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Standard of the Geology and Mineral Industry of the People's Republic of China

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Construction Specification of Green Mines of the Metallurgical Industry

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Introduction

This standard is drafted in accordance with the rules given by GB/T 1.1-2009.

This standard is put forward by Ministry of Land and Resources of the People's Republic of China.

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Construction Specification of Green Mines of the Metallurgical Industry

1 Scope

This standard specifies the basic requirements for the environment of the mining area, the resource development mode, the comprehensive utilization of resources, energy saving and emission reduction, scientific and technological innovation and digital mine, enterprise management and enterprise image of green mines in the metallurgical industry (iron mine, manganese mine, chromium mine).

This standard applies to the construction of green mines of newly-built, reconstructed and expanded and production mines in the metallurgical industry.

2 Normative references

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

GBZ 2.1 Occupational exposure limits for hazardous agents in the workplace Part 1: Chemical hazardous agents
GBZ 2.2 Occupational exposure limits for hazardous agents in the workplace Part 2: Physical factors
GB 3095 Ambient air quality standards
GB 3838 Environmental quality standard for surface water
GB 12348 Standard of noise at boundary of industrial enterprises
GB 12523 Emission standard of environment noise for boundary of construction site
GB/T 13306 Signs
GB 14161 Mine safety signs
GB 18599 Standard for pollution on the storage and disposal site for general industrial solid wastes
GB 28661 Emission standard for pollutants for mining and separation industry of iron mine
GB 31335-2014 Limit of the energy consumption per unit of product of open-pit mining of iron mine
GB 31336-2014 Limit of the energy consumption per unit of product of underground mining of iron mine
GB 31337-2014 Limit of the energy consumption per unit of product of separation of iron mine
GB 50187 Specification for general layout design of industrial enterprises
GB 50612 Code for technological design of metallurgical concentrator
GB 50830 Code for design of mining of metallurgical mines
GB 50863 Design specification for tailing facilities
HJ 651 Technical specification of eco-environmental protection and reclamation for mines
TD/T 1036 Quality control standard for land reclamation

3 Terminology and definition

The following terms and definitions are applicable to this document.

3.1

Green mine

In the whole process of development of mineral resources, the scientific and orderly mining is implemented, and the ecological environment disturbance in the mining area and its surrounding is controlled within the controllable range. The mine with an ecological environment, a scientific mining mode, the efficient utilization of resources, the digital management information and a harmonious community in the mining area is realized.

3.2

Green coverage rate of the mining area

The percentage of the greening area in the mining area in the area which can be greened within the boundary, including the waste rock yard, the industrial site in the mining area, and green belts on both sides of the mining area.

3.3

Input of R&D and technical innovation

The capital investment for an enterprise to carry out R&D and technical innovation activities. The R&D and technical innovation activities include scientific research and development, technology introduction, technological innovation, transformation and promotion, equipment renewal, scientific and technological training, information exchange, scientific and technological cooperation, etc.

4 General principles

4.1 A mine shall abide by national laws and regulations and related industrial policies, and run the mine according to law.

4.2 A mine shall carry out the development concept of innovation, coordination, greening, openness and sharing; follow the principle of adjusting measures to local conditions of the mine; and realize the overall consideration and comprehensive development of the utilization of resources, energy saving and emission reduction, environmental protection, land reclamation, corporate culture and enterprise and harmony of enterprise and land in the whole process of the development of mineral resources.

4.3 A mine shall be people-oriented, protect workers' health and prevent, control and eliminate occupational hazards.

4.4 A newly built, reconstructed or expanded mine shall be built according to this standard; a production mine shall be upgraded according to this standard; and the construction of green mines shall run through the whole process of design, construction, production and closing.

5 Environment of the mining area

5.1 Basic requirements

5.1.1 The layout of functional zonings of the mining area shall be reasonable; the mining area shall be greened and beautified, and the whole environment shall be clean and beautiful.

