

ARTICLE 6

Environmental Audit of the Steel Industry: Indian Perspectives with special reference to Steel Authority of India Limited

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Received : 15 January 2026

Accepted: 24 April 2026

Abstract

The steel industry is one of the most resource-intensive and pollution-intensive industrial sectors worldwide, playing a crucial role in infrastructure development and economic growth. India, as the second-largest producer of crude steel globally (World Steel Association, 2025), faces the dual challenge of expanding production while minimising environmental degradation. Environmental auditing has emerged as an important management and regulatory tool to ensure compliance with environmental laws, improve resource efficiency and promote sustainable development.

This paper examines the concept and practice of environmental audits in the Indian steel industry, with insights from the Steel Authority of India Limited (SAIL). Using secondary data from government reports, CAG reports, corporate sustainability disclosures and published literature, the study analyses the key environmental impacts such as air emissions, water pollution, solid and hazardous waste generation and recent initiatives such as green steel, zero liquid discharge and ISO 14001 certification. The study finds that while Indian steel plants have made measurable progress in environmental performance, significant scope remains for technological modernisation, stronger regulatory compliance and integration of audit findings into strategic decision-making.

Keywords

Environmental Audit, Steel Industry, SAIL, Environmental Regulations, Green steel and Zero Liquid Discharge.

6.1 Introduction: Indian and Global Steel Industry Scenario

Globally, crude steel production exceeds 1.8 billion tonnes annually, with China accounting for more than half of total output, followed by India, Japan and the United States. India has emerged as the world's second-largest steel producer, with crude steel production exceeding 149 million tonnes in recent years. The steel sector contributes approximately 2 per cent to India's Gross Domestic Product (GDP) and provides direct and indirect employment to millions of people. Major players in the Indian steel sector include public sector enterprises such as Steel Authority of India Limited (SAIL), Rastriya Ispat Nigam Limited (RINL) and private companies such as Tata Steel, JSW Steel and Arcelo Mittal Nippon Steel India (World Steel Association, 2025).

Steel production is inherently energy-intensive and environmentally sensitive. The sector generates significant air pollutants (particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide and carbon dioxide), large volumes of wastewater with high biological oxygen demand (BOD) and chemical oxygen demand (COD) and solid wastes such as slag, sludge, fly ash and hazardous chemical wastes. In this context, environmental auditing assumes critical importance as a mechanism for ensuring regulatory compliance and promoting sustainable industrial practices.

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6.2 Concept and Scope of Environmental Audit

An environmental audit is defined as a systematic, documented, periodic and objective evaluation of how well environmental organisation, management and equipment are performing in conserving the environment and complying with statutory requirements. Environmental audit encompasses a dual dimension, comprising compliance assessment with statutory requirements and performance evaluation focused on resource efficiency and pollution mitigation. In the steel industry, environmental audits facilitate continuous improvement and proactive environmental governance, positively influencing regulatory compliance and risk management.

These audits typically assess air and water pollution control systems, solid and hazardous waste management, occupational health and safety practices, energy and water efficiency and emergency preparedness. With the increasing emphasis on Environmental, Social and Governance (ESG) performance, environmental audits have also become a strategic tool for long-term sustainability.

6.3 Global Evolution of Sustainability Reporting

Sustainability reporting refers to the disclosure of an organisation's ESG performance, enabling stakeholders to assess the organisation's commitment to sustainable development. Over time, it has evolved from voluntary disclosures to structured and increasingly mandatory frameworks.

Globally, sustainability reporting has progressed through initiatives such as the Global Reporting Initiative (GRI), United Nations Global Compact (UNGC) and Task Force on Climate-related Financial Disclosures (TCFD), leading to greater standardisation and transparency. Many countries now emphasise mandatory ESG disclosures, reflecting growing stakeholder expectations.

In India, sustainability reporting has gained importance, particularly in industries like steel. The Securities and Exchange Board of India (SEBI) mandates Business Responsibility and Sustainability Reporting (BRSR) for specified listed companies, encouraging disclosure on environmental performance, emissions and resource efficiency.

