Best management practices in the use of cyanide in Artisanal and Small-scale Gold Mining

Online webinar, 25 January 2022
Agenda

Opening remarks and scene-setting
  ❖ Susan Keane, Co-lead of the ASGM Partnership Area, Natural Resources Defense Council (NRDC)
  ❖ Richard Gutierrez, Secretariat of the Minamata Convention

Presentations
  ❖ The International Management Code and its Implications for ASGM, by Eric Schwamberger, International Cyanide Management Institute
  ❖ Best Management Practices for the Use of Cyanide in ASGM, by Daniel Stapper, PACT
  ❖ Best Practices and Recommendations for Management of ASGM tailings, by Malgorzata Stylo, UNEP
  ❖ Questions and Answers Session

Closure
  ❖ Kenneth Davis, UNEP
The International Cyanide Management Code and Safe Cyanide Management in the ASGM Sector

Dr. Eric C. Schwamberger
Senior Vice President
International Cyanide Management Institute

January 25, 2022
Cyanide Code Overview

• Performance driven, voluntary program of best practice for the use and management of cyanide at gold and silver mines
• Recognized as the global benchmark for cyanide management
• Provides step-by-step guidance on how to achieve safer management of cyanide
• Covers use cycle of cyanide: production, transport, handling, use, recycling and disposal at mine site
• Participating operations are periodically audited to determine certification, and summary reports are available online
Cyanide Code Objectives

- To protect workers, communities and the environment from the adverse effects of cyanide exposure
- To improve management and reduce risk over entire cyanide supply chain: producers – transporters – mining operations
- To be used by large and small gold mining operations, in both developed and developing countries
- To serve as a credible form of assurance for stakeholders
Example Requirements

- Proper Personal Protective Equipment
- Signage and labelling
- Use of dyed cyanide
- First Aid equipment
- pH controls
- Secure, ventilated storage
- Secondary containments
- Training
- Routine inspections
Example Requirements

Plans and procedures for:
• Cyanide mixing
• Cyanide addition
• Emergency response
• Spill control
• Leaching
• Tailings management
Best Management Practices for Cyanide Use in the Small-Scale Gold Mining Sector

Daniel Stapper, Pact
In collaboration with:
Pact Mines to Markets

https://www.pactworld.org/our-expertise/mining
Background

- Minamata Convention in force
- Major focus on mercury-free mineral processing
- Since ~100 years ago, “cyanidation” produces majority of newly mined gold, by the global mining sector
- With pressure to eliminate/avoid Hg amalgamation, ASGM actors and investors are seeking alternatives
- CN also enables small miners to profit from lower grade gold deposits
- Therefore (obviously) safe use of CN thus warrants special attention in the drive to eliminate mercury amalgamation
Document Scope

- Overview of CN practices used in ASGM
- Guidance on minimum requirements for safe and responsible use of CN in SSM

*The guidance document does not provide:*

- Comprehensive review of technical aspects concerning cyanidation
- Technical specifications (chemical and physical operating parameters; specific protocols or controls)
Document Organization

- **Section 1**: Introduction and Important Considerations
- **Section 2**: Technical Overview of Cyanidation
- **Section 3**: Best Practices for CN Management, with reference to the nine Principles of the ICMC.
- **Section 4**: Conclusion, including risk register tools to analyze and monitor risks and develop risk-mitigation efforts.

Two national case studies are included, from Ecuador and Zimbabwe, to help readers understand typical conditions in the ASGM sector, to contextualize common challenges associated with cyanide management in ASGM.
Section 1: Introduction & Important Considerations

Using cyanidation of **mercury-contaminated ASGM tailings** constitutes a “worst-practice” as defined in the Minamata Convention.

- CN operators should not use cyanide on Hg-contaminated tailings without a clear plan for measuring and removing/addressing the Hg.
- This document should not be construed or interpreted as “advocating” for the adoption of cyanidation.
- The document encourages research into non-toxic / less-toxic alternatives to CN.
Section 2: Technical Overview of CN Leaching in the ASGM Sector

1. **Mining (extracting ore)**
   - Milled ore is submersed in CN solution (cyanide can dissolve in water), which we call ‘leaching’. In the CN leach, gold from the ore is dissolved into the solution as gold-cyanide compounds.

