ICS 73.060
D 40
B 09

DZ

Industry Standard of the People's Republic of China for Geological and Mineral Resource

DZ/T 0320—2018

Green Mine Construction Standards of Non-Ferrous Metal Industry

Issued on June 22, 2018 Implemented on October 1, 2018

Issued by the Ministry of Natural Resources of the People's Republic of China

CONTENTS

Foreword

This standard have been drafted in accordance with the rules specified in *GB/T 1.1-2009* the *Directives for Standardization — Part 1: Structure and Drafting of Standards*.

This standard was proposed by the Ministry of Natural Resources of the People's Republic of China.

This Standard falls under the purview of the National Technical Committee on Land and Resources Standardization (*SAC/TC 93*).

Drafting organizations include:

China Non-ferrous Metals Industry Association, Chinese Academy of Geological Sciences, Changsha Engineering and Research Institute of Nonferrous Metallurgy, Beijing General Research Institute of Mining & Metallurgy, Zhengzhou Institute of Multipurpose Utilization of Mineral Resources, Chinese Academy of Geological Sciences

Main drafters: Nan Zhang, Shaofu Duan, Fanglai Liu, Jianshuang Chen, Fuchun Liu, Jun Ma, Tao Peng, Dengding Wu, Meiying Hao, Kelei Chu, Bin Yu, Jianjun Hu, Quanmin Liu, Jincheng Cao, Min Guo, Peng Wu.

Green Mine Construction Standards of Non-Ferrous Metal Industry

1 Scope

This standard specifies the basic requirements for green mine construction in the nonferrous metals industry, covering mining area environment, resource development methods, comprehensive resource utilization, energy conservation and emission reduction, technological innovation and digital mines, as well as corporate management and image.

This standard is applicable to the construction of green mines for new, renovated/expanded, and existing mines in the non-ferrous metal industry (including mines of copper, bauxite, lead-zinc, tungsten, molybdenum, antimony, tin, nickel, magnesium, etc.).

2 Normative References

The following documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition (including all amendments) applies.

GB/T 13306 Plates and Signs
GB 50187 Code for Design of General Layout of Industrial Enterprises
GB 50771 Code for Design of Non-ferrous Metal Mining
GB 50782 Code for Process Design of Non-ferrous Metal Processing Plants
TD/T 1036 Quality Control Standards for Land Reclamation

3 Terms and Definitions

The following terms and definitions apply to this document.

3.1 Green Mine

A mine where scientific and orderly mining is implemented throughout the entire process of mineral resource development. Disturbance to the ecological environment of the mining area and its surroundings is kept within a controllable range. It achieves an ecological mining environment, scientific mining methods, efficient resource utilization, standardized corporate management, and harmonious mining communities.

3.2 Green Coverage Ratio of the Mining Area

The percentage of the re-vegetated land area relative to the total area suitable for greening within the mining district.

3.3 Input of Research and Development and Technical Innovation

The financial investment by an enterprise for R&D and technical innovation activities, including scientific research and development, introduction of technology and intellectual property, technical innovation, transformation and promotion, equipment upgrades, as well as technical training, information exchange and scientific collaboration etc.

4 General Principles

4.1 Mining enterprises are required to conduct their operations in full compliance with national laws, regulations, and relevant industrial policies.

4.2 Mining enterprises shall implement the development philosophy of innovation, coordination, green, openness, and shared benefits. Following the principle of "adapting to local conditions," they shall achieve overall planning and comprehensive development of resource utilization, energy conservation, emission reduction, environmental protection, land reclamation, corporate culture, and enterprise-locality harmony.

4.3 Mining enterprises shall be people-oriented and protect the health of employees.

4.4 Green mine construction shall be integrated into the entire process of planning, design, construction, and operation. New and renovated/expanded mines shall be built according to this standard; existing production mines shall be upgraded according to this standard.

5 Mining Area Environment

5.1 Basic Requirements

5.1.1 The layout of functional zones shall be rational. The mining area shall be greened and beautified to maintain a clean and aesthetic overall environment.

5.1.2 Site selection shall be rational. Waste dump sites shall be selected on grounds with low permeability.

5.1.3 Management of production, transportation and storage shall be standardized and orderly.

5.2 Mine Appearance and Condition

5.2.1 The mining area is divided into functional zones such as production, management, living, and ecological zones. Each zone should comply with *GB 50187*, operating orderly under standardized management.

