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Green mine construction standards of onshore petroleum and natural gas mine extraction industry

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Foreword

This standard was drafted in accordance with the rules set out in *GB/T 1.1—2009 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 is under the jurisdiction of the National Technical Committee on Land and Resources Standardization (*SAC/TC 93*).

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Green Mine Construction Specification for the Onshore Petroleum and Natural Gas Extraction Industry

1 Scope

This standard specifies requirements for green mine construction in the onshore petroleum and natural gas extraction industry. It covers mining area environment, resource development methods, comprehensive resource utilization, energy conservation and emission reduction, technological innovation and digitalization, as well as corporate management and corporate image.

This standard applies to the green mine construction of new, modified, expanded, and operating mines in the onshore petroleum and natural gas extraction industry.

2 Normative References

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

GB/T 13306 Plates and Signs
GB 50187 Code for Design of General Layout for Industrial Enterprises
TD/T 1036 Quality Control Standard 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 Management of production, transportation, and storage shall be standardized and orderly.

5.2 Mine Appearance and Condition

5.2.1 The mining area shall be divided into production, management, and living zones, each complying with GB 50187. 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 Rational and effective technical measures shall be adopted for noise reduction of high-noise equipment at oil and gas stations.

5.3 Mining Area Greening

5.3.1 Greening shall be coordinated with the surrounding natural environment and landscape. Plant varieties shall be reasonably combined

5.3.2 The green coverage ratio of the mining area shall reach 100%.

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 Mining technologies and equipment shall be selected according to the specific conditions of the deposit and shall meet cleaner production requirements.

6.1.3 The principle of “simultaneous extraction, remediation, and restoration” shall be implemented. The geological environment of the mining area shall be restored timely manner, and land occupied or damaged by mining activities shall be reclaimed.

6.2 Green Development

6.2.1 Development plans shall be determined scientifically and rationally, based on oil and gas resource occurrence and ecological environment. Advanced extraction technologies and processes which is suitable for the specific type of oil and gas reservoirs shall be adopted. The mature and advanced equipment shall be promoted. Technologies and equipment explicitly restricted or phased out by the state are strictly prohibited.

6.2.2 Land resources shall be used intensively and economically, in compliance with land-use quota policies. The scale of land occupied for stations, sites, pipelines, and roads shall be determined reasonably.

6.2.3 A green drilling technology system shall be implemented. Drilling methods, environmentally friendly drilling fluids, and well-control measures shall be selected scientifically. A complete solid-control system shall be provided, and drilling mud shall be treated and disposed of properly and promptly.

6.2.4 For existing projects, the development plan shall be adjusted promptly based on the dynamics of production performance. Technological innovation and upgrades shall be carried out in a timely manner.

6.2.5 For reservoirs containing associated carbon dioxide gas that does not meet industrial utilization requirements, effective disposal measures shall be implemented.

6.2.6 For reservoirs containing associated hydrogen sulfide gas that do not meet industrial utilization requirements, effective disposal measures shall be implemented.

6.3 Recovery Factor Requirements

6.3.1 For crude oil extraction, the annual recovery factor calibrated by the dynamic method shall comply with Appendix A, based on crude oil properties, reservoir lithology, and physical characteristics.

6.3.2 For natural gas extraction, the annual recovery factor calibrated by the dynamic method shall comply with Appendix B, based on reservoir type and conditions.

6.4 Ecological and Environmental Protection

6.4.1 The Mine Geological Environmental Protection and Land Reclamation Plan shall be fully implemented. Land occupied or damaged by mining, surplus land from station sites, and abandoned functional land shall be reclaimed promptly in accordance with *TD/T 1036*.

6.4.2 The ecological environment of the mining area and its surroundings shall be monitored, with active cooperation with local environmental protection authorities.

7 Comprehensive Resource Utilization

7.1 Basic Requirements

Following the principles of reduction, reuse, and recycling, associated and co-existing resources of oil and gas reservoirs shall be comprehensively developed and utilized. Solid waste, wastewater, etc. shall be comprehensively utilized to promote a circular economy.

7.2 Utilization of Associated Resources

7.2.1 In oilfields, the minimum comprehensive utilization rate of associated gas shall be: not less than 90% for medium-high permeability reservoirs, and not less than 70% for low- to ultra-low-permeability reservoirs.

7.2.2 In gas fields, associated resources shall be comprehensively utilized: the comprehensive utilization rate of condensate associated with methane gas not less than 90%; the comprehensive utilization rate of hydrogen sulfide resources associated with methane gas not less than 95%; The comprehensive utilization rate of carbon dioxide resources associated with methane gas not less than 95%.

