

# Technical Guide on Internal Audit of Mining and Extractive Industry

## DISCLAIMER

The views expressed in this Technical Guide are those of author(s). The Institute of Chartered Accountants of India may not necessarily subscribe to the views expressed by the author(s).



**Internal Audit Standards Board**  
**The Institute of Chartered Accountants of India**  
(Set up by an Act of Parliament)  
New Delhi

© The Institute of Chartered Accountants of India

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form, or by any means, electronic mechanical, photocopying, recording, or otherwise, without prior permission, in writing, from the publisher.

Edition : March, 2012

Committee/Department : Internal Audit Standards Board

E-mail : [cia@icai.org](mailto:cia@icai.org)

Website : [www.icai.org](http://www.icai.org)

Price : ₹ 150/- (including CD)

ISBN : 978-81-8441-527-8

Published by : The Publication Department on behalf of the Institute of Chartered Accountants of India, ICAI Bhawan, Post Box No. 7100, Indraprastha Marg, New Delhi - 110 002.

Printed by : Sahitya Bhawan Publications, Hospital Road, Agra - 282 003.

July/2012/1,000 Copies

## Foreword

---

The mining industry is a key segment of the Indian economy, with India being highly endowed with vast mineral resources. The country's accelerated growth rate warrants a rapid development of the mining industry, on which most of the basic industries in the manufacturing sector depend. Extraction and development of minerals are closely interlinked with other natural resources like land, water, air and forest. Hence, the management of this precious resource and its optimal and economical use are matters of national importance.

Globalization, competition of new mineral properties, and environmental regulations and concerns are some of the issues that introduce new layers of complexity for companies operating in mining industry. I congratulate CA. Rajkumar S. Adukia, Chairman, Internal Audit Standards Board, CA. Rajendra Kumar P., Vice Chairman, Internal Audit Standards Board and other members of the Board for bringing out this "Technical Guide on Internal Audit of Mining and Extractive Industry" as mining sector is one of the largest and capital intensive sector in the country. This comprehensive publication would surely help the members to understand entire spectrum of operational, conceptual and practical issues related to internal audit in mining sector.

I am sure that this Technical Guide would be an informative and useful publication for the members.

March 24, 2012  
New Delhi

**CA Jaydeep Narendra Shah**  
President, ICAI



## Preface

---

Minerals constitute the backbone of economic growth of India. It provides the foundation for industries by providing raw material and energy for manufacturing and other activities. Accordingly, with progressive industrialisation, the demand of mineral is ever-growing. In the face of growing demand, operating an efficient and streamlined business, as well as squeezing costs is most significant challenge for mining industry. The enterprise should adapt its ideal vision by analyzing its current business processes and core functions, such as production, maintenance and logistics. A strong, skilful and independent internal audit function is fundamental to achieve these objectives. Internal audit adds value to overall organizational performance by improving operational efficiencies and strengthening internal controls.

Keeping this in mind, the Internal Audit Standards Board is issuing the Technical Guide on Internal Audit of Mining and Extractive Industry, as a part of industry specific series of Technical Guides issued by the Board. The Technical Guide will help the readers to understand the basic operations undertaken in the industry, the regulatory and legal framework in which they operate and also internal audit aspects relating to the same.

The Technical Guide has been divided into various chapters. These chapters provide an overview of the mining industry. It deals with technical and operating aspects of the mining and extractive industry. It gives a brief overview on various aspects like industry structure, challenges faced by the industry, evaluation and assessment, mine planning, mine development, mineral processing, process monitoring. The Guide also covers the policies and regulation related to mining industry. It contains detailed checklist on internal audit that would help the readers in understanding the various technicalities arising during the internal audit of mining industry. List of applicable laws and statues and flow charts regarding various processes undertaken by the industry are also given in this Guide for providing valuable guidance to the readers. The Guide also contains list of abbreviations used in the mining industry for providing valuable guidance to the readers. In addition to this Guide, the Board has already issued "Technical Guide on Internal Audit in Oil & Gas Refining & Marketing (Downstream) Enterprises" and "Technical Guide on Internal Audit in Upstream Oil and Gas Companies" to help the members in understanding the basic concepts and peculiarities of the industry concerned.