5.2.2 Supporting facilities for ground transportation, water supply, power supply, sanitation, and environmental protection shall be complete. Signs such as operation prompts, instructions, and route diagrams should be set up in production areas, complying with *GB/T 13306*.

5.2.3 Dust prevention and cleaning measures shall be taken during production, transportation, and storage. Dust-generating points such as ore bins, crushers, vibrating screens, and belt conveyor loading/unloading points are recommended to be fully sealed or equipped with mechanical dust removal, spray dedusting, or bio-nanofilm dust suppression. Roads, working faces, and waste dumps shall use water sprinkling or spray for dust suppression.

5.2.4 Domestic sewage and production wastewater shall be collected and treated separately, with a 100% compliance rate for discharge.

5.2.5 Rational and effective technical measures shall be adopted for noise reduction of high-noise equipment.

5.3 Greening of Mining Area

5.3.1 Greening shall be coordinated with the surrounding natural environment and landscape. Plant varieties shall be reasonably combined, and the green coverage ratio of the mining area shall reach 100%.

5.3.2 Isolated green belts shall be established on both sides of dedicated mining roads according to local conditions.

6 Resource Development Methods

6.1 Basic Requirements

6.1.1 Resource development shall be coordinated with environmental protection, resource conservation, and urban-rural construction to minimize disturbance to the natural environment. Resource-saving and environment-friendly development methods shall be selected.

6.1.2 Based on the principle of "insisting on protection and rational development," mining sequences and methods shall be chosen according to resource occurrence, geological conditions, and ecological features. Priority shall be given to technologies and equipment with high resource utilization and low ecological damage.

6.1.3 While mining major minerals, associated (symbiotic and paragenetic) minerals with industrial value shall be subject to unified planning, integrated mining, and comprehensive utilization to prevent waste. Protective measures shall be taken for minerals that cannot be integrated for mining or utilized temporarily.

6.1.4 The principle of "simultaneous mining, control, and restoration" shall be implemented. The geological environment shall be restored timely manner, and the land occupied or damaged by mining shall be reclaimed.

6.2 Green Development

6.2.1 Mining production shall focus on efficient development and recycling. The environmental disturbance shall be minimized and ecological reconstruction shall be optimized during mining, processing, and metallurgical processes through technical innovation and process optimization.

6.2.2 Mining Process Requirements:

Open-pit mining is recommended to adopt the integrated technology of stripping-dumping-land creation-reclamation. Underground mining is recommended to adopt backfilling mining technologies that mitigate surface subsidence. Oxidized ores is recommended to adopt integrated technologies of mining-processing-metallurgy development, or technologies that extract metals directly from the deposit.

6.2.3 Mineral Process Requirements:

a) Processing processes and production output plan shall be formulated based on sufficient mineral processing tests to ensure full utilization of primary and associated elements.

b) For complex and refractory ores, innovative technologies is recommended to reduce energy consumption and improve technical-economic indicators, or integrated processing-metallurgical processes should be adopted.

c) Environmentally friendly and efficient processing reagents is recommended. Plants generating harmful gases shall have ventilation facilities; cyanide reagent rooms must be isolated and fully sealed.

6.3 Technology and Equipment

6.3.1 Underground mining should use high-efficiency mining methods and high-concentration or paste backfill technology to achieve trackless mechanized mining.

6.3.2 Open-pit mines should prioritize mechanized equipment with high automation for stripping, mining, transportation, and dumping.

6.3.3 The concentrator should use large-scale, high-efficiency, and energy-saving equipment.

6.4 Indicator Requirements

Mining recovery rates and processing recovery rates for copper, aluminum, lead, zinc, tungsten, molybdenum, tin, antimony, and nickel shall meet the requirements in Appendix A. Mineral processing recovery rate can be adjusted based on actual conditions for lead-zinc ore with complex disseminated characteristics which is extremely difficult to separate monomer. Other non-ferrous mines shall comply with the relevant national minimum requirements for the "Three Rates" (Recovery Rate of Mining, Recovery Rate of Processing, and Comprehensive Utilization Rate).

6.5 Ecological and Environmental Protection

6.5.1 Strictly implement the requirements of the mining geological environmental protection and land reclamation plan:

a) Ecological protection and restoration of waste dumps, open pits, dedicated roads, and industrial sites shall comply with relevant regulations.

b) Land reclamation quality should comply with *TD/T 1036*.

c) The rehabilitated sites shall harmonize with the surrounding natural environment and landscape. Essential land functions shall be restored to achieve sustainable land use tailored to local conditions. The overall ecological integrity of the region shall be conserved and restored.

d) The extent of mine geological environment rehabilitation and the land reclamation shall comply with the requirements of the Mine Geological Environmental Protection and Land Reclamation Plan.