2. **Ore Characterization**
   - Gold is then recovered from the pregnant leach solution (PLS) by various methods. Most often this is accomplished by: (i) depositing gold-cyanide compounds onto activated carbon (AC); (ii) rinsing the AC to produce a concentrated gold solution (elution); and (iii) producing a precious metal precipitate, which is most often done using electro-deposition (electro-winning).

3. **Ore Preparation**
   - The precious metal precipitate (residue) is digested in acid to remove unwanted metals (especially copper and silver), leaving only gold. Finally, the gold residue is smelted at very high temperature to produce a solid ingot of gold, also called a doré.

4. **CN Leaching**

5. **Recovery of gold**

6. **Gold is smelted into doré**
Section 2 includes discussion of:

- Ore Characterization
- Ore Preparation
- Difference between heap, vat, & agitated (tank) leaching
- How Activated Carbon (AC) & Zinc are used for elution
- Smelting of gold doré
- Managing Cyanide Effluent
Section 3: Best Practices for CN Management

<table>
<thead>
<tr>
<th>9 Principles of the International Cyanide Management Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle 1: Production and Purchasing</td>
</tr>
<tr>
<td>Principle 2: Transport</td>
</tr>
<tr>
<td>Principle 3: Handling and Storage</td>
</tr>
<tr>
<td>Principle 4: Operations</td>
</tr>
<tr>
<td>Principle 5: Decommissioning</td>
</tr>
<tr>
<td>Principle 6: Worker Safety</td>
</tr>
<tr>
<td>Principle 7: Emergency Response</td>
</tr>
<tr>
<td>Principle 8: Training</td>
</tr>
<tr>
<td>Principle 9: Dialogue and Disclosure</td>
</tr>
</tbody>
</table>
ICMC Principle 4: CN Operations

Principle 4: Operations - Manage cyanide process solutions and waste streams to protect human health and the environment

*Principle 4 of the Code presents nine operational standards of practice which are critical to ensure responsible CN use on active mineral processing plants or mine sites (...)*

4.1 Implement management and operating systems designed to protect human health and the environment including contingency planning and inspection and preventive maintenance procedures.
4.2 Introduce management and operating systems to minimize cyanide use, thereby limiting concentrations of cyanide in mill tailings.
4.3 Implement a comprehensive water management program to protect against unintentional releases.

(...
Establishment of standard operating procedures (SOPs)

i. Operating plans and SOPs should address activities such as inspections and maintenance, water and effluent management, spill prevention and response, and environmental protection and monitoring.

ii. Operating plans and SOPs should be specific to the facilities and CN processes at an operation, practical, and written at a level to facilitate understanding & implementation by the workers who will use them.

iii. Operating plans & SOPs should provide clarity concerning responsibilities of personnel. Workers should be trained to the plans and procedures prior to the worker beginning the activities described.

iv. (…)
Section 4: Summary and Risk Registry Tool

- Summary of Stakeholder Responsibilities
- ‘Risk register’ for ASGM cyanidation operator/processing site
- ‘Control hierarchy’ for evaluating risk control and mitigation

Table 2. Risk register for ASGM cyanidation operator/processing site

<table>
<thead>
<tr>
<th>Risk</th>
<th>Severity of Risk</th>
<th>Mitigation Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Manufacturing and Sourcing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CN was not produced by a Code-certified producer and lacks MSDSs.</td>
<td>High</td>
<td>Mine operators should implement a policy to only purchase from Code-certified or, at a minimum, registered CN suppliers.</td>
</tr>
<tr>
<td><strong>Transport</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport vehicles carrying sodium cyanide from supplier are poorly regulated and drivers are unaware of the risks hazardous</td>
<td>High</td>
<td>Invest in secure truck transport with dedicated driver, purchase from responsible, Code-certified CN suppliers with proper labelling of containers, certificates of origin, and responsible transport tendering.</td>
</tr>
</tbody>
</table>
Thank you.
Best practices and recommendations for management of ASGM tailings

Malgorzata Stylo, UNEP
TAILINGS

The waste material left over after a portion of the valuable components have been removed from the ore (dependant of the processing technology).

Due to inefficiencies in ore processing, some ASGM tailings contain significant amounts of unrecovered gold.

Cyanide leaching of tailings to which mercury has been added without first removing the mercury is one of the worst practices as defined by Annex C of the Minamata Convention.