The Indian steel industry operates within a comprehensive environmental regulatory framework administered by the Ministry of Environment, Forest and Climate Change (MoEF & CC). Key legislation includes (Figure 6.1):

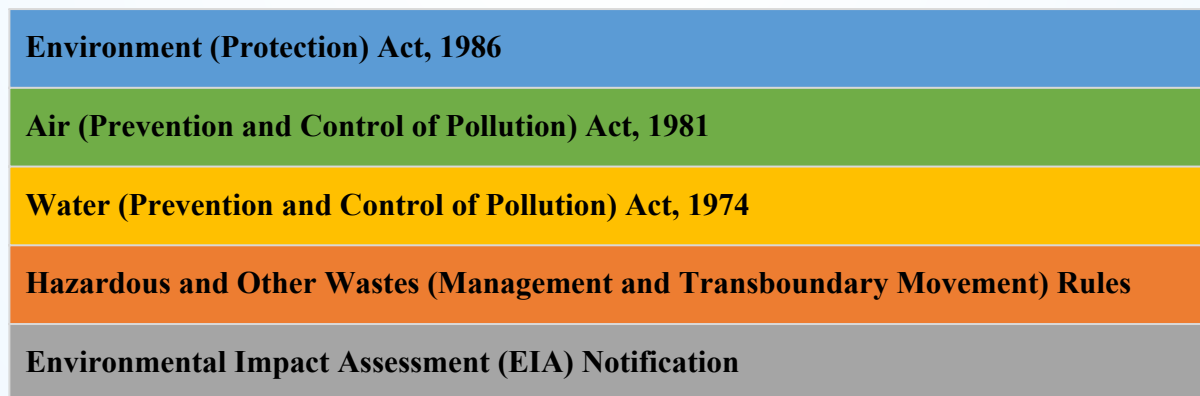


Figure 6.1: Key legislation from the comprehensive environmental regulatory framework of the Indian Steel industry

These laws and regulations are implemented and enforced by the Central Pollution Control Board (CPCB) and respective State Pollution Control Boards (SPCBs). In addition, specific rules govern hazardous and other wastes, biomedical waste, solid waste management and fly ash utilisation. The National Green Tribunal (NGT) plays an important role in adjudicating environmental disputes and ensuring compliance. Steel plants are required to obtain environmental clearances, operate pollution control equipment, submit periodic compliance reports and undergo environmental audits (Government of India, 1986).

6.4 Major Environmental Issues in the Steel Industry

6.4.1 Air Emissions and Climate Change

Steel plants are major sources of air pollutants such as dust and particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide and carbon dioxide. Carbon dioxide emissions from steelmaking significantly contribute to global greenhouse gas emissions. Environmental audits assess the efficiency of electrostatic precipitators, bag filters, gas cleaning plants and continuous emission monitoring systems, as well as initiatives for CO₂ reduction through energy efficiency and fuel substitution.

6.4.2 Water Pollution and Zero Liquid Discharge

Steel production requires large volumes of water for cooling, processing and dust suppression. Wastewater often contains suspended solids, oil and grease, heavy metals and high BOD levels. Many Indian steel plants are moving toward Zero Liquid Discharge (ZLD) by maximizing water recycling, installing Sewage Treatment Plants (STPs) and adopting rainwater harvesting systems. Environmental audits evaluate water balance, specific water consumption and compliance with discharge standards.

6.4.3 Solid, Hazardous and Other Wastes

The steel industry generates substantial quantities of solid wastes such as blast furnace slag, steel slag, fly ash and various types of sludge. Hazardous wastes include chemical residues, spent oils and contaminated sludge, while biomedical waste is generated from plant hospitals. Audits examine slag utilisation, fly ash management, ash pond safety, lagoon management and prevention of soil and groundwater contamination.

6.5 Key Environmental Metrics and Trends in SAIL

The Steel Authority of India Limited has shown progress in improving key performance indicators over the last decade (Environmental Performance of SAIL, 2025), as shown in Table 6.1.

Table 6.1: Key performance indicators over the last decade

Metric	Improvement (2015 - 2025)	Key Initiatives
Particulate Matter (PM) Emissions	31% Reduction	Electrostatic Precipitators (ESPs) → Bag Filters → Coke Dry Quenching (CDQ)
Specific Water Consumption	22% Decrease	Water Recycling → Rainwater Harvesting → Zero Liquid Discharge (ZLD)
Total Solid Waste Utilization	27% Increase	Slag Granulation → Fly Ash Utilization
CO ₂ Emissions	2% Decrease	Coal Dust Injection (CDI) Usage → Energy Efficiency Projects

6.6 Environmental Audit Practices in SAIL

Steel Authority of India Limited operates several large integrated steel plants across India, including Bhilai, Bokaro, Rourkela, Durgapur and Burnpur. Given its scale of operations, SAIL has established structured environmental management systems such as the Corporate Environmental Policy of SAIL, online Continuous Emission Monitoring Systems (CEMS) etc. supported by internal audits, third-party audits and statutory inspections.