5.1.2 The management of production, transportation and storage shall be standardized and orderly.

5.2 Appearance of the mine

5.2.1 The mining area shall be divided into functional zones such as production area, management area, living area and ecological area. Each functional zone shall comply with the provisions of GB 50187; and the production, living, management and other functional zones shall have corresponding management institutions and management systems, orderly operation and standard management.

5.2.2 The ground transportation, water supply, power supply, health, environmental protection and other supporting facilities shall be complete in the mining area; in the production area, the operating signs, illustration signs, roadmap and other signs shall be set, they shall be clear and comply with the provisions of GB/T 13306; and the safety signs shall be set in the areas requiring safety warning and comply with the provisions of GB 14161.

5.2.3 The ground transportation system, transportation equipments and the storage places shall be completely closed, or effective measures such as a screen and water spraying shall be taken to prevent dust, and the dust concentration in the workplace shall meet the requirement of allowable concentration of dust specified in GBZ 2.1.

5.2.4 The reasonable and effective technical measures shall be adopted to de-noise the high-noise equipments. The limit of noise exposure in the workplace shall comply with the provisions of GBZ 2.2. The limit of noise emission at the boundary of industrial enterprises shall comply with the provisions of GB 12348. The limit of noise emission at the boundary of construction sites shall comply with the provisions of GB 12523.

5.3 Greening of the mining area

5.3.1 The greening of the mining area shall be harmonious with the surrounding natural landscape. The greening plants shall reasonably match, and the greening coverage rate of the mining area shall reach 100%.
5.3.2 The closed tailings pond and the waste dump of an open-pit mine shall be reclaimed and greened. Two sides of the main transportation road in the mining area shall be greened and beautified according to local conditions.

5.4 Disposal of wastes

5.4.1 Wastes shall have a special stacking place. Its construction, operation, supervision and management shall comply with the provisions of GB 18599, and comply with safety, environmental protection and other provisions.
5.4.2 Wastewater shall be reused first, and 100% of the wastewater which cannot be reused shall be discharged according to the standard.
5.4.3 The solid wastes such as waste rocks and tailings shall be treated by classification and utilized continuously, and the safe disposal rate shall be 100%.
5.4.4 The stripped topsoil of an open-pit mine shall comply with safety, environmental protection and other related provisions. The disposal rate shall be 100%.

6 Resource development mode

6.1 Basic requirements

6.1.1 The newly-built, reconstructed and expanded mine shall be designed according to GB 50830, GB 50612 and GB 50863.
6.1.2 The development of resources shall be harmonious with environmental protection, resource protection and urban and rural construction, and minimize disturbance and destruction to the natural environment. The resource-saving and environment-friendly development mode shall be chosen.
6.1.3 According to the occurrence of resources, characteristics of the ecological environment and other conditions in the mining area, the mining and separation process shall be chosen according to local conditions. The mining and separation processes, technologies and equipments with a high utilization rate of resources and a small ecological damage to the mining area shall be preferred.
6.1.4 The principle of "mining while managing and recovering" shall be followed, the geological environment of the mine shall be timely managed and restored, and the land occupied and destroyed by the mine shall be reclaimed.
6.1.5 The metal balance management system shall be established, the production management and technological processes shall be improved, and metal loss shall be reduced.

6.2 Green development

6.2.1 In the mining based on the existing conditions of occurrence of different ore bodies, the mechanized, automatic, information and intelligent technologies and equipments of mining with a small environmental disturbance shall be selected.
6.2.2 The mining and separation processes, technologies and equipments encouraged, supported and promoted by the state shall be selected.
6.2.3 The green mining process and technology shall be adopted. The specific requirements are as follows:

a) In the open-pit mining of a mine, the technology with a low stripping ratio and a high loading efficiency shall be adopted. The open pit boundary shall be adjusted dynamically according to the change of the market price and the production cost of the enterprise.

b) In the underground mining, the efficient mining method and the high concentration or paste filling technology shall be adopted, and the trackless mechanized mining shall be realized.

c) The mining with filling shall be adopted in environment sensitive areas and under buildings, under the railway, in the water body and in other areas on the mine. The mining with filling shall be adopted in other areas under the condition of controllable cost and reasonable economy, so that no waste rock is piled up on the ground, and the surface deformation and secondary geological disasters are effectively controlled.

d) The technical and economic demonstration of the residual ores and pillars shall be made, and the

reasonable technology shall used to recover according to the demonstration conclusion, in order to improve the recovery rate of resources and prolong the service life of the mine.

