. +49(0)1234 56-7890

Hazard Pictograms
Nominal quantity
Signal Word
Hazard & Precautionary Statements
Product identifier
Supplier information
Space for Supplemental information

199999925
K12345678 808
125 g
min. shelf life: 31.12.08

Danger. May cause cancer. May cause genetic defects. May damage fertility or the unborn child. Fatal if inhaled. Toxic if swallowed. Causes severe skin burns and eye damage. May cause allergy or asthma symptoms or breathing difficulties if inhaled. Causes damage to organs through prolonged or repeated exposure. Obtain special instructions before use. IF exposed: Immediately call a POISON CENTER or doctor/physician. IF INHALED: If breathing is difficult, remove victim to fresh air and keep at rest in a position comfortable for breathing. Wear protective gloves/protective clothing/eye protection/face protection.
## H (hazard) Statements

<table>
<thead>
<tr>
<th>Hazard</th>
<th>Code</th>
<th>Example</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>H200-299</td>
<td>H241</td>
<td>Heating may cause fire or explosion</td>
</tr>
<tr>
<td>Health</td>
<td>H300-399</td>
<td>H311</td>
<td>Toxic in contact with skin</td>
</tr>
<tr>
<td>Environment</td>
<td>H400-499</td>
<td>H412</td>
<td>Harmful to aquatic life with long lasting effects</td>
</tr>
<tr>
<td>Code</td>
<td>Purpose</td>
<td>Example</td>
<td>Text</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>---------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>100</td>
<td>General</td>
<td>P102</td>
<td>Keep out of reach of children</td>
</tr>
<tr>
<td>200</td>
<td>Prevention</td>
<td>P201</td>
<td>Obtain special instructions before use</td>
</tr>
<tr>
<td>300</td>
<td>Response</td>
<td>P310</td>
<td>Call a poison centre</td>
</tr>
<tr>
<td>400</td>
<td>Storage</td>
<td>P410</td>
<td>Store in a well ventilated place</td>
</tr>
<tr>
<td>500</td>
<td>Disposal</td>
<td>P501</td>
<td>Dispose of container...</td>
</tr>
</tbody>
</table>
Labelling and Pregnant Employees (old CPL)

Reassess risk with:

- R40: Limited evidence of carcinogenic effect
- R45: May cause cancer
- R46: May cause heritable genetic damage
- R49: May cause cancer by inhalation
- R61: May cause harm to the unborn child
- R63: Possible risk of harm to the unborn child
- R64: May cause harm to breastfed babies
- R68: Possible risk of irreversible effects

SHWW General Application Regulations 2007
Part 6 Schedule 8-protection of pregnant employees
Labelling and Pregnant Employees (CLP)

Reassess risk with:

- H351: Suspected of causing cancer
- H350: May cause cancer
- H340: May cause genetic defects
- H350i: May cause cancer by inhalation
- H360FD*: May damage fertility or the unborn child
- H361fd: Suspected of damaging fertility of the unborn child
- H362: May cause harm to breastfed children
- H341: Suspected of causing genetic defects

*Fertility and Development

CLP Regs EC No. 1272/2008
Chemical Information
Safety Data Sheets

A means of communicating information relating to the hazardous properties of substances or mixtures being used

- SDS - 16 obligatory headings
- Must conform to EU requirements when supplied in Ireland
- Any employee can request to read an SDS on any substance
Safety Data Sheets

• As part of the Safety Statement the employer must request from its supplier any Safety Data Sheets (SDS) applicable to any chemical substances in use

• There is a legal requirement on the manufacturer to supply this information and its contents are controlled by EU directive (REACH Regs*)

*Registration, evaluation and authorisation of chemicals
Safety Data Sheets

• A system that merely requires customers to download a SDS from a company's website or from a catalogue of SDS’s is not considered appropriate

• A SDS should be provided either before or at the time of first delivery of the substance or mixture

• Safety Data Sheets are not Risk Assessments
Safety Data Sheets

The information to be provided in the SDS must be set out under 16 obligatory headings as laid out under Article (31) (6) and contain the information as prescribed in Annex II of the REACH Regulation. The 16 obligatory headings are given below:

1. Identification of the substance/preparation and of the company/undertaking;
2. Hazards identification;
3. Composition/information on ingredients;
4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information
Toxicological (Human Health) Hazard Risk Assessment

**Toxicology**: Study of harmful effects of chemicals on living systems

Key elements:

- the toxic chemical
- the target biological system
- type of toxic effect produced
- factors influencing toxicity

The toxicity of a given chemical is determined by its physico-chemical characteristics and is reflected in the dose
Chemical Agent and Dose

DOSE RESPONSE!
Chemical properties influencing toxicity

• Physical state - solid, liquid, gas
• Particle size - fine dust etc.
• Ph - acidic or basic
• Solubility - in fat or water
• Chemical structure
Risk Assessment

- Identification of hazards
- Put prevention and control measures in place following the risk assessment
- Chemical Risk Assessment recorded
Prevention and Control measures