Environmental audits in SAIL plants cover air and water pollution control, solid and hazardous waste management, occupational safety, and compliance with Central Pollution Control Board and State Pollution Control Board norms. Many units have obtained ISO 14001 certification, reflecting adherence to internationally recognised environmental management standards. Initiatives such as fly ash utilisation, slag granulation, sewage treatment, rainwater harvesting and groundwater monitoring are regularly reviewed during audits. In the recent audits of environment management practices in Steel Authority of India Limited by the CAG of India, the following issues were highlighted (CAG Report no.18 of 2020 & CAG Report no.38 of 2025):

<p>Ø Non-renewal of environment clearance certificate for the Modernisation and Expansion Plan (MEP) led to the suspension of work for installation of New Sinter plant and up-gradation of Steel Melting Shop-1 of Bokaro Steel Plant.</p>
<p>Ø Flaring up of gases due to delayed completion of Gas holder in Bokaro Steel Plant causing air pollution, loss of savings of energy and excess consumption of coal.</p>
<p>Ø Non-installation of solar power systems led to high cost of energy and emission of 3.30 lakh tonnes of CO₂ gases annually in the atmosphere.</p>
<p>Ø Shortfall in meeting the Renewable Energy Purchase Obligation (RPO), as notified by the Electricity Regulatory Commissions.</p>
<p>Ø Under-utilisation of Blast Furnace slag in Bhilai Steel Plant and Bokaro steel Plant led to the disposal of the slag in a non-eco-friendly manner.</p>
<p>Ø Under-utilisation of Basic oxygen finance (BOF) slag in Bokaro, Durgapur and Rourkela Steel Plant.</p>
<p>Ø Issues relating to other waste and hazardous waste in steel Plants in SAIL:</p> <ul style="list-style-type: none"> • Under-utilisation of BOF sludge led to water pollution and soil degradation • Non-completion of hazardous pit led to disposal of hazardous waste in open area • Accumulation of hazardous Electric Arc Furnace (EAF) dust in Alloy Steel Plant led to violation of Statutory guidelines • 'Waste to Energy' Plant and solid waste processing facilities were not installed. • Due to non-installation of Effluent Treatment Plants, effluents from hospitals were drained to oxidation pond and discharged into nallah/river.
<p>Ø Non-installation of Effluent Treatment Plants and Zero Liquid Discharge in plants led to water pollution and loss of water.</p>
<p>Ø Excess coke consumption led to higher emissions of Carbon Dioxide (CO₂) gas in the atmosphere.</p>
<p>Ø Incomplete utilisation and disposal of solid waste such as blast furnace sludge led to environmental hazards to the soil and water.</p>

SAIL has undertaken initiatives aligned with the concept of green steel, including energy efficiency projects, increased use of by-products and gradual reduction in carbon intensity. As reflected in its recent sustainability disclosures (2024-25), the company continues to focus on cleaner technologies and resource efficiency. Compliance with NGT directions, particularly related to ash ponds, groundwater protection and occupational safety, forms an integral part of audit follow-up actions (Steel Authority of India Limited, 2025).

6.7 Challenges in Environmental Auditing of Steel Industry

Despite progress, environmental auditing in the steel industry faces several challenges like:

- Ageing production technology in older plants
- High capital costs for pollution control upgrades
- Variations in audit quality and depth
- Limited public disclosure of audit outcomes

These challenges underscore the need for strengthening audit frameworks and integrating environmental audits with strategic planning and investment decisions. Global best practices emphasise low-carbon steelmaking, hydrogen-based processes and circular economy approaches, which are gradually being explored in India.

Environmental auditing in India is evolving from a compliance-focused exercise to a more performance and improvement-oriented process, in line with global trends. This is evident from initiatives such as Business Responsibility and Sustainability Reporting (BRSR) mandated by the Securities and Exchange Board of India, which emphasises measurable ESG performance, and the adoption of Continuous Emission Monitoring Systems (CEMS) linked to the Central Pollution Control Board for real-time monitoring and data-driven audits.

Strengthening audit capacity and transparency will be critical for aligning the Indian steel sector with international sustainability benchmarks such as the Global Reporting Initiative (GRI) Standards, United Nations Global Compact (UNGC) and the Task Force on Climate-related Financial Disclosures (TCFD) framework.

6.8 Conclusion

Environmental auditing plays a vital role in promoting sustainable development in the steel industry. In India, the steel sector's economic importance necessitates a careful balance between growth and environmental protection. The experience of SAIL demonstrates that systematic environmental audits, supported by regulatory oversight and management commitment, can lead to measurable improvements in environmental performance. However, continuous technological modernisation, stronger enforcement, and integration of audit findings into strategic planning are essential to meet future environmental and climate challenges.

Data Availability

None

Ethics Statement

This document meets the ethical guidelines and legal requirements of the country.

Funding

None

Conflict of Interest

No Conflict of Interest.

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