6.2.4 The green mineral separation processes and technologies shall be adopted. The specific requirements are as follows:

a) The suitable separation process shall be developed on the basis of the full separation test. In the case of economic rationality, the main mineral and associated elements shall be fully utilized.

b) The energy-saving and environment-friendly separation process shall be adopted; and it is prohibited for a newly-built, reconstructed and expanded mine to adopt the technology restricted and eliminated by the state.

c) For complex refractory ores, an innovative process shall be adopted to reduce energy consumption, and improve technical and economic indexes, or direct reduction and other separation and smelting processes shall be used.

6.2.5 The index of the recovery rate of mining and the recovery rate of separation shall meet the relevant requirements of Appendix A.1.

6.3 Ecological environment protection of the mining area

6.3.1 Environmental control and land reclamation shall be carried out in accordance with the geological environment protection and land reclamation plan of the mine. The specific requirements are as follows:

a) The protection and restoration of the ecological environment such as mine dump, open pit, special roads in the mining area, industrial site of the mine, subsidence area, barrow and contaminated site of the mine shall comply with the provisions of HJ 651;

b) The land occupied and damaged by a closed pit (mining area) and closed tailings shall be reclaimed within three years, and the quality of land reclamation shall comply with the provisions of TD/T 1036.

c) If it is temporarily difficult to deal with, effective measures shall be taken to control the negative effects on the environment.

d) After the restoration and treatment, all kinds of sites shall be safe and stable, have no threat to human and animal plants; cause no pollution to the surrounding environment; be harmonious with the surrounding natural environment and landscape; restore the basic functions of the land, realize the sustainable use of land according to local conditions; and recover and protect the whole ecological function of the region.

e) The control rate of geological environment of a mine and the land reclamation rate shall meet the requirements of the geological environment protection and land reclamation plan for the registered mine.

6.3.2 An environmental monitoring and disaster emergency warning mechanism shall be established, specialized institutions shall be set up, and there shall be full-time management and monitoring personnel. The specific requirements are as follows:

a) The pollution sources and pollutants such as production wastewater and noise shall be dynamically monitored, and the contingency plan for environmental protection disposal shall be made.

b) During and after mining, the long-term monitoring mechanism shall be established and improved, and the stability and quality of land reclamation areas shall be dynamically monitored.

c) The slope and ground pressure of a mine shall be monitored. The open-pit slope and deep earth pressure shall be dynamically displayed and monitored to prevent geological disasters.

7 Comprehensive utilization of resources

7.1 Basic requirements

The coexisted and associated mineral resources shall be comprehensively developed and utilized; in accordance with the principle of reduction, recycling and reuse, the solid wastes, wastewater and others shall be scientifically used to develop the recycling economy.

7.2 Utilization of coexisted and associated resources

7.2.1 The comprehensive exploration, comprehensive evaluation and comprehensive development shall be made on the coexisted and associated resources.

7.2.2 For the metallurgical mine with various coexisted and associated resources, the main mineral

exploitation shall be adhered to, and the coexisted and associated mineral resources shall be effectively recovered. The development of the main mineral resources shall not cause damage and waste to the coexisted and associated resources.

7.2.3 A suitable separation method shall be chosen, the separation process shall be optimized, the grinding process shall be improved, and the coexisted and associated resources shall be made comprehensive use of.

7.2.4 The comprehensive utilization rate of coexisted and associated resources and other indexes shall meet the relevant requirements of Appendix B.1.