At this juncture, I am grateful to CA. Vishal Ruia and his study group members, viz., CA. Arup Sen, CA. Dharmendra Lodha, Shri Dilip Kumar

Jena, CA. Puja Agarwal and CA. Anirban Dasgupta for sharing their experiences and knowledge with us and preparing the draft of the Guide.

I also wish to thank CA. Jaydeep N. Shah, President, ICAI and CA. Subodh Kumar Agrawal, Vice President, ICAI for their continuous support and encouragement to the initiatives of the Board. I must also thank our colleagues from the Council at the Internal Audit Standards Board, viz., CA. Rajendra Kumar P., CA. Amarjit Chopra, CA. Shiwaji B. Zaware, CA. Ravi Holani, CA. Anuj Goyal, CA. Nilesh S. Vikamsey, CA. Atul C. Bheda, CA. Charanjot Singh Nanda, CA. Pankaj Tyagee, CA. G. Ramaswamy, CA. J. Venkateswarlu, CA. Abhijit Bandyopadhyay, CA. S. Santhanakrishnan, Shri Prithvi Haldea, Smt. Usha Sankar, Smt. Usha Narayanan, Shri Manoj Kumar and Shri Sidharth Kumar Birla for their vision and support. I also wish to express my thanks to CA. Jyoti Singh, Secretary, Internal Audit Standards Board and her team of officers, CA. Gurpreet Singh, Assistant Secretary and CA. Arti Bansal, Sr. Executive Officer in giving final shape to the Technical Guide.

I am sure that this publication would prove to be a useful reference in making the process of internal audit in the mining sector comparable with the best in the world.

March 22, 2012  
Mumbai

**CA. Rajkumar S. Adukia**  
*Chairman*  
*Internal Audit Standards Board*

# Abbreviations

---

|        |  |
|--------|--|
| AFC    | Armored Flexible Conveyor                      |
| BOOT   | Build Own Operate & Transfer                   |
| BWE    | Bucket Wheel Excavator                         |
| CARO   | The Companies (Auditor's Report) Order, 2003   |
| CMMI   | Council of Mining and Metallurgical Institutes |
| CSO    | Central Statistical Organisation               |
| DMS    | Dense Medium Separation                        |
| DOA    | Delegation of Authority                        |
| DRI    | Directly Reduced Iron                          |
| ECOSOC | Economic and Social Council of United Nations  |
| ECS    | Electronic Clearing System                     |
| EFT    | Electronic Fund Transfer                       |
| EHS    | Environment, Health and Safety                 |
| ESI    | Employee State Insurance                       |
| FEMA   | Foreign Exchange Management Act                |
| FY     | Financial Year                                 |
| GDP    | Gross Domestic Product                         |
| GoI    | Government of India                            |
| GRN    | Goods Receipt Note                             |
| GW     | Giga Watt                                      |
| HMS    | Heavy Medium Separation                        |
| HR     | Human Resource                                 |
| HSE    | Health, Safety and Environment                 |
| IA     | Internal Audit                                 |
| IASB   | Internal Audit Standards Board                 |
| JC     | Job Card                                       |
| LC     | Letter of Credit                               |
| LHD    | Load Haul and Dump                             |
| LoA    | Letter of Allocation                           |
| LTIF   | Loss Time Injury Frequency                     |

