Lessons Learned on Open Pit and Underground Mine Closure
Insights from Germany

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Content

- **Introduction**
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- **Innovation** – Closurematic: Automated Mine Closure
- **Workshop** of Best Applied Practice in Mine Closure Procedures
  - Underground (Hard Coal)
  - Surface Installations (Coking Plant)
  - Open Pit (Lignite)
- >30 years experience in best practice of hard coal & lignite mine closure in Europe (30 mine closure projects since 1990s (25 hard coal, 5 lignite, incl. 60 shaft fillings).

- Mine closure services in Germany since 2003:
  - Mine *Prosper Haniel* (end 2018, in progress)
  - Mine *Ibbenbüren* (end 2018, in progress)
  - Mine *West* (end 2012)
  - Mine *East* (end 2010)
  - Mine *Lippe* (end 2008)
  - Mine *Walsum* (end 2008)
  - Mine *Lohberg* (end 2005)
Key Mine Closure and Reclamation Themes

- Key mine closure and reclamation themes within the ISO TC 82/SC/7 strategic plan

Abstract

The work program through the International Organization for Standardization (ISO), which aims to develop a series of international standards that will provide requirements and recommendations for mine closure and reclamation management, is now advanced, with two standards at committee draft level. In accordance with ISO timelines, these international standards are targeted for publication in 2020. Twelve countries are actively participating in development of these standards, with a further 11 countries observing. The two standards currently under development include one related to mine closure and reclamation terminology and one related to mine closure and reclamation planning of future or ongoing mines. A strategic plan has also been developed that outlines key themes under which further standards may be developed in the coming years. A new initiative within the work program concerning management and securing of orphan mines is currently under development.

Keywords: International Organization for Standardization, terminology, mine closure planning, standards

Source: Murphy et al. 2019, Australian Center for Geomechanics, Perth
Coal Mine Closure – Relevance in the Mining Project Cycle

International best Practice Regulations

- Mine Closure is highly regulated.
- Mine closure planning & mine site rehabilitation (incl. EIA) are integral parts of mine operation plans worldwide.
- Mining companies are required to set aside contingencies for mine closure & mine site rehabilitation.
## Requirements Mine Closure & Rehabilitation

### Mine Closure
- Technical Closure Concept (Mine Closure Plan)
- Environmental and Social Closure Concept
- Timing
- Closure Financing & Cost Management
- Social Mitigation Plan
- Community Involvement, Public Hearings, Implementation of the Community Development Plan
- Labor Relations

### Mine Site Rehabilitation
- Post-Mining Utilization of the Mining Area
- Environmental Rehabilitation Concept
- Technical Options
- Rehabilitation Planning & After-Care Cost Management
- Returning the Land to the Communities and Community Development
Updated and reported regularly (every semester according to construction status)

3rd party audit every 3 years

Use of historic data vs. market data

Threshold depending on the Life-of-Mine

Social development hand-in-hand with mine closure objectives

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<tr>
<th>COST ESTIMATE ACCURACIES</th>
<th>Initial</th>
<th>-50% to +50%</th>
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<td>Class 0</td>
<td>-25% to +35%</td>
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<tr>
<td>Improved Class 0</td>
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<tr>
<td>Class 1</td>
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<tr>
<td>Class 3</td>
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Coal Mine Closure Criteria

- Residual Risk Reduction
- Closure Criteria Identification, based on Risk & Outcome
  - Reshaping of waste rock dumps
  - Mine Water Treatment & Management
  - Surface (subsidence) and Topsoil Management
- Cost Reduction and Asset Optimization
  - Financial Perspective
  - Closure perspective – liability
  - Integrated approach – tailings
- Management and Perceptions
  - Open Pit and Housing
  - Operational Monitoring
- Reputational Risk and Licence to Operate
Some important items to be considered:

- 5 Mio population (1.138/km²)
- 1950s: 143 mines, ~1 Mio employees in coal & steel industry
- SAT monitoring of surface level changes (subsidence during mining vs. mine water rise).
- Saline mine water rise towards ground(fresh)water reservoir.
  - Prospective mine flooding models: -600m vs -380m mine water rise.
- Pilot actions of geothermal use of 20-25°C mine water, underground pumped storage facilities in mine infrastructure.
International Applications of Mine Water Model

- Ruhr area since 2002
- Southern France, 2004
- Lothringen coal basin, 2004
- Saarland since 2003
- Durham coalfield since 2006
- Oviedo, 2008
- South Africa: Ermelo, Hartogshof and East-Rand
- Ronneburger mining area since 1992 2005: density effects
- 2005: Oelsnitz
- 2006: Upper Silesia
- 6 models in Pb/Zn-mines
Management Tool for Continuous Mine Closure

CLOSUREMATIC

Product
- Automated planning and management of mine closure.
- Systematic standardized administration and sustainable environmental management of mine closure.
- Templates for EU-compliant documentation for mine closure incl. costs and risks (add-on).