7.3 Utilization of solid waste

7.3.1 The comprehensive utilization of waste rocks and tailings shall be realized by means of underground backfilling treatment, paving, brick making, concrete aggregate preparation, etc.

7.3.2 The processing and utilization system of waste rocks and tailings shall be established. In the economically feasible mine, the waste rocks and tailings shall be processed into sand and gravels, cement aggregate, glass ceramics, soil conditioners and other products.

7.4 Utilization of wastewater

7.4.1 The wastewater shall be disposed of by a clean and resourceful technology and process.

7.4.2 The wastewater utilization system shall be established. After treatment according to the standard, it shall be used for water spraying dust fall, spraying dust fall, separation and other operations.

7.4.3 The utilization rate of mine water shall be determined according to the occurrence conditions of different water resources. In the mining area with a shortage of water resources, it shall reach 95%. In the general water resource mining area, it shall not be lower than 90%. In the mining area with rich water resources, it shall not be lower than 80%. In the mining area with complex water quality, it shall not be lower than 70%. The retaining mine water of a mine with a lot of water shall be discharged according to standard.

7.4.4 The cyclic utilization rate of separation wastewater shall not be lower than 85%, and the cyclic utilization rate of separation wastewater in special areas such as arid Gobi desert shall not be lower than 50%.

8 Energy saving and emission reduction

8.1 Basic requirements

The system of energy consumption accounting in the whole process of production of a mine shall be established. By taking measures of energy saving and emission reduction, the energy consumption, material consumption and water consumption of the unit products shall be controlled and reduced, and the emission of “three wastes” shall be reduced.

8.2 Energy saving and emission reduction

8.2.1 New technologies, new processes, new equipments and new materials with a high efficiency and energy saving shall be developed and used. The processes and equipments with high energy consumption, high pollution and a low efficiency shall be eliminated. The use of frequency conversion equipments and energy saving lighting fixtures shall be popularized.

8.2.2 The energy consumption accounting system for the whole production process shall be established, and the energy consumption of a unit of product shall be controlled. The energy consumption accounting system for the whole production process shall be established, and the energy consumption of a unit of product shall be controlled. The energy consumption of a unit of product in the iron mining and the energy consumption of a unit of product in separation shall be lower than that specified in 4.2 and 4.3 of GB 31335-2014, 4.2 and 4.3 in GB31336-2014, and 4.1 and 4.2 in GB 31337-2014. The specific indexes are shown in C.1 and D.1.

8.2.3 A mining enterprise shall comply with the provisions of 4.4 in GB 31335-2014, 4.4 in GB 31336-2014 and 4.3 in GB 31337-2014 through energy saving technology transformation and energy saving supervision. The specific indexes are shown in Appendix E.1 and F.1.

8.2.4 The comprehensive energy consumption of mining and separation (or processing) of a manganese mine or a chrome mine shall be lower than the national and industrial related standards and the limits stipulated by the relevant departments of the local government.

8.3 Waste gas discharge

8.3.1 The water spraying measure shall be adopted to reduce the dust production volume at the material reshipment points of the production and operation sites and reduce occupational hazards.

8.3.2 The use of clean energy shall be promoted to replace the internal combustion power equipment and reduce air pollution caused by the exhaust emission.

8.3.3 The gas emission of an iron mine shall be lower than the emission limit of air pollutants specified in GB 28661; and the gas emission of a manganese mine or a chrome mine shall be Level 2 and above specified in GB 3095.

8.4 Wastewater discharge

8.4.1 A mine shall establish a wastewater treatment station of the mine separately or jointly with other mines. At the same time, the rainwater diversion and the clean-up diversion shall be realized.

8.4.2 An intercepting drain (drainage channel) of rainwater shall be built in the mining area and the storage yards.

8.4.3 The discharge concentration of water pollutants in an iron mine shall be lower than the limit specified in GB 28661, the discharge amount shall be lower than the benchmark discharge amount of product specified in GB 28661; and the discharge concentration of water pollutants in a manganese mine or a chromium mine shall comply with the provisions of GB 3838.