6.5.2 Establish an environmental monitoring system and assign full-time staff for management and monitoring.

7 Comprehensive Resource Utilization

7.1 Basic Requirements

Comprehensive development of associated resources following the principles of "reduction, reuse, and recycling" to scientifically utilize solid waste and wastewater to develop a circular economy.

7.2 Utilization of Associated Resources

7.2.1 Comprehensive exploration, evaluation, and development of associated resources shall be conducted national regulations.

7.2.2 Advanced and economically rational technologies shall be used to maximize the recovery of molybdenum/gold in copper mines, tungsten in molybdenum mines, silver/antimony in lead-zinc mines, gallium in bauxite, lithium in tantalum-niobium mines, and low-grade polymetallic ores. The utilization rate shall meet the national "Three Rates" minimum requirements.

7.2.3 For new, expanded, and upgraded mines, the utilization project for associated and co-existing mineral resources shall be designed, constructed, and put into operation simultaneously with the mining, processing, and metallurgical facilities of the principal mineral. If not possible, conditions for future exploitation must be reserved.

7.3 Solid Waste Treatment and Utilization

7.3.1 Storage of waste rock and other solid waste shall comply with relevant regulations.

7.3.2 Enterprises should recover useful components from waste rock and tailings (e.g., rare and scattered metals) and utilize them for backfilling, road construction, or building materials.

7.4 Wastewater and Waste Gas Treatment and Utilization

7.4.1 Use advanced water-saving technologies and build standardized drainage systems and necessary treatment facilities.

7.4.2 Use cleaning and recycling technologies to handle mine water and processing wastewater.

7.4.3 Mine water should be fully utilized; processing wastewater shall be recycled and reused.

7.4.4 Waste gas purification devices shall be installed to ensure emissions meet standards.

8 Energy Conservation and Emission Reduction

8.1 Basic Requirements

Establish an energy consumption accounting system for the entire mine production process. Control and reduce energy, material, and water consumption per unit of product. "Three wastes" (waste gas, wastewater, and solid residue) discharge shall comply with the relevant standards, regulations, and requirements of the environmental protection authorities.

8.2 Requirements of Mining Energy Consumption

Mining methods shall be determined by evaluating resources, energy, economy and environment to reduce consumption. New energy-saving technologies, methods and equipment should be adopted.

8.3 Requirements of Processing Energy Consumption

Follow the principle of "more crushing and less grinding, early recovery of minerals". Advanced technologies shall be adopted to implement automated monitoring and control throughout the mineral processing production process, ensuring that equipment operates under optimal conditions, maximizing equipment efficiency, and achieving the goal of energy conservation and consumption reduction.

8.4 Wastewater Discharge

8.4.1 Establish a wastewater treatment system to achieve the separation of rainwater from sewage and the separation of clean water from polluted water.

8.4.2 Rainwater interception/drainage ditches shall be built for waste dumps. Leaching water shall be reused after treatment or discharged after reaching standards.

8.5 Solid Waste Discharge

8.5.1 Optimize mining and processing techniques to comprehensively utilize solid waste.

8.5.2 Solid waste should be used as backfill, building materials, or for secondary utilization.

8.5.3 Topsoil stripped from open-pit mines shall be stored separately for future reclamation.

9 Technological Innovation and Digital Mine

9.1 Basic Requirements

9.1.1 Establish an R&D team, promote the transformation of scientific achievements, and increase technical transformation to drive green industrial upgrading.

9.1.2 Build digital mines to achieve Digitalization and intelligence in production, operation, and management of mining enterprises.

9.2 Technological Innovation

9.2.1 Establish a tech-innovation system that is enterprise-led, market-oriented, and combines "industry-university-research-application.

9.2.2 Equip specialized staff to research key technologies for efficient development and comprehensive resource utilization to improve process and upgrade technology。.

9.2.3 R&D and technical innovation investment shall be no less than 1.5% of the previous year's main business revenue.

9.3 Digital Mine

9.3.1 Build mine production automation systems.

9.3.2 A digital resource reserve model should be established for dynamic management and economic evaluation of mineral reserves to achieve high-precision management and effective utilization of mineral resource reserves.

9.3.3 Establish a production monitoring system to ensure efficient and orderly operations.

9.3.4 Promote "replacing and reducing staff with machines via automation" to achieve mechanized mining and automated processing/metallurgy.

