Tier 3: Electrowinning Orientation

1. Electrowinning

1.1 Electrowinning

Electrowinning Orientation

Tier Three – Site Specific Access

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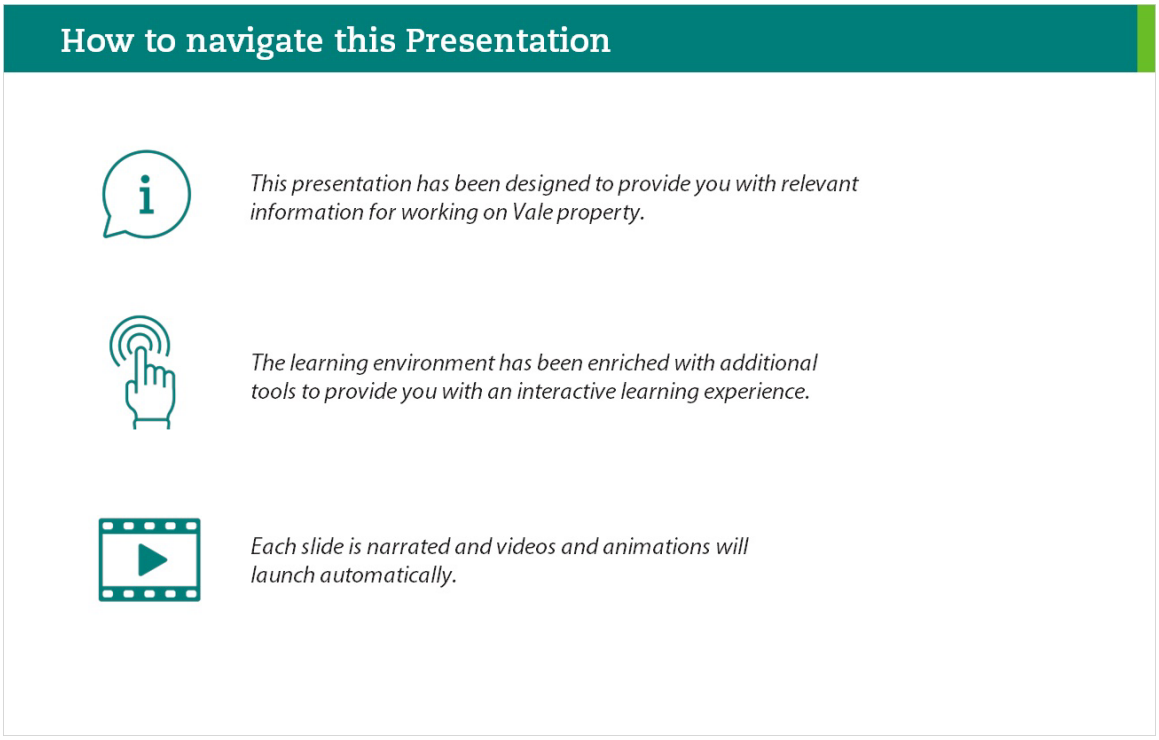
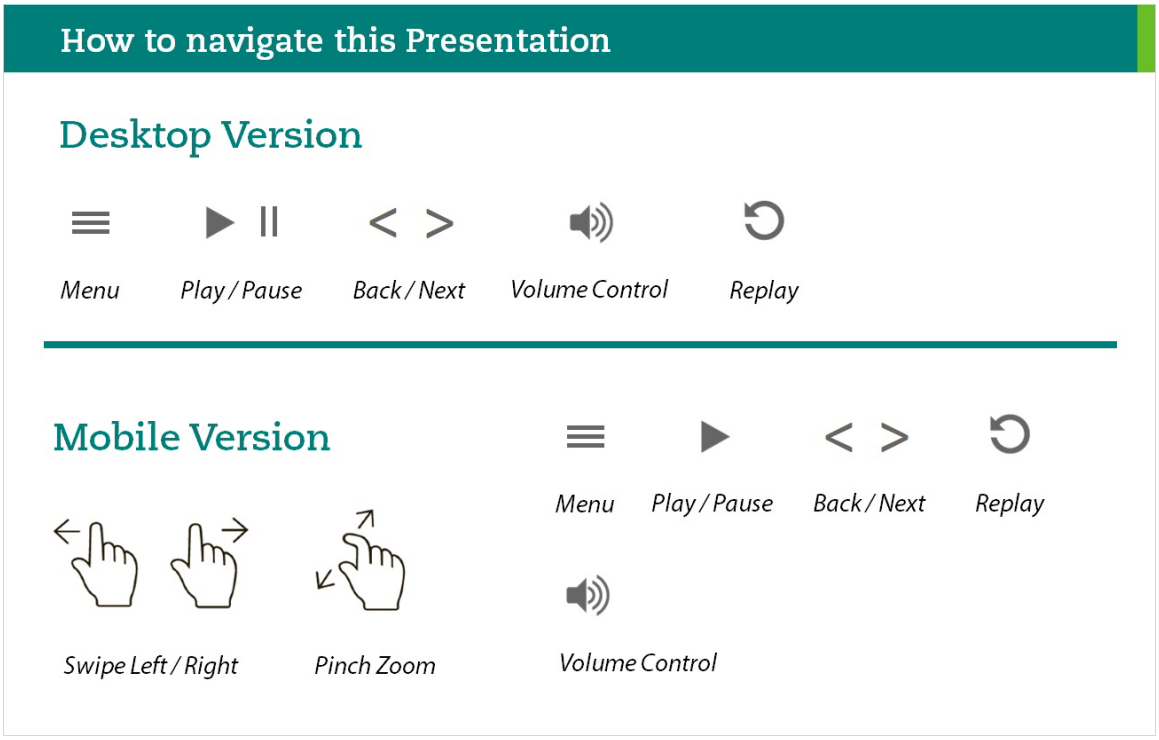
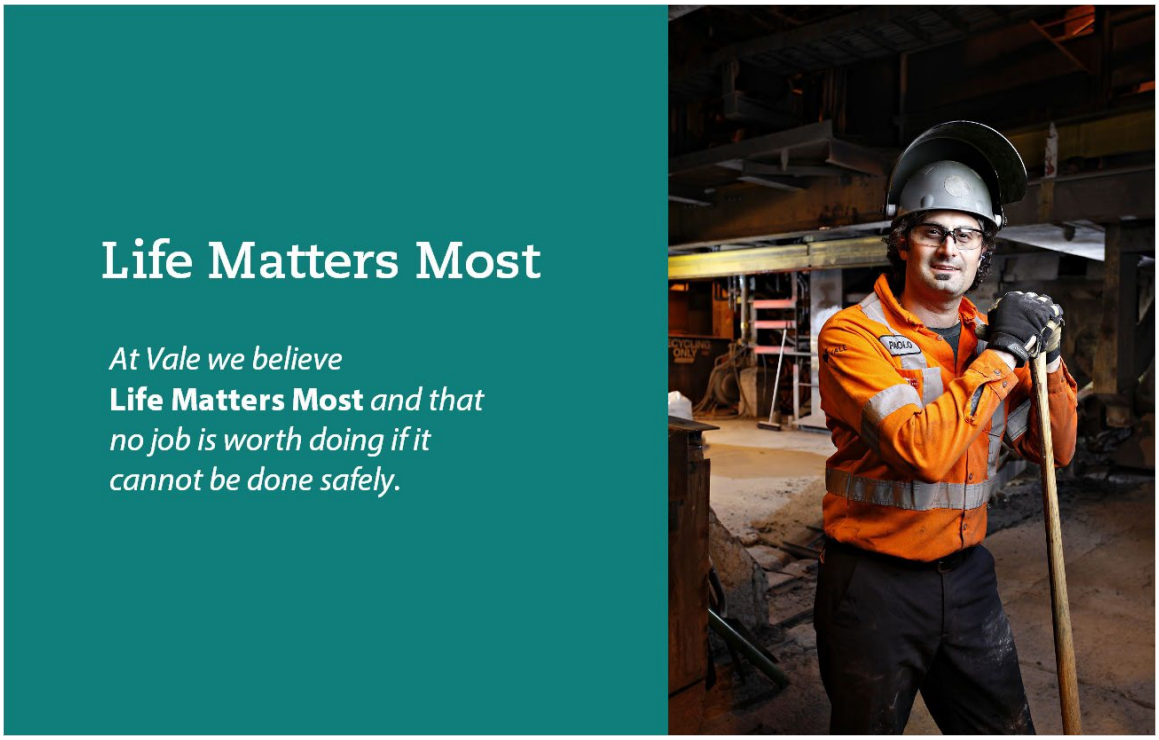
1.2 How to navigate this Presentation