8 Energy Conservation and Emission Reduction

8.1 Basic Requirements

An energy consumption accounting system covering the entire oil and gas production process shall be established. Energy, material, and water consumption per unit product shall be controlled and reduced through measures of energy conservation and emission reduction. Discharges of wastewater, waste gas, and solid waste shall comply with the relevant standards, regulations and and requirements of environmental protection authorities.

8.2 Energy Conservation and Consumption Reduction

8.2.1 Energy consumption per unit product across the entire production process shall meet design standards and annual energy-saving targets.

8.2.2 efficient, energy-saving technologies, processes, equipment, and materials shall be adopted during key production stages. High-consumption, high-pollution, and low-efficiency processes and equipment shall be phased out promptly.

8.3 Waste Disposal and Utilization

8.3.1 Waste liquids, gases, and solids shall be recorded, categorized, and treated cleanly and harmlessly, with a treatment rate of 100%.

8.3.2 Produced water shall be treated to meet standards for recycling. If recycling is not feasible, it shall be discharged or reinjected in compliance with standards or otherwise effectively utilized.

8.3.3 Crude oil spilled during extraction shall be fully and promptly recovered.

8.3.4 Oil-bearing sludge shall be treated with technology to recover and reuse crude oil. The oil content of treated solids shall be less than 2%.

9 Technological Innovation and Digitalization

9.1 Basic Requirements

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

9.1.2 Build digital oil and gas fields to achieve digitalization of production, operation, and management.

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 Develop the research on key technologies supporting the enterprise’s core business, with continuous improvement of processes, technologies, and equipment.

9.2.3 Investment in R&D and technical innovation shall be no less than 1.5% of the enterprise’s main business revenue from the previous year.

9.3 Digitalization Development

9.3.1 Monitoring platforms shall be established at different levels according to production needs, achieving automated, digital, and remote monitoring of key processes such as production, metering, gathering, transportation, and processing.

9.3.2 Station-area monitoring systems shall be established to collect real-time data on flow, pressure, liquid level, and combustible gas concentration, etc., and integrate manually tested or recorded data of operation for systematic real-time management.

9.3.3 Technologies such as artificial intelligence and network information shall be applied to achieve digitalized management of operations, production decision-making, environmental monitoring and governance, equipment control, and safety in oil and gas field mining area.

10 Corporate Management and Corporate Image

10.1 Basic Requirements

10.1.1 An enterprise management system shall be established covering property rights, responsibilities, administration, and culture.

10.1.2 A green mine management system shall be established.

10.2 Corporate Culture

10.2.1 A corporate culture shall be fostered that is people-oriented, encourages innovation and learning, regulates behavior, ensures efficiency and safety, embraces ecological civilization, and promotes green development.

10.2.2 The enterprise vision shall align with common employee goals, integrating long-term strategy with personal value realization.

10.2.3 Labor unions shall be strengthened to enrich employees' material and cultural life. Employee satisfaction shall not be less than 70%.

10.2.4 A mechanism should be established to synchronize employee income growth with enterprise performance.

10.3 Corporate Management

10.3.1 Rules and mechanisms for resource management and ecological protection shall be established and responsibilities fully implemented.

10.3.2 Reports, ledgers, files, and documentation shall be complete, accurate, and authentic.

10.3.3 Management and technical staff shall regularly participate in green mine training. A clear employee training system with defined plans and clear records shall be established.

10.4 Corporate Integrity

Honesty and trustworthiness shall be upheld in production, operations, and social responsibility. Mining right holders shall fulfill the obligation to disclose exploration and mining information publicly.

10.5 Corporate –Community Harmony

10.5.1 A philosophy of joint enterprise–community development, shared benefits, and common progress shall be promoted. Community development platforms should be established to build long-term cooperation mechanisms, leverage resources, and create diversified, win-win social management models.

10.5.2 A mechanism for surveying community satisfaction shall be established. Support should be provided in education, employment, transportation, daily life, and environmental protection to improve quality of life and promote harmony.

10.5.3 Consultation and negotiation mechanisms shall be established with local townships, villages, and communities to resolve disputes promptly and properly.

Appendix A

(Normative Annex)

Recovery Factor of Crude Oil Requirements

The minimum recovery factor requirements for various types of oil reservoirs, as calibrated annually by the dynamic method, are shown in Table A.1.