9.3.5 Use computer and intelligent control technologies to build intelligent mines, achieving deep integration of Digitalization and industrialization.

10 Corporate Management and Corporate Image

10.1 Basic Requirements

10.1.1 Establish corporate management systems for property rights, responsibilities, management, and culture.

10.1.2 Establish a green mine management system.

10.2 Corporate Culture

10.2.1 Build a corporate culture centered on people, innovation, standardized behavior, efficiency, safety, ecological civilization, and green development.

10.2.2 The corporate vision shall align with employees' common goals, integrating long-term strategy and individual value realization.

10.2.3 Improve the labor union to enrich employees' material, sports, and cultural lives. Employee satisfaction shall be no less than 70%.

10.2.4 It is recommended to institute a mechanism ensuring that employee remuneration rises in tandem with the enterprise's financial results.

10.3 Corporate Management

10.3.1 Establish rules for resource management and ecological protection, with clear responsibilities.

10.3.2 All reports, ledgers, and archives shall be complete, accurate, and authentic.

10.3.3 Organize regular green mine training for management and technical staff. Establish a clear employee training system and records.

10.4 Corporate Integrity

Adhere to honesty and trustworthiness in production and social responsibility. Fulfill the obligation to publicize information regarding exploration and mining activities as a mining right holder.

10.5 Enterprise-Locality Harmony

10.5.1 Build a mining philosophy of "joint construction, benefit sharing, and common development." Establish community development platforms and long-term cooperation mechanisms to create synergy from multiple resources and advantages. Establish a diversified and collaborative win-win model for social management in mining areas.

10.5.2 Establish a satisfaction survey mechanism for local residents. Support education, employment, transportation, and environmental protection to improve local quality of life and promote harmonious development between enterprises and local communities.

10.5.3 Establish consultation mechanisms with local townships, villages, and communities to promptly and properly handle interest disputes.

Appendix A

（Normative Annex）

Reference Values for Mining Recovery Rate and Mineral Processing Recovery Rate of Selected Metals

Annex A.1: The requirements for copper mining recovery rate and mineral processing recovery rate are specified in Table A.1 and Table A.2.

Table A.1 Requirements for Copper Mining Recovery Rate

Open-pit Mining			
Large-scale mines			95%
Medium/small-scale mines, or mines with large variation in orebody shape, thin orebodies, or poor rock mass stability			92%
Underground Mining			
Orebody Thickness	Co Eq. Grade ≥1.2%	Co Eq. Grade 0.60%～1.2%	Co Eq. Grade ≤0.60%
≤5m	88%	80%	75%
5～15m	92%	83%	80%
≥15m	92%	85%	85%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Copper Resources (Trial)*.			

Table A.2 Requirements for Copper Processing Recovery Rate Indicators Unit: %

Unit：%

Ore Type	Structure & Texture Type	Grade and Grain Size			Grade and Grain Size			Grade and Grain Size			Grade and Grain Size		
		Sulfide ore with copper grade≥1 Mixed ore with copper grade≥1.5 Oxide ore with copper grade≥3			0.6≤Sulfide ore with copper grade＜1 1≤Mixed ore with copper grade＜1.5 1.5≤Oxide ore with copper grade＜3			0.4≤Sulfide ore with copper grade＜0.6 0.6≤Mixed ore with copper grade＜1 1≤Oxide ore with copper grade＜1.5			Sulfide ore with copper grade<0.4 Mixed ore with copper grade<0.6 Oxide ore with copper grade<1		
		Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained
Sulfide Ore	Massive/Granular Texture	90.0	87.5	86.0	88.5	86.0	84.0	86.5	84.0	82.0	83.0	80.5	79.0
	Banded Structure	89.5	86.5	85.0	87.5	85.0	83.0	86.0	83.0	81.5	82.0	80.0	78.0
	Stratabound/ Net-veined	87.5	85.0	83.0	86.0	83.0	81.5	84.0	81.5	80.0	80.5	78.0	76.5
	Disseminated /Metasomatic	86.5	84.0	82.0	85.0	82.5	80.5	83.0	80.5	79.0	79.5	77.5	76.0
Mixed Ore	Massive/Granular Texture	87.0	84.5	83.0	85.5	83.0	81.0	83.5	81.0	79.5	80.0	77.5	76.0