8.5 Solid waste discharge

8.5.1 The process and technology of mining and separation shall be optimized to reduce the discharge of solid wastes such as waste rocks and tailings.

8.5.2 The solid wastes such as the stripped topsoil of an open-pit mine, waste rocks produced in the process of production and tailings shall be utilized as resources.

9 Scientific and technological innovation and digital mine

9.1 Basic requirements

9.1.1 A technical R&D team shall be established, the transformation of scientific and technological achievements shall be promoted, the technological transformation shall be intensified, and the upgrading of the green industry shall be promoted.

9.1.2 A digital mine shall be built. The informationization of production, operation and management of the mining enterprise shall be realized.

9.2 Scientific and technological innovation

9.2.1 The scientific and technological innovation system with the enterprise as the main body and market orientation combining production, teaching and research shall be established.

9.2.2 An enterprise shall make the scientific and technological innovation plan combined with the key technologies supporting the development of the main business of the enterprise.

9.2.3 The specialized scientific and technological personnel shall be recruited to research the key technologies which support the development of the main business of the enterprise and constantly improve the level of process and equipments in the comprehensive utilization of resources and other aspects.

9.2.4 The investment in R&D and technical innovation shall be no less than 1.5% of the main business income of the previous year.

9.3 Digital mine

9.3.1 The automation system of mine production shall be built, and the centralized control and information linkage of subsystems such as production and monitoring shall be realized.
9.3.2 The digital resource reserve model and economic model shall be established, the dynamic management and economic evaluation of mineral resources reserves shall be carried out, and the precision management of the reserves utilization of geological and mineral resources shall be realized.
9.3.3 The safety monitoring and control system shall be established to ensure the safety in production.
9.3.4 The mechanized reduction of personnel and the automatic substitution shall be promoted. The mining mechanization and the automation of the separation technology shall be realized. The rate of numerical control of key production processes shall not be lower than 70%.
9.3.5 The computer, intelligent control and other technologies shall be used to build the intelligent mine and realize the deep integration of informatization and industrialization.

10 Enterprise management and corporate image

10.1 Basic requirements

10.1.1 The enterprise management system of property rights, responsibilities, management, culture and other aspects shall be established.
10.1.2 The quality management system, environmental management system and occupational health and safety management system shall be established to ensure the management of quality, environment, occupational health and safety.

10.2 Corporate culture

10.2.1 The core values of the enterprise of people orientation, innovative learning, standard behaviors, high efficiency and safety, ecological civilization and green development shall be established. The enterprise spirit of unity and struggle, optimism, innovation, pragmatic entrepreneurship and advancement shall be cultivated.
10.2.2 The vision of enterprise development shall be consistent with the goal pursued by all the staffs. The long-term development strategy of the enterprise and the personal value of employees shall be closely integrated.
10.2.3 The trade union organization shall be improved, and it shall play an effective role. The staffs' material, sports and cultural life shall be enriched. The satisfaction of the employees of the enterprise shall not less than 70%. The occupational health inspection rate of workers exposed to occupational hazards shall not be less than 90% during their work.
10.2.4 The mechanism of synchronous growth of employees' income with the performance of the enterprise shall be established.

10.3 Enterprise management

10.3.1 The rules and regulations for resource management, ecological environment protection, safety production, occupational disease prevention and control and others shall be established. The working mechanism shall be defined and the duties shall be fulfilled.
10.3.2 All kinds of statements, standing books and archival data shall be complete.
10.3.3 The staff training system shall be established. The training plan and the training records shall be clear.