Table A.1 — Minimum Recovery Factor Requirements for Different Types of Oil Reservoirs

Reservoir Type		Primary Recovery Factor (%)	Secondary Recovery Factor (%)	Tertiary Recovery Factor (%)
Light Oil	Medium–high permeability multilayer sandstone reservoir	6~10	18~24	28~35
	Medium–high permeability complex fault-block sandstone reservoir		10~14	14~20
	Low-permeability sandstone reservoir		8~11	—
	Ultra-low-permeability sandstone reservoir	3~5	6~8	—
	Special lithology reservoir		6~10	—
Heavy Oil	Ordinary heavy oil, Class I	7~9	10~15	20~30
	Other heavy oil	—	11~15	20~30

Notes:

1. Light oil refers to reservoirs where crude oil viscosity under reservoir conditions is ≤ 50 mPa·s. Heavy oil refers to reservoirs where crude oil viscosity under reservoir conditions is > 50 mPa·s. Ordinary heavy oil, Class I refers to heavy oil with viscosity between 50–150 mPa·s under reservoir conditions.
2. Medium–high permeability multilayer sandstone reservoir: reservoir lithology is sandstone, layered, with average air permeability ≥ 50×10^{-3} μm². Medium–high permeability complex fault-block sandstone reservoir: reservoir formed by petroleum accumulation in fault-block traps. Low-permeability sandstone reservoir: sandstone reservoir with average air permeability ≥ 10×10^{-3} μm² and < 50×10^{-3} μm². Ultra-low-permeability sandstone reservoir: sandstone reservoir with average air permeability ≥ 1×10^{-3} μm² and < 10×10^{-3} μm². Special lithology reservoir: reservoir with lithology such as igneous rock, metamorphic rock, carbonate rock, or conglomerate.
3. Tertiary recovery methods include chemical flooding, steam flooding, SGAD (steam-gas-additive drive), and in-situ combustion.

Appendix B

（Normative Annex）

Recovery Factor of Natural Gas Requirements

The minimum recovery factor requirements for various types of gas reservoirs, as calibrated annually by the dynamic method, are shown in Table B.1.

Table B.1 — Minimum Recovery Factor Requirements for Different Types of Gas Reservoirs

No.	Reservoir Type	Minimum Recovery Factor (%)
1	Active water-drive gas reservoir	40
2	Moderately active water-drive gas reservoir	60
3	Inactive water-drive gas reservoir	70
4	Gas-drive reservoir	70
5	Low-permeability gas reservoir	30
6	Ultra-low-permeability gas reservoir	15

Notes:

1. Active water-drive gas reservoir: Water invasion replacement coefficient ≥ 0.4; abandonment relative pressure ≥ 0.5. Large movable edge/bottom aquifers. Typically, some wells begin producing large volumes of water or become flooded early in development. Stable production period is short. Water-invasion curve rises linearly. Generally medium-high permeability reservoirs or low-permeability fractured reservoirs.
2. Moderately active water-drive gas reservoir: Water invasion replacement coefficient ≥ 0.15 and < 0.4; abandonment relative pressure ≥ 0.25. Reservoir partially connected with larger water bodies, with relatively weak energy. Local water breakthrough usually occurs in the mid-to-late development stage, causing some wells to produce water. Generally medium-high permeability reservoirs or low-permeability fractured reservoirs.
3. Inactive water-drive gas reservoir: Water invasion replacement coefficient ≥ 0 and < 0.15; abandonment relative pressure ≥ 0.05. Mostly closed reservoirs. In mid-to-late development, occasional wells may produce water, or the reservoir may not produce water at all. Water-drive energy is extremely weak. Production shows elastic gas-drive characteristics. Generally medium-high permeability reservoirs or low-permeability fractured reservoirs.
4. Gas-drive reservoir: No edge or bottom water present. Typically closed systems with multiple fractures, fault blocks, sand bodies, or abnormally pressured reservoirs. No water invasion occurs throughout production. Abandonment relative pressure > 0.05.
5. Low-permeability gas reservoir: Average reservoir permeability between 0.1×10^{-3} and 1.0×10^{-3} μm². Fractures are not well developed, lateral connectivity is poor. Stable production rate at 1 km depth is 0.3×10^4 m³/(d·km). Absolute open-flow potential ≤ 3×10^4 m³/(d·km). Water invasion during production is weak (replacement coefficient < 0.1). Abandonment relative pressure ≥ 0.5.
6. Ultra-low-permeability gas reservoir: Average reservoir permeability ≤ 0.1×10^{-3} μm². Fractures are undeveloped. Without special measures, generally no production capacity. Stable production rate at 1 km depth ≤ 0.3×10^4 m³/(d·km). Water invasion during production is extremely weak.

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