1.3 How to Navigate this Presentation

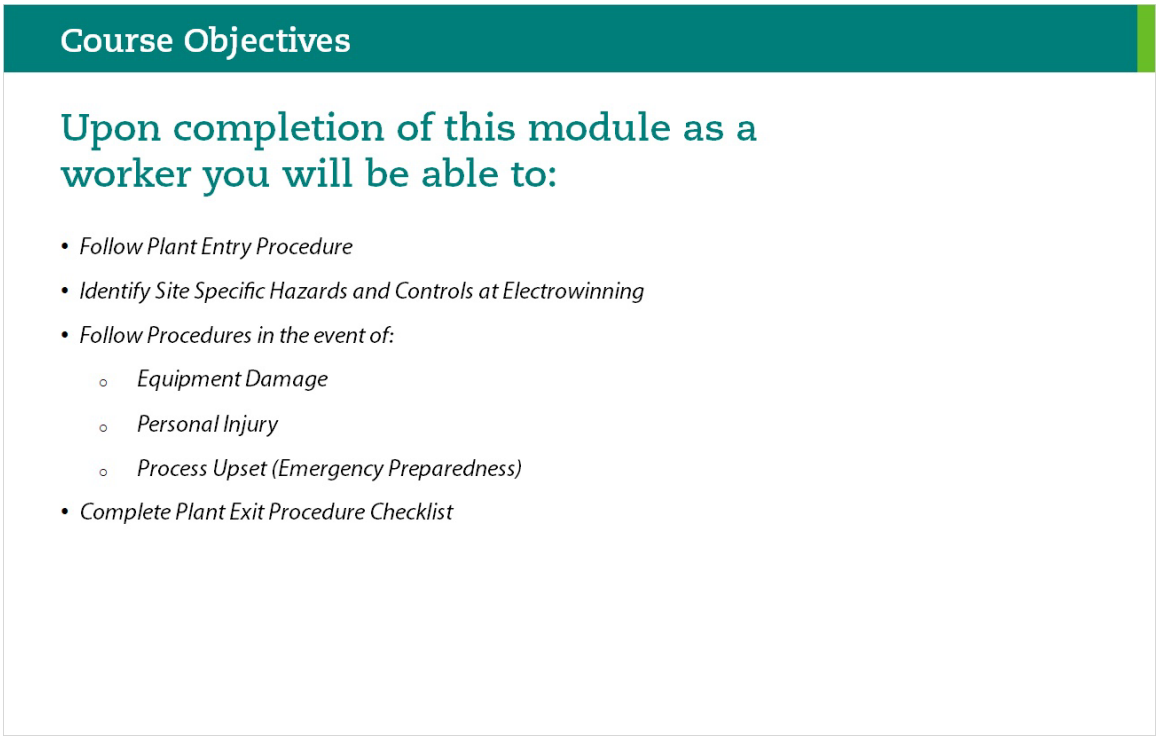


1.4 Life Matters Most



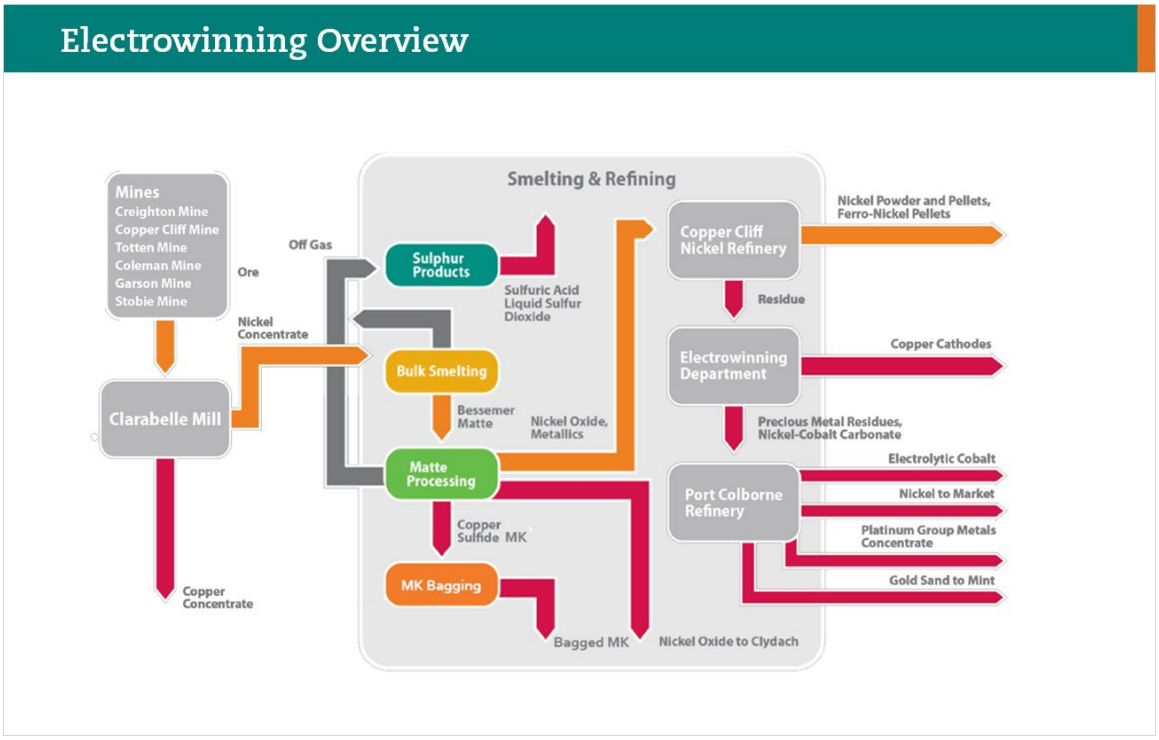
1.5 Course Objectives

1.6 Course Objectives



1.7 Introduction

1.8 Electrowinning



1.9 Electrowinning Overview

Electrowinning Overview

The Electrowinning Plant receives residue slurry from the Nickel Refinery IPC area (IPC Residue), prepares it into batches and processes it to obtain a precious-metals rich TOL (Total Oxidative Leach) Residue Slurry.

Any remaining precious metals as well as selenium and tellurium are recovered as a Tower Underflow Solids (TUS) Residue Slurry. Both residues are shipped to Port Colborne's Precious Metals Refinery operation for further processing.

1.10 Electrowinning Overview

Electrowinning Overview

In addition, the Electrowinning Plant also produces pure Copper Cathodes suitable for market and a Nickel/Cobalt Carbonate product for shipment to Port Colborne's Cobalt Refinery for further processing.

Iron contained in the IPC Residue feed is separated from the residue and pumped, with other waste matter, to Vale's tailing area.

1.11 Electrowinning Overview

Electrowinning Overview

The insoluble portion from the First Stage Autoclave operation then proceeds to the 2nd stage Autoclave where the conditions are suitable for leaching the Copper in solution.

This leached copper moves through a copper shot tower that removes selenium and tellurium. The Cu solution then goes to the electrowinning tankhouse where Cu cathode is produced for market.

1.12 Electrowinning Overview

Electrowinning Overview

Cu cathode production is approximately 21 million lbs annually.

The insoluble product from the 2nd Stage Autoclave operation which contains the bulk of the PGMs and residual Cu and impurities is pumped into a tanker truck and shipped to Port Colborne Refinery for further processing.

1.13 Plant Entry

1.14 Approaching the Plant

Approaching the Plant

Electrowinning has one point of entry into the plant which is accessed via Power Street off of Municipal Road 55.

The road is a single laned roadway with strict restrictions from passing any vehicles.

The road traverses two sets of railway tracks.

Be aware of large trucks hauling various products to and from the Power Street roadway.

Always be aware of your surroundings and proceed with caution.

1.15 Approaching The Plant