It leads to generation of mercury-cyanide complexes that are highly mobile in the environment and bioavailable.
### ASGM Worst Practices

<table>
<thead>
<tr>
<th>Country</th>
<th>Open pit mining</th>
<th>Dynamite and mercury</th>
<th>Burning in residential areas</th>
<th>Whole ore mismanagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burundi</td>
<td>●</td>
<td></td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Cameroon</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Democratic Republic of Congo</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Eritrea</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Guinea</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Namibia</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Laos</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Malaysia</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Mali</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Mongolia</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Niger</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Somalia</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Uganda</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

**Legend:**
- ●: Worst practice reported
- ●: No information in NAP
- ●: Worst practice not present

**NAP Status:**
- In progress
- Submitted

---

**Map:** World map showing the status of NAPs in various countries.
The Third Conference of the Parties of the Minamata Convention requested the Secretariat, in cooperation with the Global Mercury Partnership, to improve the guidance on the preparation of national action plans for ASGM regarding management of tailings from such mining.

Updates to NAP guidance document submitted for COP 4 consideration (COP.4/6)

To further guide the Parties in their efforts to soundly manage ASGM tailings, UNEP in collaboration with the Minamata Secretariat and Global Mercury Partnership developed a complementary technical document, highlighting best practices for ASGM tailings management (COP.4/INF/6).

Best practices and recommendations for management of ASGM tailings

- Basics of Tailings Management
- Mercury and Gold Recovery from Tailings
- Disposal, Ecological Restoration and Monitoring of Mercury Containing Tailings
- Legal Aspects and Governance
- Providing Information and Engaging Communities
The best way to manage mercury-containing tailings is **not to generate them in the first place**.

**Understand** the local political, socio-economic, and environmental **context**.

- Keep mercury-contaminated tailings separate.
- Measure mercury content and perform additional chemical and mineralogical characterization of tailings.
Never apply cyanide to mercury-contaminated tailings.

Ensure safe disposal of the recovered mercury.

Prior to reprocessing of mercury-contaminated tailings, mercury must first be removed.

Cyanide should only be used by organized and trained miners that can comply with chemical management.
DISPOSAL OF MERCURY CONTAINING TAILINGS

- Use **impermeable lining** systems or concrete and cover tailings.
- Do **not use mercury contaminated material** to construct tailings structures.
- Mark and fence the tailings' structures.
- Ensure tailings structures are constructed **away from human settlements**, grazing and farming areas, rivers and outside flood areas.
- Do **not to dump the tailings** that contain mercury back into streams or in flood-prone areas.
- Ensure **safe transport** of tailings.
ECOLOGICAL RESTORATION OF MERCURY CONTAINING TAILINGS

- Restore the surface grading and **revegetate** the land to reduce erosion
- **Consult Art 12 of the Minamata Convention** if the land is **contaminated** with mercury
- Engage ASGM communities in the restoration plans
- Organize **educational sessions** focused on the benefits of restoration and future restored land use possibilities
MONITORING OF MERCURY CONTAINING TAILINGS

Consider using remote sensing to identify and track progress of the existing tailings.

Consider using geospatial tools, e.g. GIS, to keep track of the locations and characteristics of mercury containing tailings.

Consider periodic sampling and characterization of the tailings to monitor changes.
LEGAL ASPECTS AND GOVERNANCE

Ensure **miners participation** and build interventions on the formalization efforts.

Review legal and regulatory frameworks to identify gaps and propose improvements in respect to tailings management.

Allocate **financial mechanisms and responsibilities** to ensure the sound management of tailings.
PROVIDING INFORMATION AND ENGAGING COMMUNITIES

Inform the community about the presence of mercury-contaminates tailings and the associated risk.

Design and conduct educational programs.

Disseminate information about mercury pollution and mitigation programs in affected communities.

Ensure the engagement of indigenous populations.
Tailings

Separate safe storage
- Mercury free tailings
- Tailings containing mercury*

Contain economically viable concentrations of gold

Contains mercury?
- Yes: Treatment (Mercury recovery)
- No: Reprocessing

YES: Treatment (Mercury recovery)
- Sound mercury disposal or recycling
- Gold recovery

NO: Reprocessing
- Final disposal and reclamation

*If tailings contain mercury, separate storage is required.
SOUND TAILINGS MANAGEMENT IN ARTISANAL AND SMALL-SCALE GOLD MINING
Technical Document

Available at:

Contact: malgorzata.stylo@un.org