Hoisting Upgrade
Challenges and Approach

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Presentation Outline

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Safety Share

Distracted Walking – be aware of your surroundings

You may have the right of way but a bus / pedestrian interaction – bus wins

Distractions include

• Talking or looking down on a cell phone
• Talking to your buddy
• Daydreaming about the riveting and provocative Hoisting Plant Upgrade presentation
Introduction

Presentation from an Engineering Perspective

Who is WSP?

- WSP is a professional services firm, providing integrated solutions across many disciplines of industry
- 36,000 employees, including engineers, technicians, scientists, architects, planners, surveyors environmental specialists, as well as other design, program and construction management professionals,
- Based in more than 500 offices,
- Across 40 countries,
- On 5 continents.
- WSP has been the design engineering firm for many of the potash upgrade projects and has experience with this challenge.

MISSION
Be a solution-driven advisor with outstanding expertise

VISION
Always be the first choice for clients, partners and employees
Why Upgrade a Hoisting Plant?

Mine operators must ‘do more for less’

A Mine Expansion occurs when

- Existing underground mine increases production – this is the most common reason to upgrade a hoisting plant
- Existing mine deepens shaft to access deeper reserves
- Recommissioned mine, add new Hoisting Plant
Brownfield vs Greenfield Hoisting Plant

**Greenfield Mine - New**

- Extensive Environmental Permitting procedure (can be extensive process in an area without an operating mine)
- Design Infrastructure to required production rates
- New Infrastructure required (Mill, Hoisting Plant, Shaft, Underground Infrastructure)
  - High Cost
  - Longer Schedule
- New Mine plan w New, Efficient Technologies
- Training for New Operators
Brownfield vs Greenfield Hoisting Plant

Brownfield Mine - New

- Less Extensive Environmental Permitting procedure (permitting exists for operating mine)
- Review increasing production with existing infrastructure
- Evaluate reusing / upgrading existing infrastructure (Mill, Hoisting Plant, Shaft, Underground Infrastructure)
  - Lower Cost *
  - Shorter Schedule *
- Old Mine plan w older Technologies
- Minimal Training for Existing Operators

*Note – extensive evaluation of the cost and schedule must be evaluated; renovations are not always cheaper and quicker to complete
Brownfield Risk Evaluation

Process to Evaluate Updating an Existing Mine

- Evaluate the capacity of existing structure for new Hoisting Plant
  - Can the new hoist fit within the existing hoist floor area?
  - Can the existing headframe and foundation support new hoist loads?
    - Hoist mass
    - Operational loads
  - Does the longer skips have sufficient operational clearance in headframe and shaft bottom?
  - Is the shaft arrangement capable of the larger skips and loads?
  - Is the material handling system sufficient for additional production?
  - What is the cost and schedule to renovate?
  - Other factors (not part of this presentation)
    - Power distribution
    - Ventilation
Hoist Upgrade

Hoist Required to Increase Production

– The infrastructure evaluation / design is dependent on:
  • Environment loading conditions (wind load, snow load, etc.)
  • Operational conditions – The Hoisting Plant loading
  • Hoisting depth
  • Production rate
– Hoist design must be sufficient to accommodate production rate
– Hoist type
  • Friction Hoist
  • Double Drum
  • Multiroped Blair Hoist
– Hoist Orientation
  • Ground Mounted
  • Tower Mounted
Note – This presentation will evaluate Friction Hoists
Hoist Orientation

**Hoist Loading Effect on Structure**

**Ground Mounted Fiction Hoist**
- Hoist is at ground level – easily accessible
- Large mass concrete foundation to resist high uplift forces
- Significant ropeway enclosure required, for cold weather climates
- Marginally shorter headframe to house only deflection sheaves
- Larger headframe loading due to multiple rope breaking criteria

**Tower Mounted Friction Hoist**
- Elevated hoist, requires elevator access
- Elevated hoist foundation, large mass
- No ropeway required, ropes within headframe
- Taller headframe to accommodate hoist maintenance crane
- Reduced rope breaking reactions, loads are only vertical

Note – consider tower mounted hoist for load distribution purposes.
Requirements to Upgrade Infrastructure

Process to Upgrade to Increase Production

- To Increase Production
  - > Longer Skips (additional volume required for increased production)
  - > Larger capacity Hoist for larger skips (@ higher operating speeds?)
  - > Longer Skips require Greater Operational Clearance
  - > Taller Headframe
  - > Deeper Shaft
  - > Increased Material Handling system

Note – additional capacity should be building into the original hoist design to account for:
- Unforeseen operational limits
- Operator wishes to increase production in future
Reuse Existing Headframe Infrastructure

Support New Loading in New Structure

- The existing structure was designed for the original hoisting parameters
- The new hoisting parameters can increase by 20-100%, HOW TO SUPPORT THIS INCREASED LOADING?