10.4 Enterprise credit

10.4.1 The production and operation activities and the performance of social responsibilities must be honest and trustworthy. The mining right owner shall fulfill the obligation to publicize the information about prospecting and mining, and relevant information shall be publicized.
10.4.2 Relevant information shall be disclosed on the company's website and other locations accessible by the public, mainly including:
a) the environmental impact report and reply for the establishment of the enterprise and subsequent construction projects;
b) environmental, health, safety and social impact, and the greenhouse gas emission performance;

c) the contact information of the responsible department for the safety production and environmental protection of the enterprise.

10.5 Harmony of enterprise and land

10.5.1 The mining concept of construction of the enterprise and land, sharing of interests and common development shall be established. A long-term cooperative mechanism shall be built by creating a community development platform. The resources and advantages of different parties shall be given full play to, and a multi-cooperative model of win-win for the social management of the mining area shall be established.

10.5.2 The investigation mechanism of mass satisfaction in the mining area shall be established. Support shall be provided in the aspect of education, employment, transportation, life and environmental protection. The quality of people's life in the mining area shall be improved, and the harmony of enterprise and land shall be promoted.

10.5.3 The mechanism of consultation and negotiation with the township and town (street) and village (community) of a mine shall be established, all kinds of interest disputes shall be handled in a proper and timely manner, and there shall be no major group event.

Appendix A
(normative appendix)
Index of the recovery rate of mining and the recovery rate of mineral separation of a metallurgical mine

Combined with different conditions of open mining and underground mining in a metallurgical mine, different recovery rates are specified, and different mineral separation recovery rates are specified according to the ore type. The specific index of the mining recovery rate and the separation recovery rate of a metallurgical mine are shown in Table A.1.

Table A.1 Index of the recovery rate of mining and the recovery rate of mineral separation of a metallurgical mine

Type of mine	Mining recovery		Recovery rate of mineral separation (%)		
	Mining method	Recovery rate			
	Open-pit mining	Large: ≥95 Middle	Type of iron mine	Grinding degree	Recovery rate of mineral separation
			Magnetite (the recovery rate	Medium fine-grained and above	95

Iron mine*	Underground mining	Stable ore body	Low dip and high dip: 83	of magnetic iron)	Fine-grained and micro-fine-grained	90	
			Dip: 81	Hematite (including specular hematite)	Medium fine-grained and above	75	
		Unstable ore body	Low dip and high dip: 79		Fine-grained and micro-fine-grained	70	
			Dip: 78	Magnetite-hematite	Medium fine-grained and above	78	
					Fine-grained and micro-fine-grained	72	
		Extremely unstable ore body	Low dip and high dip: 77	Limonite	Medium fine-grained and above	55	80*
					Fine-grained and micro-fine-grained	50	
			Dip: 75	Siderite (roasting process)	Medium fine-grained and above	80	
					Fine-grained and micro-fine-grained	70	
Vanadium titano-magnetite mine in Panxi, Sichuan Province	Open-pit mining	≥94		Grade of iron ore concentrate≥54%			
				Grade of crude ore	Recovery rate of mineral separation of iron		
				TFe≥30%	Not lower than 71		
	Underground mining	≥82		25%≤TFe＜30%	Not lower than 66		
				20%≤TFe＜25%	Not lower than 60		
				TFe＜20%	Not required for the time being		

<table>
<tr><td rowspan="6">Manganese mine</td><td>Open-pit mining</td><td colspan="2">Large and medium-sized: 92
Small-sized: 90</td><td>Ore type</td><td>Grade of crude ore (Mn %)</td><td>Recovery rate of mineral separation</td></tr>
<tr><td rowspan="5">Underground mining</td><td rowspan="2">Stable</td><td>Thin ore body: 82</td><td rowspan="2">Manganese oxide</td><td>≥20</td><td>85</td></tr>
<tr><td>Medium-thick and thick ore body: 85</td><td>＜20</td><td>80</td></tr>
<tr><td>Moderately-stable</td><td>Thin ore body: 81</td><td rowspan="3">Manganese carbonate</td><td>≥15</td><td>83</td></tr>
<tr><td rowspan="2">Medium-thick and thick ore body: 84</td><td>＜15</td><td>78</td></tr>
<tr><td>Unstable</td><td>Thin ore body: 80</td><td>Other manganese mines</td><td></td><td>65</td></tr>
<tr><td>Medium-thick and thick ore body: 83</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Chromium mine</td><td>Open-pit mining</td><td colspan="2">≥93</td><td colspan="3" rowspan="2">≥78</td></tr>
<tr><td>Underground mining</td><td colspan="2">≥85</td></tr>
</table>