Approaching the Plant

Perimeter Warning Lights

While approaching the Power Street Gate, take notice of the Pre-Entry Warning Sign located at the corner of the parking lot immediately after the railway crossing.

The red light on top of the sign is activated during a plant emergency, to warn and stop incoming traffic.

Inside the plant property, there are additional red flashing lights to alert of such emergencies.

1.16 Approaching The Plant

Approaching the Plant

Power Street Gate

Adhere to the stop signs protecting pedestrians crossing from the South Mine Parking Lot to the PS&S Building.

Look both ways before proceeding through the pedestrian crosswalk.

Be cautious of pedestrians, vehicles and motorized equipment that may be in the area.

Pedestrians can access EW by a non-designated walkway from the Power Street Gate to the EW Dry Building.

1.17 Parking Lot 1

Parking

To get to the Electrowinning Plant, proceed past the Power Street Gatehouse.

1. *Vehicles without gate access through Power Street Gate*
2. *Electrowinning Utilities (Dry) Parking Lot*
3. *Staff/Visitor Parking Lot*

The area approaching the sign in location is a high activity area. Vehicles pulling over to the side either signing in or out, and a major pedestrian crossover is in the area. Be aware and be vigilant to the activity.

show (Slide Layer)

Parking

To get to the Electrowinning Plant, proceed past the Power Street Gatehouse.

1. *Vehicles without gate access through Power Street Gate*
2. *Electrowinning Utilities (Dry) Parking Lot*
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The area approaching the sign in location is a high activity area. Vehicles pulling over to the side either signing in or out, and a major pedestrian crossover is in the area. Be aware and be vigilant to the activity.

Show2 (Slide Layer)

Parking

To get to the Electrowinning Plant, proceed past the Power Street Gatehouse.

1. *Vehicles without gate access through Power Street Gate*
2. *Electrowinning Utilities (Dry) Parking Lot*
3. *Staff/Visitor Parking Lot*

The area approaching the sign in location is a high activity area. Vehicles pulling over to the side either signing in or out, and a major pedestrian crossover is in the area. Be aware and be vigilant to the activity.

Show3 (Slide Layer)

Parking

To get to the Electrowinning Plant, proceed past the Power Street Gatehouse.