	Banded Structure	86.0	83.5	82.0	84.5	82.0	80.0	83.0	80.0	78.5	79.0	77.0	75.5
	Stratabound/ Net-veined	84.5	82.0	80.0	83.0	80.0	78.5	81.0	78.5	77.0	77.5	75.5	74.0
	Disseminated /Metasomatic	83.5	81.0	80.0	82.0	79.5	77.9	80.0	77.9	76.0	77.0	74.5	73.0
Oxide Ore	Massive/Granular Texture	78.5	76.0	74.5	77.0	74.5	73.0	75.0	73.0	71.5	72.0	70.0	68.5
	Banded Structure	77.5	75.0	74.0	76.0	74.0	72.0	74.5	72.0	71.0	71.5	69.0	68.0
	Stratabound/ Net-veined	76.0	74.0	72.0	74.5	72.0	71.0	73.0	70.8	69.5	70.0	68.0	66.5
	Disseminated /Metasomatic	75.0	73.0	71.5	74.0	71.5	70.0	72.0	70.0	68.5	69.0	67.0	66.0
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Copper Resources (Trial).*													

Annex A.2: Requirements for Mining Recovery Rate and Mineral Processing Recovery Rate of Lead and Zinc Mines are shown in Tables A.3 to A.5.

Table A.3 Requirements for Lead-Zinc Mining Recovery Rate Indicators

Open-pit Mining									
Large-scale mines				95%					
Medium/small-scale mines, or mines with large variation in orebody shape, thin orebodies, or poor rock mass stability				92%					
Underground Mining									
Orebody Thickness	Pb+Zn Eq. Grade (Sulfide)			Pb+Zn Eq. Grade (Sulfide)			Pb+Zn Eq. Grade (Sulfide)		
	≥9.0%	4.5%～9.0%	≤4.5%	≥11.5%	6.0%～11.5%	≤6.0%	≥14.0%	7.5%～14.0%	≤7.5%
≤5m	88%	80%	75%	88%	80%	75%	88%	80%	75%
5～15m	92%	83%	80%	92%	83%	80%	92%	83%	80%
≥15m	92%	85%	85%	92%	85%	85%	92%	85%	85%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Lead-Zinc Resources (Trial)*.									

Table A.4 Requirements for Lead Processing Recovery Rate Indicators

Unit：%

Ore Type	Structure & Texture Type	Grade and Grain Size			Grade and Grain Size			Grade and Grain Size			Grade and Grain Size		
		Sulfide ore with copper grade≥3 Mixed ore with copper grade≥3.6 Oxide ore with copper grade≥5			1.5≤Sulfide ore with copper grade＜3 2.5≤Mixed ore with copper grade＜3.6 3≤Oxide ore with copper grade ＜5			0.5≤Sulfide ore with copper grade＜1.5 1.0≤Mixed ore with copper grade＜2.5 1.5≤Oxide ore with copper grade＜3			Sulfide ore with copper grade<0.5 Mixed ore with copper grade<1 Oxide ore with copper grade<1.5		
		Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained
Sulfide Ore	Massive/Granular Texture	93.0	90.0	88.0	91.0	88.0	86.5	89.0	86.5	84.5	85.0	83.0	81.0
	Banded Structure	92.0	89.0	87.0	90.0	87.0	85.5	88.0	85.5	84.0	84.5	82.0	80.0
	Stratabound/Net-veined	90.0	87.0	85.5	88.0	85.5	84.0	86.5	84.0	82.0	83.0	80.0	78.5
	Disseminated/Metasomatic	89.0	86.5	84.5	87.0	84.5	83.0	85.5	83.0	81.0	82.0	79.5	78.0
Mixed Ore	Massive/Granular Texture	90.0	87.5	85.5	88.5	85.5	84.0	86.5	84.0	82.0	83.0	80.5	79.0
	Banded Structure	89.0	86.5	85.0	87.5	85.0	83.0	85.5	83.0	81.5	82.0	79.5	78.0
	Stratabound/Net-veined	87.5	85.0	83.0	85.5	83.0	81.5	84.0	81.5	80.0	80.5	78.0	76.5
	Disseminated/Metasomatic	86.5	84.0	82.0	85.0	82.0	80.5	83.0	80.5	79.0	79.5	77.0	75.5
Oxide Ore	Massive/Granular Texture	81.0	78.5	77.0	79.5	77.0	75.5	78.0	75.5	74.0	74.5	72.5	71.0
	Banded Structure	80.5	78.0	76.0	79.0	76.5	75.0	77.0	75.0	73.0	74.0	71.5	70.0

	Stratabound/Net-veined	78.5	76.5	75.0	77.0	75.0	73.0	75.5	73.0	72.0	72.5	70.0	69.0
	Disseminated/Metasomatic	78.0	75.5	74.0	76.5	74.0	72.5	75.0	72.5	71.0	71.5	69.5	68.0
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Lead and Zinc Mineral Resources (Trial)*.													