Quoted from *the Minimum Index Requirement for "Three Rates" for the Rational Exploitation and Utilization of Vanadium Titano-magnetite Resources in Panxi, Sichuan Province (Trial), the Minimum Index Requirement for "Three Rates" for the Rational Exploitation and Utilization of* Iron Ore Resources (Trial), *the Minimum Index Requirement for "Three Rates" for the Rational Exploitation and Utilization of Manganese Ore Resources (Trial),* and *the Minimum Index Requirement for "Three Rates" for the Rational Exploitation and Utilization of Chrome Ore Resources (Trial).*

* Under the condition of the limonite roasting process, the recovery rate of mineral separation shall be above 80%.

Appendix B
(normative appendix)
Index of the comprehensive utilization rate of a metallurgical mine

B.1 Comprehensive utilization ratio of coexisted and associated minerals

B.1.1 When the grade of coexisted and associated minerals reaches the specified value for an iron mine (not containing Panxi Vanadium Titano-Magnetite) and a manganese mine, the plan of mining design or exploitation and utilization shall put forward the requirement for the comprehensive utilization method of this element. When the useful coexisted and associated minerals cannot be recycled for the time being under the existing technical conditions, or the conclusion of the technical and economic evaluation shall not be used synthetically, the disposal measures shall be put forward and conditions shall be created for the future comprehensive utilization. The specific utilization level of the mine is based on geological prospecting report, separation test, mine design, the actual mining and separation product of the mine, etc.

B.1.2 The comprehensive utilization of titanium in Panxi Vanadium Titano-Magnetite (TiO_2 is calculated from the original ore to the titanium concentrate): The comprehensive utilization of titanium shall meet the requirement of Table B.1 according to the ratio of iron and titanium of the selected ore (TFe/ TiO_2) and the grade of the titanium concentrate.

Table B.1 Comprehensive utilization index of titanium

The ratio of iron and titanium of the selected ore	Grade of titanium concentrate	Requirements for the comprehensive utilization of titanium
$2.1 \leq TFe/TiO_2 < 2.6$	Not lower than 47%	Not lower than 20%
$2.6 \leq TFe/TiO_2 < 3.5$		Not lower than 16%
$TFe/TiO_2 \geq 3.5$		Not lower than 12%

B.1.3 When the TiO_2 grade of titanium concentrate is lower than 47%, the comprehensive utilization rate of titanium shall be raised correspondingly.

B.1.4 The comprehensive utilization ratio of vanadium (V_2O_5 is calculated from raw ore to iron concentrate) and chromium (Honggenan Mining Area) (Cr_2O_3 is calculated from raw ore to iron-vanadium concentrate) in Panxi Vanadium Titano-Magnetite: According to the separation recovery rate of iron, the comprehensive utilization rate shall meet the requirements of Table B.2.

Table B.2 Comprehensive utilization index of vanadium

The separation recovery rate of iron	Requirement for the comprehensive utilization rate of vanadium (V_2O_5)	Requirement for the comprehensive utilization rate of chromium (Cr_2O_3)

≥71%	Not lower than 75%	Not lower than 75%
66%≤the separation recovery rate of iron＜71%	Not lower than 70/%	Not lower than 70/%
60%≤the separation recovery rate of iron＜66%	Not lower than 64%	Not lower than 64%

B.1.5 The comprehensive utilization of sulfide in Panxi Vanadium Titano-Magnetite: A mine enterprise must utilize sulfide comprehensively. Specific requirements for the comprehensive utilization of sulfide shall be specified in the development and utilization plan for a newly built or expanded mine.