|       |   |
|-------|---|
| MGR   | Merry-go-round                            |
| MIS   | Management Information System             |
| MT    | Million Tonnes                            |
| MTBF  | Mean Time between Failures                |
| MTTR  | Mean Time to Repair                       |
| OEM   | Original Equipment Manufacturer           |
| OT    | Over Time                                 |
| PERT  | Programme Evaluation and Review Technique |
| PF    | Provident Fund                            |
| PO    | Purchase Order                            |
| PPE   | Personal Protective Equipments            |
| PR    | Purchase Requisition                      |
| RBI   | Reserve Bank of India                     |
| ROI   | Return on Investment                      |
| ROM   | Run of Mine                               |
| SDL   | Side Discharge Loader                     |
| SEBI  | Securities and Exchange Board of India    |
| SIA   | Standards on Internal Audit               |
| SOA   | Schedule of Authority                     |
| SRN   | Services Receipt Note                     |
| TDS   | Tax Deducted at Source                    |
| UNECE | UN-Economic Commission for Europe         |
| UNFC  | United Nation Framework Classification    |
| UOA   | Utilisation of Available Hours            |
| VCR   | Vertical Crater Retreat                   |



# Contents

---

|  |             |
|--|-------------|
| <b>Foreword</b> .....                                  | <b>iii</b>  |
| <b>Preface</b> .....                                   | <b>v</b>    |
| <b>Abbreviations</b> .....                             | <b>vii</b>  |
| <b>Chapter 1. Introduction</b> .....                   | <b>1-2</b>  |
| Objective and Scope of Technical Guide.....            | 1           |
| <b>Chapter 2. Mining Sector- An Introduction</b> ..... | <b>3-22</b> |
| History of Mining .....                                | 3           |
| Mining – International Scenario.....                   | 3           |
| Global Mining Trends.....                              | 5           |
| Overview of Mining in India.....                       | 6           |
| Minerals and its Contribution to GDP .....             | 6           |
| Availability of Resources.....                         | 7           |
| Current Level of Production.....                       | 8           |
| Sector-wise Usage Overview .....                       | 9           |
| Coal.....  | 9           |
| Iron Ore.....  | 10          |
| Aluminium.....   | 10          |
| Copper.....  | 10          |
| Lead and Zinc.....                                     | 11          |
| Type of Mines (Open Pit/ Underground).....             | 11          |
| Methods of Mining .....                                | 12          |
| Open Cast Mines.....                                   | 12          |
| Underground Mines.....                                 | 13          |
| Business Outlook .....                                 | 14          |
| Industry Overview.....                                 | 14          |
| Industry Structure.....                                | 15          |
| General Challenges .....                               | 16          |
| Evaluation and Assessment in Mining .....              | 18          |

|  |              |
|--|--------------|
| United Nations Framework Classification for Energy and Mineral Resources ..... | 18           |
| Introduction.....  | 18           |
| Background.....  | 18           |
| Key Features.....  | 19           |
| Classification.....  | 20           |
| Codification.....  | 21           |
| Qualified Person.....  | 21           |
| Mapping and Modeling.....  | 21           |
| <b>Chapter 3. Technical Aspects of Mining Industry .....</b>                   | <b>23–59</b> |
| Mine Planning and Mine Scheduling .....  | 23           |
| Mine Planning – In General.....  | 23           |
| Components of a Mine Plan.....   | 23           |
| Mine Scheduling .....  | 27           |
| Mine Development .....   | 28           |
| Mine Development Strategy.....   | 28           |
| Site Survey.....   | 28           |
| Site Identification .....  | 28           |
| Mine Development Methodology – Opencast Mining/<br>Underground Mining .....    | 29           |
| Key Activities in Mining .....   | 34           |
| Mining Operations.....   | 34           |
| Mineral Processing .....   | 38           |
| Mineral Beneficiation.....   | 39           |
| Mine Closure.....  | 48           |
| Afforestation and Mine Closure .....   | 48           |
| Closure Plan .....   | 49           |
| Process Monitoring .....   | 52           |
| Budgeting, Cost Recording and Reconciliation Process .....                     | 52           |
| Quality Management Process .....   | 58           |