Table A.5 Requirements for Zinc Processing Recovery Rate Indicators

Unit：%

Ore Type	Structure & Texture Type	Grade and Grain Size Sulfide ore with copper grade≥5 Mixed ore with copper grade≥5.5 Oxide ore with copper grade≥7			Grade and Grain Size 3≤Sulfide ore with copper grade＜5 3.5≤Mixed ore with copper grade＜5.5 5≤Oxide ore with copper grade＜7			Grade and Grain Size 1≤Sulfide ore with copper grade＜3 1.5≤Mixed ore with copper grade＜3.5 3≤Oxide ore with copper grade＜5			Grade and Grain Size Sulfide ore with copper grade<1 Mixed ore with copper grade<1.5 Oxide ore with copper grade<3		
		Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained	Coarse/Medium-grained	Fine-grained	Micro/Ultra-fine grained
Sulfide Ore	Massive/Granular Texture	91.0	88.0	84.0	89.0	86.5	84.5	87.0	84.5	83.0	83.5	81.0	79.5
	Banded Structure	90.0	87.5	83.0	88.0	85.5	84.0	86.5	84.0	82.0	83.0	80.5	78.5
	Stratabound/Net-veined	88.0	85.5	81.0	86.5	84.0	82.0	84.5	82.0	80.5	81.0	79.0	77.0
	Disseminated/Metasomatic	87.0	84.5	80.5	85.5	83.0	81.0	84.0	81.0	79.5	80.5	78.0	76.0
Mixed Ore	Massive/Granular Texture	89.0	86.0	82.0	87.0	84.5	82.5	85.0	82.5	81.0	81.5	79.0	77.5
	Banded Structure	88.0	85.0	81.0	86.0	83.5	82.0	84.5	82.0	80.0	81.0	78.5	77.0
	Stratabound/Net-veined	86.0	83.5	79.5	84.5	82.0	80.0	82.5	80.0	78.5	79.0	77.0	75.0
	Disseminated/Metasomatic	85.0	82.5	78.5	83.5	81.0	79.5	82.0	79.5	77.5	78.5	76.0	74.5
Oxide Ore	Massive/Granular Texture	81.0	78.5	75.0	79.5	77.0	75.5	78.0	75.5	74.0	74.5	72.5	71.0
	Banded Structure	80.5	78.0	74.0	79.0	76.5	75.0	77.0	75.0	73.0	74.0	71.5	70.0
	Stratabound/Net-veined	78.5	76.5	72.5	77.0	75.0	73.0	75.5	73.0	72.0	72.5	70.0	69.0
	Disseminated/Metasomatic	78.0	75.5	72.0	76.5	74.0	72.5	75.0	72.5	71.0	71.5	69.5	68.0
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Lead and Zinc Mineral Resources (Trial)*.													

Annex A.3: Requirements for Mining Recovery Rate and Mineral Processing Recovery Rate of Bauxite are shown in Table A.6 and Table A.7.

Table A.6 Requirements for Bauxite Mining Recovery Rate Indicators

Open-pit Mining			
92%			
Underground Mining			
Orebody Thickness	A/S≥10	10＞A/S＞5	A/S≤5
H ≥5m	88%	80%	75%
5～2m	80%	75%	72%
H≤2m	75%	72%	70%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Manganese, Chrome, Bauxite, Tungsten, Molybdenum, Pyrite, Graphite, and Asbestos Resources (Trial).*			

Table A.7 Requirements for Bauxite Processing Recovery Rate Indicators

Ore Type	Alumina-to-Silica Ratio (A/S)	Alumina-to-Silica Ratio (A/S)	Remarks
Accumulation Type		95%	Slime content required to be≤3.0%
Sedimentary Type	A/S ≥5	80%	Enrichment ratio required to reach 1.8; A/S of tailings < 1.5
	5＞A/S＞3	76%	
	A/S≤3	72%	
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Manganese, Chrome, Bauxite, Tungsten, Molybdenum, Pyrite, Graphite, and Asbestos Resources (Trial).*			

Annex A.4: Requirements for Mining Recovery Rate and Mineral Processing Recovery Rate of Tungsten Mines are shown in Table A.8 and Table A.9.