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2. *Electrowinning Utilities (Dry) Parking Lot*
3. *Staff/Visitor Parking Lot*

The area approaching the sign in location is a high activity area. Vehicles pulling over to the side either signing in or out, and a major pedestrian crossover is in the area. Be aware and be vigilant to the activity.

1.18 Sign in Procedures

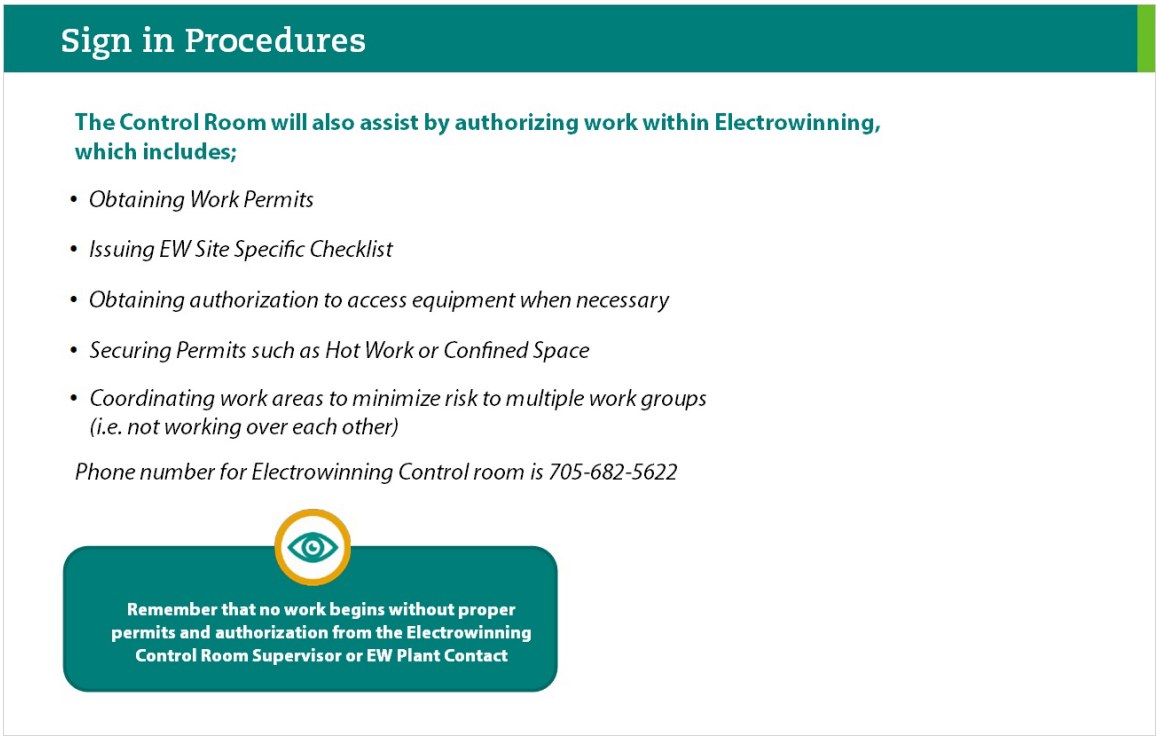
Sign in Procedures

All contractors and visitors entering Electrowinning need to sign in the sign-in book, located on the 3rd floor as you exit the elevator.

Depending on where you're working within Electrowinning, there may be other requirements such as checking in with a control room operator.

Be sure to write legibly when filling in the Sign-In Sheet

1.19 Sign in Procedures



2. Site Specific Hazards

2.1 Plant Hazards and Controls

2.2 Site Specific Hazards

Site Specific Hazards

Using the tools that you learned in Tier 1 Orientation, ensure you apply the necessary operation controls to mitigate risk associated with the identified hazards.

Be Aware
Be aware of your surroundings and the risks around you.

Follow Policies & Procedures
Our internal policies and procedures guide us in doing our work in a manner that reduces risk.

The following section lists identified hazards that may be encountered in the work you're doing. Knowing if these hazards apply to your work can be found through:

- *Vale Contact Person*
- *PHA/PHR (or other Risk Assessment Tools)*
- *SLAM*

2.3 Site Specific Hazards

Site Specific Hazards

Electrowinning has workplace specific hazards that have been identified and need to be controlled. These include but are not limited to:

- **Arsine*
- *Electrical hazards*
  - *Magnetic Fields*
  - *Open bus bars*
- *Reagents*
  - *Lime*
  - *Filter Aid*
  - *Sulphuric Acid*
  - *Soda Ash*
  - *Oxygen*
- *Mobile Equipment*
- *Hydraulic Equipment*
- *Overhead Cranes*

Communicate with your Vale contact person concerning the procedures pertaining to designated substances, product locations, and process hazards in your work area.

*** Separate training is required for handling / working with designated substances.**

2.4 Arsine (AsH3) - Hazard

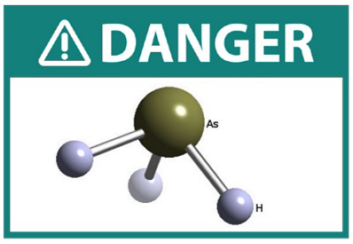
Arsine (AsH3) - Hazard

Arsine gas is an inorganic compound that is colourless, heavier than air with a slight garlic odour. Arsine can be generated in Electrowinning by one of two ways:

1. *Contact of electrolyte solutions with galvanized metal (zinc coating).*
2. *Continuing to plate copper in the tankhouse when the copper in solution has been depleted below 10 gpl.*

Hazards of Arsine:

- *Poisonous with an 8 hour exposure limit of 0.005 ppm (5ppb).*
- *Immediately Dangerous to Life and Health (IDLH) at 3 ppm.*
- *Extremely flammable. Arsine is heavier than air and accumulates close to the surface, which makes distant ignition possible in the presence of flame or spark.*



2.5 Arsine (AsH3) - Hazard

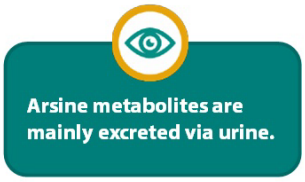
Arsine (AsH3) - Hazard

How can arsine enter my body?