|   |               |
|---|---------------|
| <b>Chapter 4. Overview of Policy and Regulation.....</b>                        | <b>60–67</b>  |
| Existing Policies and Regulations.....  | 60            |
| Constitutional Mandate and Regulatory Framework .....                           | 60            |
| List of Central Acts, Rules, Regulations and Policies .....                     | 62            |
| The Mines and Minerals (Development and Regulation) Act, 1957.....              | 64            |
| The Mines Act, 1952 .....   | 65            |
| The Offshore Areas Mineral (Development and Regulation) Act, 2002 .....         | 65            |
| The Coal Mines (Nationalisation) Act, 1973.....                                 | 66            |
| Coal Mine (Nationalisation) Act (CMNA) 1973.....                                | 66            |
| List of Important Stakeholders having Significant Impact on Mining Sector ..... | 67            |
| <br>  |               |
| <b>Chapter 5. Internal Audit — Concepts .....</b>                               | <b>68–80</b>  |
| Internal Audit - Definition.....  | 68            |
| Internal Audit - Objectives .....   | 69            |
| Internal Control - Definition .....   | 70            |
| Internal Audit Team .....   | 71            |
| Legal Requirements for Conducting Internal Audit .....                          | 71            |
| Standards on Internal Audit.....  | 74            |
| Stages in Internal Audit.....   | 75            |
| Audit Planning .....  | 75            |
| Field Work.....   | 76            |
| <br>  |               |
| <b>Chapter 6. Relevance and Role of Internal Audit in Mining Industry .....</b> | <b>81–103</b> |
| Mine Evaluation and Assessment.....   | 82            |
| Mine Planning and Scheduling .....  | 83            |
| Mine Development .....  | 83            |
| Mining Operations .....   | 84            |
| Mineral Processing .....  | 89            |
| Consumption/Sale .....  | 90            |
| Mine Closure .....  | 91            |
| Process Monitoring .....  | 92            |

|   |     |
|---|-----|
| Human Resource and Payroll.....                     | 93  |
| Sub-Contracting Process .....                       | 94  |
| Finance, Accounts and Treasury Activities .....     | 96  |
| Procurement and Contract Management .....           | 98  |
| Statutory Compliance and Industrial Relations ..... | 101 |
| Information Technology.....                         | 102 |

# Chapter 1

## Introduction

---

1.1 The concern for ensuring effective corporate governance has become more pronounced with increasing complexity, global inter-linkages and fierce competitiveness in the business world. The basic wisdom that effective corporate governance leads to enduring wealth creation is, unfortunately, overlooked by some organizations. However, good organizations and agencies always adhere to the fundamentals of corporate governance for ensuring sustainable success. The various systems of checks and balances, of which internal audit is a very important one, constitute the architecture of corporate governance.

1.2 India's mining infrastructure is among the largest in the world and the complexity and financial resources involved are enormous. Further, the mining sector in India is on an unprecedented growth trajectory. Mining sector being one of the most capital intensive sectors, the financial implications of the sector's business dynamics are huge. This 'Technical Guide on Internal Audit of Mining and Extractive Industry' Inducting deals with the entire spectrum of conceptual and practical issues concerning internal audit. This will prove to be a very useful reference in making the process of internal audit in the mining sector of India comparable with the best in the world.

### Objective and Scope of Technical Guide

1.3 Internal audit is an independent management function, which involves a continuous and critical appraisal of the functioning of the entity with a view suggest improvements thereto and add value to and strengthening the overall governance mechanism of the entity, including the entity's risk management and internal control system. Thus, through its appraisal of management processes, internal audit can be of great assistance on effective and efficient management of mining sector.

Today, the scope of internal audit has increased from mere verification of financial transactions to reviewing of proper, efficient and economical usage of resources by the entity. Therefore, it is imperative that an internal auditor familiarizes with various management aspects and technical aspects of the

## **Technical Guide on Internal Audit in Mining and Extractive Industry**

mining sector for performing internal audit in more efficient and effective manner.

1.4 The Technical Guide deals with operational areas of entities operating in mining sector. The scope of this Technical Guide is confined to discussing the role that the Internal Audit function can play in this regard. This Technical guide is intended to assist internal auditors in carrying out internal audit in entities operating in mining sector.