• Elimination or Substitution
• Engineering controls
• Safe systems of work
• PPE
Specific Protection Measures

- Eliminate or Reduce risk by
  - Avoidance
  - Substitution
  - Minimise Release
  - Extract at Source
  - PPE

- Maintain equipment / engineering control measures

- Measure exposure and ensure Occupational Exposure Limits not exceeded

- If exceeded take appropriate action

- Health Surveillance and Records of Exposure
Occupational Exposure Limit

• The maximum permissible concentration of a chemical agent in the air at the workplace to which workers may be exposed in relation to an 8 hour or a 15 minute reference period
Terms Used

- OELV 8hr and 15 min. (Ire) (Occupational Exposure Limit Value)
- TLV (threshold limit value) (USA)
- TWA (time weighted average) (USA)
- STEL (short term exposure limit) (USA)
- OES (occupational exposure standard) (UK)
- MEL (maximum exposure limit) (UK)
- MAK (maximum allowable concentration) (Ger)
Occupational Hygiene
- Definition -

• Identification, evaluation and control of potential hazards in the workplace
Occupational Hygiene
- Chemical -

• Dust
  nuisance dusts, toxic dusts (lead), fibrogenic dusts (asbestos)

• Fumes
  – small particle
    airborne dust
    (Welding)

• Mists
  - airborne droplets

• Gases / vapours
Routes of entry

- Inhalation - main route, OEL’s set
- Ingestion
- Absorption

Exposed skin in the lab can lead to burns
Personal sampling

• Monitoring in the breathing zone
Health Surveillance

- To protect health and prevent occupationaly related disease
- Early identification of health effects
- List of exposed employees
- Self inspection (eg. skin problems)
- Biological monitoring (eg. blood tests)
- Medical examinations
Safe chemical handling

The following are general precautions that should be noted with regard to the use and handling of chemicals:

- Read the labels before opening the container. Refer to the SDS if necessary
- Take note of any hazard warnings and symbols, and find out what they mean
- Check that the chemical is the one required
- Check that you are wearing any prescribed protective clothing, i.e. gloves, glasses etc
- Open container carefully in a well-ventilated area
- Take care while extracting hazardous chemicals and use methods, which reduce the risk of inhalation, ingestion and contact with the skin, eyes and clothing
- Never try and identify a chemical by inhaling its vapour or fumes
- Consider the hazards of violent reaction between chemicals
- Avoid using contaminated apparatus and instruments
- Seal container after use
- Ensure split portions are labelled as per the original
- Do not eat, drink or smoke while using or handling chemicals
- Remove gloves before removing goggles or visors
- Wash hands and exposed areas regularly and change contaminated clothing
- Deal with spillage’s promptly using the appropriate methods according to the SDS
- Do not dispose of chemicals down a drain or sink
- If affected by a chemical use plenty of cold running water or the safety shower, and inform your supervisor immediately - ask someone else to do so, on your behalf if necessary
Storage of Chemicals

- Location
- Space requirements
- Temperature
- Ventilation
- Containers
- Quantities
Storage of Chemicals

- Age and condition
- Labelling
- Security
- Flammable chemicals
- Segregation of incompatible chemicals
The primary objectives of spill control are:

a) Containment
b) Neutralisation
c) Collection and Disposal

These operations should be carried out using the appropriate safety equipment.

All liquid spills can be contained using Chemical absorbent or Chemical absorbent mats
Contamination by Chemicals

- Contact First Aider ASAP

- Refer to SDS and container immediately for any special instructions.

- Safety showers

- Eye wash bottles
Chemical Safety Summary

• Identify the Hazard
• Assess the Risk....then, either
• Eliminate it
• Find a substitute
• Manage / contain it
• Protect yourself and others....or
• RUN!!!!!!!
Our Perception of Hazard?

• Found in all tumours
• Exposure times of more than 3 minutes usually result in death
• Estimated to be a major factor in ~15% of all electrocutions
• Major component of acid rain
• Reduces the effectiveness of automobile brakes by up to 80%
• Major cause of soil erosion
Further Information

- **Safety Office:** [www.tcd.ie/estatesandfacilities/health-and-safety/Lab-Safety/chemical-safety/](http://www.tcd.ie/estatesandfacilities/health-and-safety/Lab-Safety/chemical-safety/) or [safetyoffice@tcd.ie](mailto:safetyoffice@tcd.ie)

- **HSA Website:**
  [www.hsa.ie/eng/Sectors/Chemicals/](http://www.hsa.ie/eng/Sectors/Chemicals/)

- **European Chemicals Agency (ECHA) website:**
  [www.echa.eu](http://www.echa.eu)

- **EU-OSHA website:**
  - [https://healthy-workplaces.eu/en](https://healthy-workplaces.eu/en)

- **Hazardous Materials Facility, 4th Floor, East End 4/5.**
  01-8963565

- **College Safety Training:**
TTMI Induction Training
Chemical Safety

Thank You
ANY QUESTIONS?

Dr Katharine Murray
Head of Safety
November, 2019