Inhalation is the major route of exposure to arsine. Skin absorption and ingestion are not significant routes of exposure.

After exposure, the concentration of arsine increases rapidly in the blood, and then is distributed to the liver, kidneys, and other organs at a much slower rate.

Arsine is metabolized to various inorganic forms of arsenic.



2.6 Arsine (AsH3) - Hazard

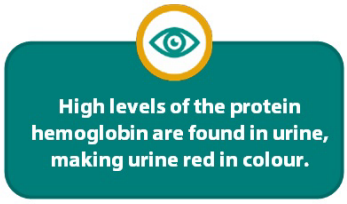
Arsine (AsH3) - Hazard

How can arsine affect my health?

There are no immediate warning signs except for a slight garlic odour which is detected at 0.5 ppm and greater. Within 2-24 hours following exposure, initial symptoms may include general feeling of discomfort, dizziness, thirst, headache, nausea, abdominal pain and/or, shortness of breath (dyspnea).

- *The main effect of arsine poisoning is the destruction of red blood cells causing anemia as well as kidney damage.*
- *Jaundice may occur up to 12-48 hours following exposure.*
- *In severe cases, arsine can have a direct effect on the heart, liver, kidney and/or nervous system.*

Maintaining concentrations below recommended limits (i.e. OELs) would prevent both acute and chronic health effects.



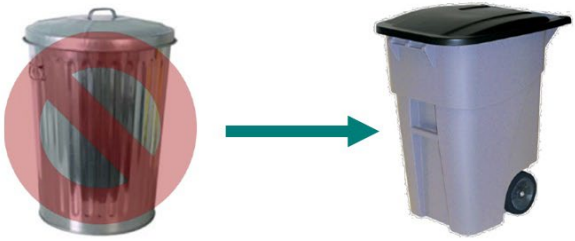
2.7 Arsine (AsH3) - Control

Arsine (AsH3) - Control

Galvanized Metal – Best Practice

While the likelihood of Arsine being generated is considered low, Electrowinning has a policy of no galvanized metal in any operating areas that could be exposed to spills.

- *All new cable tray installations in the plant use FRP or stainless where corrosion resistance is required.*
- *Duct work repairs generally use stainless steel.*
- *Steel and plastic garbage cans are used instead of ones made of galvanized material.*



2.8 Arsine (AsH3) - Control

Arsine (AsH3) - Control

Copper Plating

- *The operational process of the Electrowinning Tankhouse normally operates with a minimum copper concentration of* **40 gp/l** *in the electrolyte solution.*

- *Regular cell flow checks are performed by the tankhouse and chemical operators to ensure parameters are maintained to prevent the generation of arsine.*

2.9 Arsine (AsH3) - Control

Arsine (AsH3) - Control

Monitoring

- *Hydride monitors are used to detect levels of arsine as well as other hydrides; an evacuation of the tankhouse area will be announced if the hydride monitor goes into alarm.*
- *Urine analysis to detect the presence of blood in the urine is the recommended biological monitoring for suspected arsine exposures.*
- *Airborne concentrations of hydride gases will be measured using a real-time portable monitor.*

If there is an incident of exposure, workers are encouraged to submit a urine sample.

2.10 Arsine (AsH3) - Control

Arsine (AsH3) - Control

Treatment

There is no antidote for arsine poisoning, but it can be treated.

- *Fluids can be administered to protect the kidneys from damage.*
- *For severe poisoning, blood transfusions and hemodialysis (cleaning of the blood) may be needed.*

2.11 Reagents - Hazard

Reagents - Hazard

Reagents are compounds or mixtures that are added to a process to cause chemical reactions. Some of these reactions create additional hazards due to the reaction.

Shown here are some of the reagents used in Electrowinning's operational process to assist in the reaction and separation of the feed.

Reagent	Purpose	Hazard
Lime	Provides pH control in Iron and Effluent Circuits	is caustic, upwards of pH 12.
Filter Aid	assist in filtration of very fine solids	Inhalation of dry filter aid may contain some *crystalline* silica which is harmful to the lungs, causing silicosis.
Sulphuric Acid	Helps to provide necessary chemical ratios and control for operating multiple circuits and is required for leaching Copper	Sulphuric acid is highly corrosive
Soda Ash	Controls the pH and precipitation of copper, nickel and cobalt in the Copper Clean Up and Ni/Co Circuits	Soda ash is a mild irritant if ingested, inhaled or if contact is made with eyes or skin.
Oxygen	Required to carry out reactions in the 2nd stage and Iron autoclaves	Oxygen is not flammable but makes other materials that are not usually flammable more flammable.
Dow Fax	Reduces the presence of acid mist in the Tankhouse by putting a layer of foam on the surface of the electrolyte.	Low toxicity if ingested. May cause severe irritation to eyes or upper respiratory tract if splashed or inhaled for extended period of time (excessive exposure).
Glue	Glue is necessary to promote smooth plating of copper on the cathodes in the Tankhouse.	Industrial glue is a mild irritant if ingested, inhaled or if contact is made with eyes or skin.

2.12 Reagents - Control

Reagents - Control

Be aware, some reagents and materials produced may be hazardous and classified as controlled products under WHMIS regulations. If you are unsure about proper handling, refer to the relevant Safety Data Sheets (SDS).

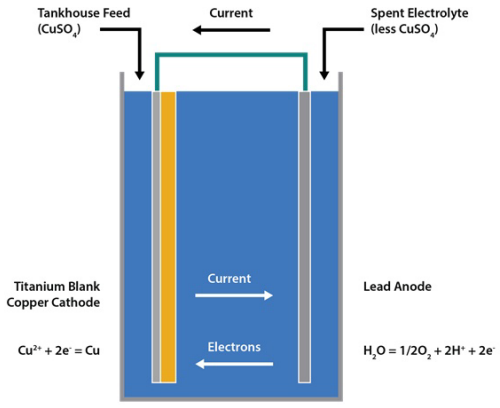
Familiarize yourself with your work environment. Identify emergency showers indicated by a blue light; and Eye-Wash stations in your vicinity. Locate the closest exit leading to the nearest OUTVAC location.