Result
- Effective mine closure process according to EU technical and environmental standards.
- Social, economical and ecological sustainability of mining.

Source: Kauppila et al. 2019
Thank you for your attention

Questions & Comments ?
1) Colectar y discutir los aspectos relevantes para la preparacion de un plan de cierre considerando las siguientes operaciones:

- Mina a tajo abierto
- Mina subterranea
- Planta de tratamiento de minerales

2) Se tiene una pasivo minero (antigua presa de relave), esta fue construido con el sistema aguas arriba. La composicion del relave viene del tratamiento de una mina de oro. La presa esta rodeada de laderas. A 500 metros aguas abajo de la presa existe un rio y tambien vive gente en los alrededores. La presa se encuentra a 4000 msnm.

- Identificar los posibles parametros que deberian tomarse en cuenta para asegurar la estabilidad de la presa.
- Identificar las entidades estatales que estan de alguna manera realicionadas con la seguridad de la presa de relave.
- Elabore un plan para asegurar la presa.
Closure Operating Plan – UG Hard Coal Mines

Surface restoration and remediation of operational areas of hard coal mining areas

Detailed Description of Planned Closure Activities (Abschlussbetriebsplan appr. by Bezirksregierung Arnsberg, NRW)

- Description of UG mine operational facilities and components to be decommissioned
  - UG mine to be shut down
  - Company chronicle (according to §53 Abs.2 BBergG)

- Details on intended final operations
  - Removal of mechanical equipment, lubricants, and other operating materials
  - Sealing and backfilling work (drifts, shafts)
  - Time schedule for closure operations
  - Occupational health & safety protection during final work
  - Ventilation during final works & the closure operations, incl. ventilation sites
  - Pit structure mapping and planned sealing of drift segments
  - Waste disposal plan

- Effects on mine water
  - Time of setting the dewatering systems
  - Simulation of mine water rise scenarios

- Surface protection above mine areas
  - Securing the structural integrity of surface area above mines
  - Protection against uncontrolled gas leaks at the surface (e.g. by mine gas extraction for energy generation)
  - Simulation of mine water level rise on the surface

Source: www.ruhr-tourismus.de, accessed 24/9/2019
Closure Operating Plan – Coking Plants (and other surface facilities)

Remediation of operational areas of surface installations

Detailed Description of Planned Closure Activities (Abschlussbetriebsplan appr. by Bezirksregierung Arnsberg, NRW)

- **Description of Surface Facilities to be Closed**
  - Operational facilities and installations to be decommissioned
  - Operating history (according to §53 Abs.2 BBergG) incl. references to potentially contaminated sites
  - Planned use of plant site after decommissioning
  - Time schedule for closure operations

- **Buildings and Installations intended for Alternative Use or Disposal**
  - Buildings and facilities intended for further use incl. remaining supply and disposal lines
  - Buildings and facilities intended for disposal, incl. descriptions of foundations remaining in the ground (e.g. cable canals, bunkers …)

- **Hazard assessment**
  - Documentation of historic use (e.g. construction plans, air photographs)
  - Documentation of geological and hydrological settings
  - Investigation of groundwater, soil, soil air, and building substance for potential contamination

- **Decontamination or safety measures based on hazard assessment for future use**
- **Design of business site premises with regard to planned future use**
- **Disposal of waste resulting from closure works**
- **Occupational health & safety protection during closure measures, incl. securing site against unauthorized access**

Closure Operating Plan – Lignite

Surface restoration and remediation of operational areas of lignite mining areas

Detailed Description of Planned Closure Activities (Abschlussbetriebsplan appr. by Bezirksregierung Arnsberg, NRW)

- General information
  - Planning documents, spatial and state (lignite) planning, legal requirements
  - Operational planning & Opencast mining development
  - Timetable for closure actions
  - Balancing of soil material required for reuse

- Structuring of landscape, surface design and types of reuse
  - Landscape design, surface waters, and catchment areas prior to mining use
  - Agricultural & forest rehabilitation, landscape-structuring elements & wetlands
  - Redevelopment of road infrastructure
  - Area balance according to types of reuse & requirements from the lignite plan
  - Future groundwater level in the former mining area

- Implementation planning & specifications for implementation
  - Condition & treatment of raw dumps for reuse
  - Agricultural rehabilitation & development of agricultural land
  - Measures to avoid harmful soil changes
  - Measures to improve reuse profitability & soil improvement (melioration)
  - Reforestation, development of new forest, forest management

- Occupational health & safety documentation (appointment of responsible personnel)

- Documentation of reuse statistics, loess balances, aerial photographs, etc.