ANSWER – Build a free standing tower over the existing headframe to support the additional loading – A PENTHOUSE OVER A HEADFRAME
Headframe Structure

Preliminary Design

- The preliminary headframe structural engineering to establish load paths
- Dimensional General Arrangement (GA) to consider hoist arrangement over shaft, including
  - Hoist w hoist foundations (symmetry is optimal)
  - Deflection sheave (to ‘push ropes into the 2nd skip compartment)
  - Hoist power, drive and controls (in tower or on ground)
- Headframe height, minimized
- Finite Element Analysis (FEA) model based on GA to consider
  - Environment loading conditions (wind load, snow load, etc.)
  - Operational conditions – The Hoisting Plant loading
- Prefer 6 legs to allow for redundancy and differential settlement
- Establish loading parameters at the baseplates, required for foundation design
Headframe Foundation Design

What is the first to construct is the last to design

- The site has ground capacities, known from geological testing and report
- There may be a proven foundation type that must be considered
- The foundation design must consider
  - Static loading (Self-weight, Hoist plant, Guide ropes)
  - Transient loading (Live, Wind, Hoisting, Rope breaking)
- FEA w load tables often reveal large uplift component
- Legs that are not vertical require tie beams to manage the horizontal reaction.
- Note – foundation design is more challenging if tie beams are not possible, i.e. there is interferences from
  - Essential buried services,
  - Other foundations
- The foundation design must be updated as the structural loads are confirmed
Now there is a preliminary layout and a foundation system, what is the construction process?

- Perform a Process Hazard Analysis (PHA) to establish
  - Risk to schedule
  - Risk to cost
  - Operational down time
  - Conversion / integration into existing infrastructure
  - Safety – the most important feature

Though the PHA slide is brought into the process later, there are PHA throughout the life of the project, including during the preliminary design phase. This PHA confirms the path forward.
Penthouse Design

The Keys to Success

- Minimize lower support structural member dimensions to minimize wind loading effect
- Penthouse loading distributed
  - Out to trust type walls
  - Down to ring girder
  - Down braced support legs
  - Into baseplates
  - Into foundation system and into ground
- Concrete floors and hoist beams provide ballast during construction
- Construction sequence is essential to determine when
  - Form and pour concrete floors
  - Form and pour hoist beams
  - Install girts
  - Install overhead crane
  - Install other large equipment (deflection sheave, hoist?)
Headframe Modification

The Keys to Success

– Is there an existing surge bin, if so is it sufficient for larger skips? Should have capacity for 5-10 skips
– Physical arresters, design for headframe operating speed or full shaft speed (a large influence on length, \(v^2\))
– Catch gear – this can have significant loading and should be transferred through the penthouse is possible
– Crash steel – this is significant structure to prevent run away skip from damaging hoisting plant above
– Fixed guides, length should be minimized to maintain full shaft speed as long as possible. Note – 12” clearance to all support steel shall be maintained in the rope guided zone
– Access to critical elevations
  • Conveyance installation access
  • Top of skip at dump
  • Arrestor on
  • Catch gear
Shaft Design

The Keys to Success

- Rope guided or fixed guided shaft (depends on risk matrix)
  - Rope guided shaft shall have 12-18” clearance
  - Fixed guided shaft shall have 3-6” clearance
- Larger skips in same sized shaft, clearances to
  - Electrical and control services
  - Piping services
  - Other conveyance (rope guides)
- Larger skips have large lateral loading on rope guides and fixed guides
- Ventilation can influence conveyance movement, can have larger effect on longer conveyances
Shaft Bottom

The Keys to Success

- As with the headframe getting taller, the shaft must get deeper
- Is there a loadout and is it efficient to upgrade to new larger skips? Conveyor loadout vs flask or measuring pocket
- Physical arresters, operating speed (a large influence on length, \( v^2 \))
- Crash steel – this is significant structure to prevent over wound skip from damaging shaft bottom infrastructure
- Fixed guides, length should be minimized to maintain full shaft speed as long as possible. Note – 12” clearance to all support steel shall be maintained in the rope guided zone
- Access to critical elevations
  - Shaft station
  - Conveyance installation access
  - Top of skip at loadout
  - Arrestor on
  - Crash steel
  - Guide rope tensioning
  - Loop dividers
Upgrading Potash Mines

Potash Mining in Saskatchewan

- Saskatchewan accounts for almost half of world potash reserves
- In 2013, 15.8 million tonnes of potash was produced from 10 potash mines in Saskatchewan, including eight conventional underground mines
  - PotashCorp owns and operates five mines (Rocanville, Allan, Lanigan, Cory and Patience Lake).
  - The Mosaic Company owns and operates four mines (Esterhazy K1 and K2, Colonsay and Belle Plaine)
  - Agrium owns and operates one mine (Vanscoy).
- All brownfield potash mines have invested in expansion projects totaling more than $13 billion

Saskatchewan produced a record 18.2 million tonnes of potassium chloride in 2015, with a value of $6.1 billion dollars.
Thank You

Hoisting Upgrade - Challenges and Approach

– Thank you to ABB for the opportunity to present to you today

– Any questions?

*Show and Tell