Table A.8 Requirements for Tungsten Mining Recovery Rate Indicators

Open-pit Mining	
92%	
Underground Mining%	
Geological Grade（WO_3）	Indicator Requirements
≤0.2%	80%
0.2%＜≤0.4%	85%
＞0.4%	90%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Manganese, Chrome, Bauxite, Tungsten, Molybdenum, Pyrite, Graphite, and Asbestos Resources (Trial).*	

Table A.9 Requirements for Tungsten Processing Recovery Rate Indicators

Ore Type	Disseminated Grain Size	Feed Ore Grade		
		＜0.2%	≥0.2%～0.4%	≥0.4%
Wolframite (Wolframite Phase ≥ 90%)	≥0.2 mm	75%	80%	82%
	＜0.2 mm	70%	72%	81%
Scheelite (Scheelite Phase ≥ 90%)	≥0.2 mm	70%	74%	76%
	＜0.2 mm	68%	71%	72%
Mixed Ore (Either phase {Wolframite and Scheelite}＞10%)	≥0.2 mm	59%	62%	64%
	＜0.2 mm	56%	60%	62%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Manganese, Chrome, Bauxite, Tungsten, Molybdenum, Pyrite, Graphite, and Asbestos Resources (Trial).*				

Annex A.5: Requirements for Mining Recovery Rate and Mineral Processing Recovery Rate of Molybdenum Mines are shown in Table A.10 and Table A.11.

Table A.10 Requirements for Molybdenum Mining Recovery Rate Indicators

Open-pit Mining			
Large-scale mines			95%
Medium/small-scale open-pit mines, or mines with high variation in orebody shape, thin orebodies, or poor rock mass stability			92%
Underground Mining			
Orebody Thickness（m）	Mo Grade		
	≥0.2%	0.2%～0.1%	≤0.1%
5 m	88%	80%	75%
5～15m	90%	83%	80%
≥15	92%	85%	85%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Manganese, Chrome, Bauxite, Tungsten, Molybdenum, Pyrite, Graphite, and Asbestos Resources (Trial).*			

Table A.11 Requirements for Molybdenum Processing Recovery Rate Indicators

Structure and Texture Types	Feed Ore Grade（α）					
	α≤0.06%	0.06%<α ≤0.08%	0.08%<α ≤0.10%	0.10%<α ≤0.20%	0.20%<α ≤0.50%	α>0.50%
Massive/Granular Texture	80.5%	81.5%	86%	88%	92.5%	93.5%
Banded Structure	80%	81%	85%	87%	92%	93%
Stratabound/Net-veined	79.5%	80.5%	84%	86%	91%	92%
Disseminated/Metasomatic	79%	80%	83%	85%	90%	91%
Note: Cited from *Minimum Requirements for the "Three Rates" for the Rational Development and Utilization of Mineral Resources including Manganese, Chromium, Bauxite, Tungsten, Molybdenum, Pyrite, Graphite, and Asbestos (Trial).*						

Annex A.6: Requirements for Mining Recovery Rate and Mineral Processing Recovery Rate of Nickel Mines are shown in Tables A.12 to A.14.

Table A.12 Requirements for Nickel Open-pit Mining Recovery Rate Indicators

Open-pit Mining	
Standard open-pit mines	92%
Open-pit mines with complex orebody morphology	88%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*	

Table A.13 Minimum Requirements for Nickel Underground Mining Recovery Rate Indicators

Ore Grade		Mining Recovery Rate Requirements	
Primary Ore	Other Ores	Orebody Thickness≤5m	Orebody Thickness＞5m
≤0.5%	≤1.2%	75%	80%
0.5%-0.8%	1.2%-2.0%	85%	88%
≥0.8%	≥2.0%	88%	92%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*			

Table A.14 Minimum Requirements for Nickel Processing Recovery Rate Indicators

Ore Grade	Mineral Processing Recovery Rate Requirements	
	Moderately Beneficiated Ore	Complex/Refractory Ore
≤0.7%	68%	55%
0.7%-1.0%	73%	62%
≥1.0%	82%	72%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*		

Annex A.7: Requirements for Mining Recovery Rate and Mineral Processing Recovery Rate of Tin Mines are shown in Tables A.15 to A.17.