2.13 Magnetic Fields - Hazard

Magnetic Fields - Hazard

This current creates a strong magnetic field that, when combined with the electrical potential, has potential to harm workers by:

- *Electrical shock from contact with bus bars*
- *Interference with pacemaker operation*
- *Interference with artificial metal joints*



What is Happening in the Tankhouse?

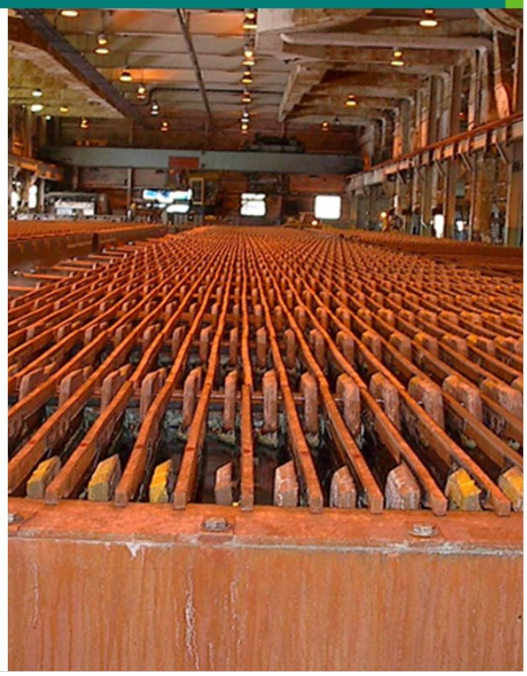
2.14 Magnetic Fields - Control

Magnetic Fields - Control

With any live conductors, caution must be taken to prevent accidental grounds and possible shocks.

To mitigate the risks associated with electrical current and magnetic fields, Electrowinning has implemented the following controls:

- *Report all electrical shocks and arcing to your supervisor*
- *Practice good house-keeping*
- *Properly maintain equipment*
- *Follow all associated work procedures and the EW Site Specific Checklist*



2.15 Magnetic Fields - Control

Magnetic Fields - Control

The Tankhouse is a restricted area and is controlled by signage indicating no access to any:

- *Workers with pacemakers*
- *Workers with artificial metal joints*

2.16 Buried/Hidden Wiring - Hazard

Buried/Hidden Wiring - Hazard

Anyone performing work in the tankhouse must be aware of the possibility of hidden or buried electrical wiring, creating the hazard of damage to equipment or electrocution.

Let's review the following incident where an electrician was installing new teck cable on a wall of EW tank house. Approx. 70 cable anchors had been installed when the electrician noticed sparks coming from the anchor hole as he drilled with a cordless drill.

The drill bit was about 2 cm (3/4") into the wall.

2.17 Buried/Hidden Wiring - Control

Buried/Hidden Wiring - Control

Immediate Actions Taken:

The Electrical and Instrumentation Supervisor was notified.

The 120 VAC lighting circuit was traced. Once the source was found it was discovered that the panel had not tripped. (breaker tested OK). A work order was submitted to repair or re-feed entire circuit.

2.18 Mobile Equipment - Hazard

Mobile Equipment - Hazard

Electrowinning utilizes various pieces of mobile equipment to aid in the movement of materials or in the maintenance of areas.

Forklifts: *transporting supplies and materials.*

Elevated Work Platforms: *used to perform various maintenance activities.*

Transport Trucks: *movement of metal products and by-products to and from other areas.*

Mobile equipment presents several hazards including restricted visibility, limited clearance, shifting loads all lending to collisions with pedestrians, machinery or other mobile equipment.

2.19 Mobile Equipment - Control

Mobile Equipment - Control

In addition to the general controls associated with mobile equipment, Electrowinning has mandated the following controls applicable to mobile equipment in their area:

- *The best practice is to use overhead doors for mobile equipment only; Pedestrians should use personnel access doors.*
- *Certain walkways are intersected with the routes of mobile equipment.*
- *Caution and awareness must be exercised when cathodes are being moved across the main aisle on 1 Floor.*

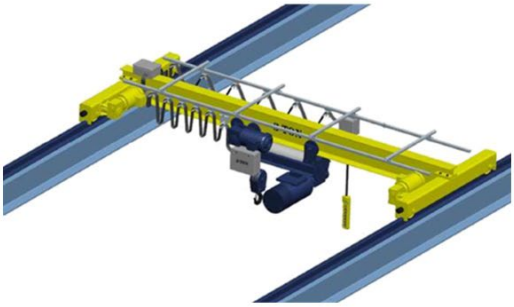
2.20 Overhead Cranes - Hazard

Overhead Cranes - Hazard

There are overhead cranes in Electrowinning to either facilitate the movement of cathodes or anodes in the tankhouse or to move materials throughout the plant.

Cranes present the hazards of:

- *Suspended loads*
- *Unstable loads*
- *Open bus-bars*
- *Collisions and entanglements*
- *Contact with other equipment*



2.21 Overhead Cranes - Control

Overhead Cranes - Control

To mitigate the risks with cranes, Electrowinning has implemented the following controls:

- *Overhead cranes may not be operated by non-Vale personnel without pre-authorization and reviewing of Vale procedures*
- *Mandatory daily inspections*
- *Mandatory log book entries completed daily*
- *Ensure no material comes within 3 meters of live crane rails*

2.22 Equipment Damage

Risk Management

As mentioned, there are controls to manage risk. Actions or inactions in response to controls may result in one of three conditions; an Unsafe Condition, a Near Miss, or a an Incident.

Any of the three must be reported immediately to a Supervisor or Contact Person.

In the case of incidents, there may be additional steps required if the resulting action includes:

- *Equipment Damage*
- *Personal Injury*
- *Process Upset*

BE AWARE

Be aware of my surroundings and the risks around me.

