Insight Session

Occupational Health & Safety Issues in Process Plants

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• **ACKNOWLEDGEMENTS**
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• **Occupational Health & Safety is #1 priority**

• Process plants are hazardous areas and can present risks to the operators

• Human exposure to chemicals, electrical, fire, dust, gases, noise, machines, trips & falls, vehicles, radiation

• Legal responsibility & requirements

• Safe design principles

• Harmonisation - national consistency - (NOHSC)

• Risk analysis - eliminating hazards

• Impacts for designers
• Australia- QLD, NSW, ACT, NT and Commonwealth commenced harmonised WHS laws 1 January 2012
• Tasmania passed its WHS Bill which commenced on 1 January 2013
• South Australia introduced their Bill into Parliament and is waiting for their Bill to be debated
• Western Australia (WA) is waiting until the model mining health and safety laws are finalised so that both sets of laws can be implemented at the same time
• Victoria has completed their state-specific regulatory impact statement and will not implement at this time
Section 295 of the Work Health & Safety (WHS) Regulations specifies additional duties on designers of a structure to provide a written report to the Person Conducting Business or Undertaking (PCBU) commissioning the design where:

- the designer is aware of hazards that could create a risk to health and safety to persons constructing the structure; and

- these hazards are associated only with that particular design and not with other designs of the same type of structure.
Reasonable steps to

- acquire knowledge of WHS matters
- understand nature of the operation and associated WHS hazards & risks
- ensure resources and processes to eliminate or minimise WHS risks
- ensure processes for receiving, considering and responding to WHS information in a timely way
- ensure processes and implementation for complying with WHS duties
- verify compliance
### Duties of Care Occupational Health & Safety Issues

<table>
<thead>
<tr>
<th>NATURE OF ACTIVITY</th>
<th>DUTIES ASSOCIATED WITH THE ACTIVITY</th>
<th>RELEVANT STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation of business</td>
<td><strong>Primary duty of care</strong>&lt;br&gt;Persons conducting a business or specific classes of duty holders</td>
<td>Reasonably practicable</td>
</tr>
<tr>
<td>Organisational decision making and governance</td>
<td><strong>Officers’ duty of care</strong></td>
<td>Due diligence</td>
</tr>
<tr>
<td>Work activities (including supervision)</td>
<td><strong>Workers’ duty of care</strong></td>
<td>Reasonable care</td>
</tr>
<tr>
<td>Others e.g. visitors</td>
<td><strong>Duty of care of others</strong></td>
<td>Reasonable care</td>
</tr>
</tbody>
</table>
Offences Under the WHS Act

- **Category 1**: recklessly exposes a person to risk of death or serious injury or illness - $3M corporations; $600,000 individuals; 5 years imprisonment
- **Category 2**: serious risk of harm without recklessness - $1.5 million corporations; $300,000 individuals
- **Category 3**: fails to comply with WHS duty - $0.5 million corporations; $100,000 individuals
- Appeals to High Court of Australia
- Independent right of review when regulator does not prosecute for Category 1 or 2 offences – by the Director of Public Prosecutions
Safety Signage In Process Plants

**Mandatory (must use)**

In order to minimise the likelihood of loss or injury being sustained

**Caution (be careful)**

Exercise care to avoid hazard

**Prohibited (do not)**

These actions are forbidden
Typical Safety Equipment (PPE)

- Head protection
- Short or tied back hair
- Ear protection
- Face protection when required
- Eye protection
- Reinforced footwear
- Gloves when required
- No rings or watch and close-fitting cuffs
- Pipes labelled
- Valves open or closed
Preparing for Emergencies

- A copy of the Emergency Procedures Chart and Site Plan indicating locations of Fire Extinguishers, Eyewashes and Emergency Showers, Muster Points and First Aid Facilities are displayed in all buildings.