Table A.15 Requirements for Tin Open-pit Mining Recovery Rate Indicators

Open-pit Mining	
Standard open-pit mines	95%
Mines with high variation in orebody morphology, thin orebodies, or poor rock mass stability	92%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*	

Table A.16 Minimum Requirements for Tin Underground Mining Recovery Rate Indicators

Ore Grade（%）	Mining Recovery Rate Requirements	
	Orebody Thickness≤5m	Orebody Thickness＞5m
≤0.4%	78%	80%
0.4%-0.8%	80%	85%
≥0.8%	88%	90%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*		

Table A.17 Minimum Requirements for Tin Processing Recovery Rate Indicators

Ore Grade	Mineral Processing Recovery Rate Requirements	
	Moderately Beneficiated Ore	Complex/Refractory Ore
≤0.4%	62%	50%
0.4%-0.8%	70%	60%
≥0.8%	80%	65%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*		

Annex A.8: Requirements for Mining Recovery Rate and Mineral Processing Recovery Rate of Antimony Mines are shown in Tables A.18 to A.20.

Table A.18 Requirements for Antimony Open-pit Mining Recovery Rate Indicators

Open-pit Mining	
Standard open-pit mines	95%
Mines with high variation in orebody morphology, thin orebodies, or poor rock mass stability	92%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*	

Table A.19 Minimum Requirements for Antimony Underground Mining Recovery Rate Indicators

Ore Grade（%）	Mining Recovery Rate Requirements	
	Orebody Thickness≤5m	Orebody Thickness＞5m
≤1.5	75	80
1.5-2.5	77	85
≥2.5	80	90
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*		

Table A.20 Minimum Requirements for Antimony Processing Recovery Rate Indicators

Ore Grade	Mineral Processing Recovery Rate Requirements	
	Moderately Beneficiated Ore	Complex/Refractory Ore
≤1.5%	75%	60%
1.5%-2.5%	82%	65%
≥2.5%	90%	75%
Note: Cited from *Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Nickel, Tin, Antimony, Gypsum, and Talc Resources (Trial).*		

Appendix B

（Informative Annex）

Scale and Classification of Non-ferrous Metal Mines

Mineral Category	Mine Production & Construction Scale Level			
	Unit per Annum	Large-scale	Medium-scale	Small-scale
Copper	10,000 tons of ore	≥100	100～30	<30
Lead	10,000 tons of ore	≥100	100～30	<30
Zinc	10,000 tons of ore	≥100	100～30	<30
Tungsten	10,000 tons of ore	≥100	100～30	<30
Tin	10,000 tons of ore	≥100	100～30	<30
Antimony	10,000 tons of ore	≥100	100～30	<30
Bauxite	10,000 tons of ore	≥100	100～30	<30
Molybdenum	10,000 tons of ore	≥100	100～30	<30
Nickel	10,000 tons of ore	≥100	100～30	<30
Cobalt	10,000 tons of ore	≥100	100～30	<30
Magnesium	10,000 tons of ore	≥100	100～30	<30
Bismuth	10,000 tons of ore	≥100	100～30	<30
Mercury	10,000 tons of ore	≥100	100～30	<30

References

[1] Ministry of Land and Resources (MLR), Ministry of Finance (MOF), Ministry of Environmental Protection (MEP), General Administration of Quality Supervision, Inspection and Quarantine (AQSIQ), China Banking Regulatory Commission (CBRC), and China Securities Regulatory Commission (CSRC). Implementation Opinions on Accelerating the Construction of Green Mines (MLR Reg. [2017] No. 4). March 2017.

[2] Ministry of Land and Resources, National Development and Reform Commission (NDRC), Ministry of Industry and Information Technology (MIIT), et al. National Mineral Resources Plan (2016-2020). November 2016.

[3] Ministry of Land and Resources. Announcement on the Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Mineral Resources including Iron, Copper, Lead, Zinc, Potash, and Fluorite (Trial) (Announcement [2013] No. 21). December 2013.

[4] Ministry of Land and Resources. Announcement on the Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Mineral Resources including Manganese, Chromium, Bauxite, Tungsten, Molybdenum, Pyrite, Graphite, and Asbestos (Trial) (Announcement [2014] No. 31). December 2014.

[5] Ministry of Land and Resources. Announcement on the Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Mineral Resources including Nickel, Tin, Antimony, Gypsum, and Talc (Trial) (Announcement [2015] No. 30). December 2015.

[6] Ministry of Land and Resources. Announcement on the Minimum Requirements for the "Three Rates" for Rational Development and Utilization of Mineral Resources including Lithium, Strontium, Barite, Limestone, Magnesite, and Boron (Trial) (Announcement [2016] No. 30). December 2016.