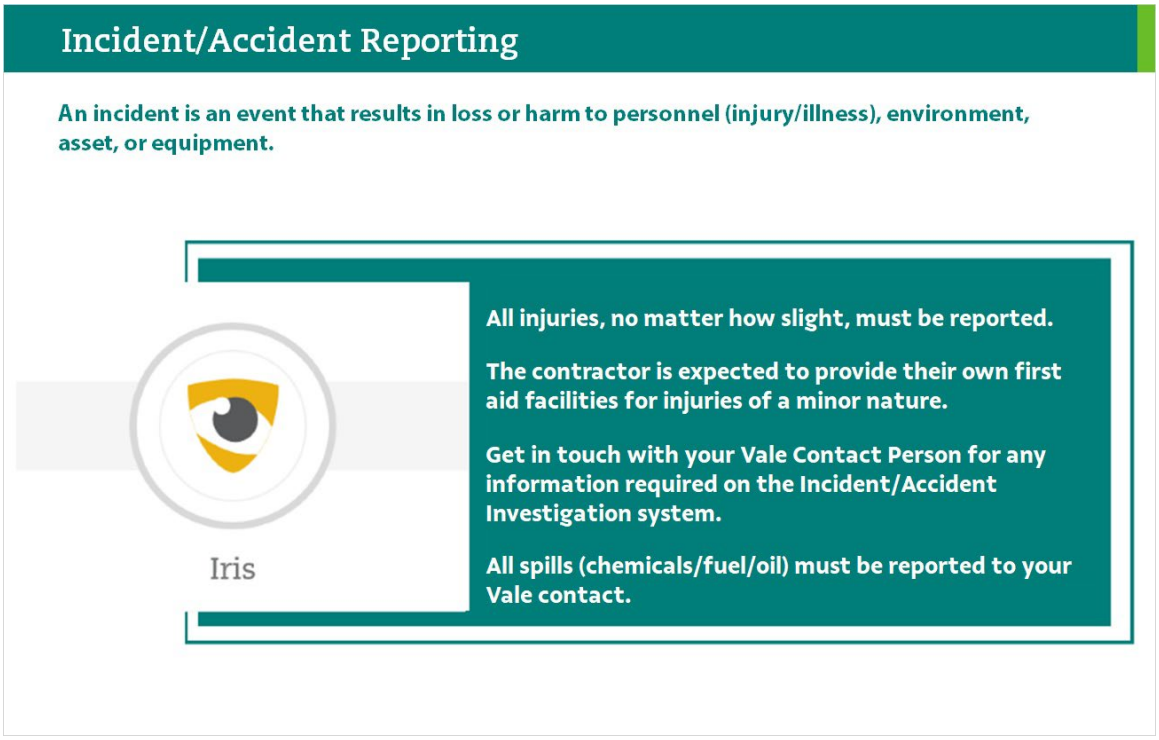
FOLLOW POLICIES & PROCEDURES

Our internal policies and procedures guide us in doing our work in a manner that reduces risk.

3. Incident/Accident Reporting

3.1 Incident/Accident Reporting

3.2 Incident/Accident Reporting



3.3 Personal Injury

Personal Injury

In the case of personal injury, contact your supervisor and report immediately to First Aid.

Electrowinning

Emergency Numbers

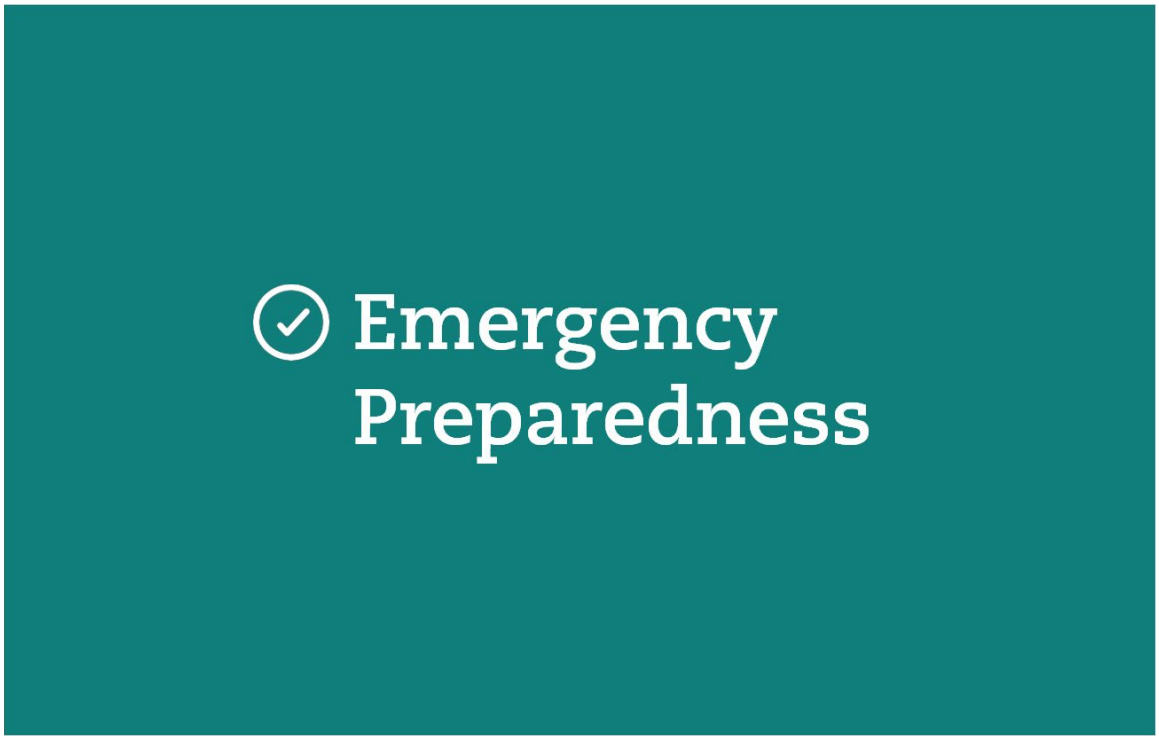
#1 First Aid ……..…..…… 6622

Electrowinning First Aid ……..…… 5592

Control Room (Electrowinning)……..… 5622

4. Emergency Preparedness

4.1 Emergency Preparedness



4.2 Emergency Preparedness

Emergency Preparedness

The Surface Tier 2 Orientation provided guidance on the application of Emergency Preparedness including activating an emergency and how to classify one.

The following is how to respond to an emergency at Electrowinning.

4.3 Notification – Central Tailings Area

Notification - Electrowinning

Fire Evacuation - OUTVAC

Continuous Tone

In the event of a fire evacuation at Electrowinning, all workers, except specific, qualified personnel, will proceed immediately to the fire evacuation area and await further instructions.

Leave the building by the nearest exit.