- Inductions - Duty of care

- Job Safety Analysis (JSA)
**Hearing Damage & Fire Risk**

Maximum acceptable exposure per 8 hours:

5. Less than 5 min
4. Less than 20 min
3. 1 - 2 h
2. 2 - 5 h
1. 5 - 8 h

* Minimise where possible then hearing protection mandatory

*= middle frequency of octave Band (Hz) (Impact crusher on 1 m distance).
• Recommendations for Limiting Exposure to Ionising Radiation (1995) and the National Standard for Limiting Occupational Exposure to Ionising Radiation (republished 2002). RPS 1


• Code of Practice for the Safe Transport of Radioactive Material (2002). RPS 2 and RPS 2.1
Agitator - cyanide accumulation may be a problem during cleaning and maintenance

Leach Tanks

During sampling in CIP

Possible Exposure to HCN Gas Gold Plants
The potential health hazard to an individual by a material used in any chemical or biochemical process is a function of the inherent toxicity of the material and the frequency and duration of the exposure.

The main objective of health hazard control is to limit the chemical dosage of a chemical by minimizing or preventing exposure.

It is not practical to measure or control the chemical dosage directly; rather, exposure is measured and limits are set for its control.

Dangerous Goods Safety Act 2004

Sources of Exposure
  e.g. Inhalation
    – Thus an understanding of the sources of contaminants to which workers are exposed is important for the recognition, evaluation and control of occupational health hazards
    – E.g. mechanical abrasions of solid material by cutting, grinding or drilling can produce small particles that can form an airborne dust cloud or solid aerosol.
In any professional activity, engineers are obligated to pursue their profession with the highest level of ethical behaviour
- Early gold plants buried cables
- Site installation - no drawings
- No blocked chute alarms
- Safety was not foremost - HCN gas, guarding rails, job safety analysis

The personal conduct of engineers has obligations to the individual engineer, employer and/or client, colleagues and co-workers, the public and the environment

There are various codes of ethics adopted by the various engineering societies
- Engineers Australia
- AusIMM
- SME
- CIM
- SAIME
- American Institute of Chemical Engineers Code of Ethics
- National Society of Professional Engineers (NSPE) Code of Ethics
The selection of inherently safe processes in the concept stage can eliminate many hazards that would otherwise require complex and costly engineering in later design stages.

Formalized hazard assessment techniques include:

- **Hazard and Operability study (HAZOP)-process related**
  - Systematic technique for identifying all internal plant or equipment hazards and operability problems

- **HAZID - risk Assessment process for the facility as a whole**

- **Fault-tree Analysis**
  - A means of analyzing hazardous events after they’ve been identified by other techniques
  - Used to estimate the likelihood of an accident by breaking it down into its contributing sequences, each of which is separated into all its necessary events
Hazard Assessment Techniques (Cont.)

- **Failure Mode and Effect Analysis**
  - Applied to a specific piece of equipment in a process or a particularly hazardous part of a larger process
  - To evaluate the frequency and consequences of component failures on the process and surroundings

- **Safety Indexes**
  - Numerical fire and explosive indexes can be calculated based on the nature of the process and the properties of the materials

- **Safety Audits**
  - To verify the adequacy of safety equipment and safety rules
    - Includes equipment for fire protection, personnel protection and on-site emergency responses
    - Detailed checklists covering every aspect of health, safety and loss prevention

Autoclave 5,000 Kpa
Personnel Safety Considerations

- Every attempt should be made to incorporate facilities for health and safety protection of plant personnel in the original design
  - Includes, but is not limited to:
    - Protected walkways
    - Platforms
    - Stairs
    - Work areas
    - Tripwires
    - Emergency exits
    - Nucleonic sources-density gauges

- Physical hazards, if unavoidable must be clearly defined
- Means for egress must be unmistakable
- All machinery must be guarded with protective devices
- Medical services and first aid must be readily available
“Loss Prevention” is an insurance term where the loss represents the financial loss associated with an accident.

The loss represents:
- the cost of repairing/replacing the damaged facility
- damage claims
- the loss of earnings from lost production during the repair period
- any associated lost sales opportunities

The Design Engineer must ensure that the risks involved with hazards are reduced to acceptable levels through the application of engineering principles and proven engineering practice.
Loss Prevention Steps

1. Identification and assessment of the major hazards

2. Control of the hazards by the most appropriate means
   E.g. containment, substitution, improved maintenance etc.

3. Control of the process
   i.e. prevention of hazardous conditions in process operating variables by utilizing automatic control and relief systems, interlocks, alarms etc.