B.1.6 If a chromium mine has the coexisted and associated platinum group and cobalt, nickel, gold and other elements, when the total amount of platinum group is greater than 0.2g/t, that of cobalt is greater than 0.02%, and that of nickel is greater than 0.2%, the comprehensive evaluation shall be strengthened and these elements shall be recycled as much as possible. The comprehensive utilization rate of minerals coexisting with chromite shall not be lower than 50%; and the comprehensive utilization rate of minerals coexisting with chromite shall not be lower than 30%.

B.2 The comprehensive utilization rate of tailings of an iron mine shall not be lower than 20%.

B.2.1 The comprehensive utilization of tailings includes recycling and utilization of valuable elements in tailings reservoir, utilization of tailings as building materials or backfilling of a mine, etc.

Appendix C
(normative appendix)
Energy consumption limit per
unit of product of iron mining

According to the mining method, mining type and ore size of an iron mine, different energy consumption limits per unit of product of iron mining have been developed, and the specific limits are shown in Table C.1.

Table C.1 Energy consumption limit per
unit of product of iron mining

Mining method	Mining type	Mine scale	Comparable comprehensive energy consumption per unit of product (kgce/t)
Open-pit mining	Existing mine	Medium or above (containing medium)	≤0.80
		Small	≤1.04
	Newly-built, reconstructed and expanded mine	Medium or above (containing medium)	≤0.49
		Small	≤0.64
Underground mining	Existing mine	Medium or above (containing medium)	≤3.60
		Small	≤4.68
	Newly-built, reconstructed and expanded mine	Medium or above (containing medium)	≤2.60
		Small	≤3.38

Appendix D
(normative appendix)
Energy consumption limit per unit of product of mineral separation of an iron mine

According to the mining method and the type of separation process of an iron mine, different energy consumption limits per unit of product of separation of an iron mine have been developed, and the specific limits are shown in Table D.1.

Table D.1 Energy consumption limit per unit of product of mineral separation of an iron mine

Mining method	The type of separation process		Comparable comprehensive energy consumption per unit of product (kgce/t)
Existing mine	Weak magnetic separation		≤4.1
	Combined separation		≤5.7
	Roasting separation	Shaft furnace	≤48.5
		Rotary kiln	≤54.3
Newly-built, reconstructed and expanded mine	Weak magnetic separation		≤3.3
	Combined separation		≤4.2
	Roasting separation	Shaft furnace	≤45.6
		Rotary kiln	≤51.8

Quoted from GB 31337-2014

Appendix E
(normative appendix)
Advanced value of energy consumption per unit of product of iron mining

According to the mining method and the ore size of an iron mine, different advanced values of energy consumption per unit of product of iron mining have been developed, and the specific advanced values are shown in Table E.1.

Table E.1 Advanced value of energy consumption per unit of product of iron mining

Mining method	Mine scale	Comparable comprehensive energy consumption per unit of product (kgce/t)
Open-pit mining	Medium or above (containing medium)	≤0.30
	Small	≤0.39
Underground mining	Medium or above (containing medium)	≤2.05
	Small	≤2.67

Quoted from GB 31335-2014 and GB 31336-2014

Appendix F
(normative appendix)
Advanced value of energy consumption per unit of product of mineral separation of an iron mine

According to the type of separation process of an iron mine, different advanced values of energy consumption per unit of product of separation of an iron mine have been developed, and the specific advanced values are shown in Table F.1.

Table F.1 Advanced value of energy consumption per unit of product of mineral separation of an iron mine

Type of the separation process		Comparable comprehensive energy consumption per unit of product (kgce/t)
Weak magnetic separation		≤2.4
Combined separation		≤3.3
Roasting separation	Shaft furnace	≤42.4
	Rotary kiln	≤49.7

Quoted from GB 31337-2014

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