Assembly Area - INVAC

Intermittent Tone

Upon hearing an intermittent alarm at Electrowinning, all workers, except specific, qualified personnel, will proceed immediately to the Safe Assembly Area and await further instructions.

Go to the nearest Safe Assembly Area.

Alarm testing is conducted each Monday at 1:30 pm. Report any malfunctions immediately to your Supervisor to ensure that it is corrected in a timely manner.

4.4 Fire Evacuation Area - OUTVAC

Fire Evacuation Area - OUTVAC

Located on the north side of the Electrowinning building outside door 45.

Do not leave the evacuation area until instructed to do so, or until the all clear is given.

Dont show (Slide Layer)

Fire Evacuation Area - OUTVAC

Located on the north side of the Electrowinning building outside door 45.

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show (Slide Layer)

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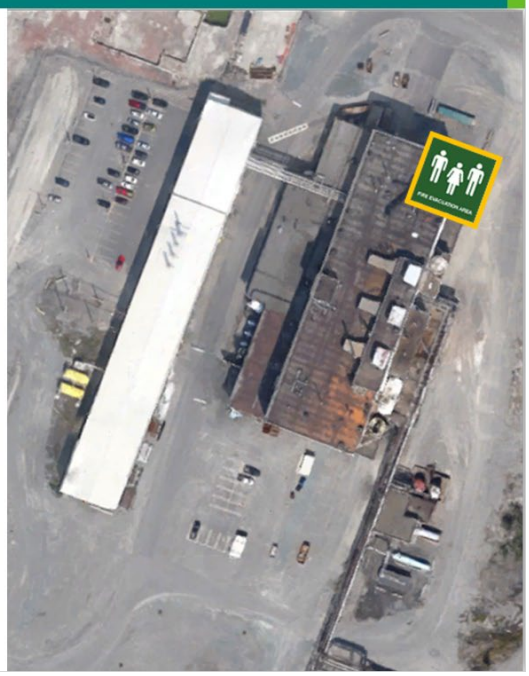
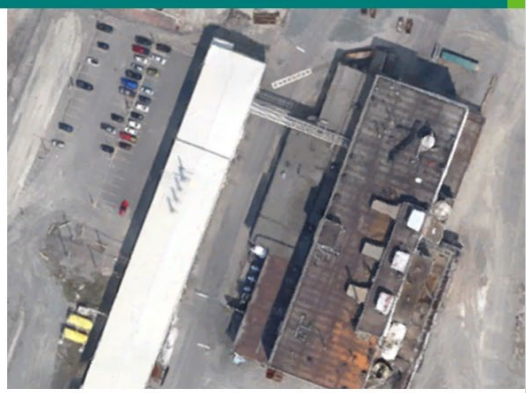


4.5 Safe Assembly Area - INVAC

Safe Assembly Area - INVAC

Dry Area

- *If accessing from outside, proceed to door 60*
- *From inside, the dry is located at the north end of the utilities building*



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Safe Assembly Area - INVAC

Dry Area

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Dontshow (Slide Layer)

Safe Assembly Area - INVAC

Dry Area

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4.6 Safe Assembly Area - INVAC

Safe Assembly Area - INVAC

Dry Area

- *If accessing from outside, proceed to door 60*
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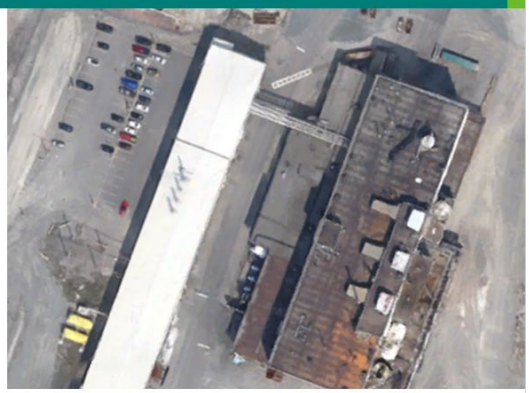
Electrowinning Lunchroom

- *The Electrowinning Lunchroom is located on the 3rd floor inside the Electrowinning plant*



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Safe Assembly Area - INVAC

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Electrowinning Lunchroom

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Dontshow (Slide Layer)

Safe Assembly Area - INVAC

Dry Area

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Electrowinning Lunchroom

- *The Electrowinning Lunchroom is located on the 3rd floor inside the Electrowinning plant*

5. Plant Exit

5.1 Plant Exit

5.2 Plant Exit

Plant Exit

Good work practices dictate that you close the loop on work you were doing to avoid creating risks or hazards for other work groups, cross shifts, or other work in the area. Here are some tasks to consider when getting ready to exit the plant to ensure your safety and that of those around you:

Housekeeping: *Is your worksite cleaned up after your job?*

Personal Lock and Tag: *Has your personal protection been removed at the end of the shift?*

Status Tagging: *Is there ongoing work that needs a status tag placed or is there equipment in Bad Order that needs to be identified?*

End States: *Have you left the process in the proper state?*

Waste Segregation: *Have you disposed of materials in the appropriate waste receptacles/bin/area?*

Control room: *Do I need to let the control room know that I'm clear of an area?*

Vale Contact Person: *do they need an end of shift report from me?*

Permits: *do I need to close or hand in any permits?*

Sign out: *at the gate or other designated areas.*

6. Conclusion

6.1 Conclusion

6.2 Conclusion

Conclusion

This concludes the material for the Electrowinning Tier 3 Orientation. You should now have a working knowledge and understanding of:

- *Plant Entry*
- *Site Specific Hazards and Controls for Electrowinning*
- *Procedures in the event of:*
  - *Equipment Damage*
  - *Personal Injury*
  - *Process Upset (Emergency Preparedness)*
- *Plant Exit Procedure*

This Orientation provided information to access Electrowinning. In order to feel comfortable with the area, you may arrange a field visit with your Vale Contact Person to specifically identify procedures provided in the Orientation.

Additionally, depending on the site or work you're doing, you may require task-specific information through either the local Learning & Development Group or your Vale Contact Person.

6.3 Conclusion

Conclusion

Remember, At Vale we believe Life Matters Most and that no job is worth doing if it cannot be done safely.

Thank-you for your participation and your commitment to safety at Vale.

HOME SAFE