4. Limitation of the loss when an accident occurs
Typical phases of a project and the corresponding application of safe plant design processes for each phase

The level of detail and the types of hazard studies undertaken will depend upon the project facility, the number and the types of risks identified in the risk review process.
Safety In Design Impact

- Conceptual Design
- Detailed Engineering
- Procurement
- Construction
- Start-up

Ability to Influence Safety

Start date

End date

Project Schedule
Environment Regulations

- Environmental Impact Statements and Assessments
  - Requires determination of what environmental standards require compliance by the project
  - Obtaining baseline data
    - Air quality
    - Water quality
    - Ambient noise levels
    - Ecological studies and social surveys
    - Emissions and effluents
  - Examining existing data to determine environmental safety of the project
  - Preparation of an effluent and emission summary with possible alternatives to meet acceptable standards
Environment Protection

- Development of a Pollution Control System involves:
  - Investigation of the pollution sources
  - the pollutants and the volume dispersed
  - Determination of the properties of the pollution emissions
  - Design of the collection and transfer systems
  - Selection of the control device
  - Dispersion of the exhaust to meet applicable regulations

- Consideration should be given to changing raw materials used and even process operations if a significant reduction in pollution source can be attained

- The extent to which source correction is justified depends on the cost of the proposed treatment plan
Safety Definitions

- **Lost time injury (LTI):** A work injury that results in an absence from work for at least one full day or shift any time after the day or shift on which the injury occurred.

- **Serious injury:** A lost time injury that results in the injured person being disabled for a period of two weeks or more.

- **Minor injury:** A lost time injury that results in the injured person being disabled for a period of less than two weeks.

- **Incidence rate:** The number of lost time injuries per 1000 employees for a 12 month period.

- **Fatal injury incidence rate:** The number of fatal injuries per 1000 employees for a 12 month period.

- **Lost time injury frequency rate (LTIFR):** The number of lost time injuries per million hours worked.
Figure 3  Comparison of Australia’s work-related injury fatality rate with the best performing countries standardised by industry

Key Work Health and Safety Statistics 2013  ...  3

* Reference-Safe Work Australia
Guidelines For Safe Design

1) Perform appropriate analyses
2) Comply with published standards
3) Use state-of-the-art technology
4) Include reasonable safety features or devices
5) Take into account how the user might misuse the product
6) Consider hidden dangers that might surprise the user
7) Consider variations in materials or manufacturing processes, or effects of wear
8) Carry out appropriate testing and interpret results correctly
9) Provide adequate warnings
10) Implement superior quality control
11) Document everything
Designing For Safety

- No injury to user, (products liability)

- No injury to consumer / society - Vendors

- No injury to production worker (e.g. OHSA)

- No damage to personal property

- No damage to real property (environment)
Risk Analysis in Design

1. Eliminate the hazard pro-active approach, “design-out” the hazard (eliminate any moving parts, hot or sharp surfaces)

2. Protect against the hazard passive approach, (machine guards, seat belts)

3. Warn against the hazard - weak remedy, (warning labels, alarms)

4. Provide training Provide and require operating training.

5. Provide personal protection - least effective, (safety glasses, gloves, shoes)
## Australian Standard Risk Matrix

### Risk Assessment Tool

<table>
<thead>
<tr>
<th>LIKELIHOOD</th>
<th>CONSEQUENCE</th>
<th>INSIGNIFICANT</th>
<th>MINOR</th>
<th>MODERATE</th>
<th>MAJOR</th>
<th>CATASTROPIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALMOST CERTAIN</td>
<td></td>
<td>High Risk 15</td>
<td>High Risk 10</td>
<td>Extreme Risk 6</td>
<td>Extreme Risk 3</td>
<td>Extreme Risk 1</td>
</tr>
<tr>
<td>LIKELY</td>
<td></td>
<td>Moderate Risk 19</td>
<td>High Risk 14</td>
<td>High Risk 9</td>
<td>Extreme Risk 5</td>
<td>Extreme Risk 2</td>
</tr>
<tr>
<td>POSSIBLE</td>
<td></td>
<td>Low Risk 22</td>
<td>Moderate Risk 18</td>
<td>High Risk 13</td>
<td>Extreme Risk 8</td>
<td>Extreme Risk 4</td>
</tr>
<tr>
<td>UNLIKELY</td>
<td></td>
<td>Low Risk 24</td>
<td>Low Risk 21</td>
<td>Moderate Risk 17</td>
<td>High Risk 12</td>
<td>Extreme Risk 7</td>
</tr>
<tr>
<td>RARE</td>
<td></td>
<td>Low Risk 25</td>
<td>Low Risk 23</td>
<td>Moderate Risk 20</td>
<td>High Risk 16</td>
<td>High Risk 11</td>
</tr>
</tbody>
</table>

**Extreme (1)**

Cease activity or task; detailed research and planning required

**High (2)**

Senior management attention, immediate corrective and preventative action required.

**Moderate (3)**

Management responsibility assigned, corrective and preventative action plan developed

**Low (4)**

Manage by routine procedures
Impacts on Safety, functionality, operability, OH&S
Safe Design Principals

- **Safe-Life**
  - entire predicted useful life without malfunction
  - designers to identify all operating conditions, misuses and abuses
  - design appropriate maintenance and repair schedules

- **Fail-Safe**
  - upon failure of a component, product/system shuts down safely, critical functions are sometimes still performed (e.g. boiler feed-water valve failing in the open position)

- **Redundant design**
  - additional product components or systems are designed to take over the principle function of the failed component or system. (e.g. multi-engine airplanes, emergency brakes)
Construction

- The installation of large and heavy plant items requires space and perhaps access for cranes. Such activities introduce risks not normally encountered in operating plants.
What is Registrable Classified Plant?

• Basically, three main groups of registrable classified plant encountered on mining operations:
  – pressure vessels
  – cranes
  – hoists and other plant used to lift people
What are relevant Australian Standards that Apply to Pressure Vessels?

- Applicable standard for the design, construction and testing of pressure vessels is **AS 1210**
- Prescribed standard to assess the hazard level of a pressure vessel is **AS 4343**
- Applicable standard for in-service inspection and maintenance for pressure vessels is **AS 3788**

Tip: If you are responsible for classified plant at your site, make sure your maintenance staff are made aware of these requirements.
What About Boilers?

- The applicable standard for the design, construction and testing of boilers is **AS 1228**

- **AS 4343** is also used to assess the hazard level of a boiler

**Tip:** Many boilers and pressure vessels are designed, manufactured and testing overseas using other design codes. If you’re in the market for a pressure vessel or boiler, always make sure that you specify and check that it is designed, constructed and tested to the applicable Australian Standard – otherwise you will encounter problems when trying to register it with Resources Safety.
Why is AS 4343 so important?

- AS 4343 essentially takes into account the following when assessing the hazard level of a pressure vessel or boiler:
  - Internal volume
  - Design pressure
  - Contents

**Rule of thumb:** The greater the volume, design pressure and more lethal the contents, the higher the hazard level

Hazard level “A” is the highest and “C” is the lowest requiring registration
Cranes Hoists & Lifts Must Be Registered
Security

- The site should be provided with a boundary fence and all entrances should have a gatehouse.

- The number of entrances should be kept to a minimum.
Operability or Design?

- No training
- Poor workmanship
- Poor design
- Abuse of equipment
- Neglect
Design for Safety: Prevent injury or damage

Hazards exist, and depend on conditions

We have Legal Responsibilities

Guidelines for Safe Products/systems

Safety Hierarchy - maximize our efforts

Safe Design Principles

Failure Modes & Effects Analysis (FMEA)
Acknowledgement

• Thanks to COM 2014 for the opportunity to present

• Thanks to various companies, colleagues, engineers

• METS engineering staff and consultants

• Vendors for their input
What did you get out of this presentation?
Please share your thoughts in an informal discussion

Questions?
THANK YOU

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