## Chapter 2

# Mining Sector - An Introduction

---

### History of Mining

2.1 Mining of stone and metal has been done since pre-historic times. Since the beginning of civilization, people have used stone, ceramics and, later, metals found on or close to the Land. These were used by them to manufacture early tools and weapons, for example, high quality flint found in northern France and southern England was used to create flint tools. Flint mines have been found in chalk areas where seams of the stone were followed underground by shafts and galleries. The mines at Grimes Graves are especially famous, and like most other flint mines, are Neolithic in origin (ca 4000 BC-ca 3000 BC). Other hard rocks mined or collected for axes included the greenstone of the Langdale axe industry based in the English Lake District. Traditionally, mining focused on extracting minerals economically and with a degree of safety considered practical.

2.2 Ancient Egyptians mined malachite at Maadi. At first, Egyptians used the bright green malachite stones for ornamentations and pottery. Later, between 2613 and 2494 BC, large building projects required expeditions abroad to the area of Wadi Maghara in order "to secure minerals and other resources not available in Egypt itself." Quarries for turquoise and copper were also found at "Wadi Hamamat, Tura, Aswan and various other Nubian sites" on the Sinai Peninsula and at Timna.

2.3 Mining in Europe has a very long history, examples including the silver mines of Laurium, which helped support the Greek city state of Athens. However, it is the Romans who developed large scale mining methods, especially the use of large volumes of water brought to the minehead by numerous aqueducts. The water was used for a variety of purposes, including using it to remove overburden and rock debris, called hydraulic mining, as well as washing comminuted or crushed ores, and driving simple machinery.

### Mining - International Scenario

2.4 The price boom in the past decade has also brought renewed attention to the sharing of energy and mineral related wealth between host countries

## Technical Guide on Internal Audit of Mining and Extractive Industry

and investors. A number of world class deposits are now either being developed or are in the detailed pre-feasibility explorations stage-minerals such as bauxite, iron ore and mineral sands in Africa, and copper and iron ore in Asia. Strong demand and high prices have prompted a rush by investors to obtain access to mineral resources, with BRIC-based companies joining both large multinational and smaller juniors in seeking new resources.

2.5 With the rush in activity, access to resources has shifted from a “buyers’ market” (with countries seeking to attract mineral exploration and investment) to a “sellers’ market,” especially in Africa and Asia, with companies competing strongly to obtain mineral rights. The exploration boom has resulted in prospective areas being contracted or licensed with a shift towards competitive bidding and away from open access for mineral license. However, some mineral-rich countries have found that their mineral tax revenues have not increased commensurate with the sharp rise in prices and the increased profits of private developers, and therefore have been seeking to improve their EI-related tax collection in recent years.

2.6 Against this background of increased competition of resources, higher profitability and in some cases government frustration over low tax revenues at a time when the sector is booming, there has been a change in government attitudes toward sharing the profits of their resource wealth. Mining contract reviews have taken place in several African Countries (DRC, Tanzania, Guinea, Zimbabwe, Sierra Leone, Madagascar, and Guinea) and regulation changes and adjustments to royalty and tax rates have been either proposed or adopted in many others (South Africa, Chile, Australia, Ghana, Quebec, India, Peru, Argentina and Nigeria).

2.7 In addition, governments seem to be increasingly conscious of social and environmental safeguards, and are more focused on deriving economic benefits, whether in the form of infrastructure development, local content requirements, or increasing employment opportunities and skills training for local communities. Private sector companies are being held to higher standards, whether with respect to their management of environmental and social concerns, or to the transparency of their interaction with host governments.

2.8 The World Bank forecasts that global metals demand will grow faster than global GDP through 2015, and energy demand is likely to rise by 55 percent until 2030. 80 percent of this increase will be in fast-growing developing countries like China and India. Accordingly to the US Energy Information Administrator(EIA) International Energy Outlook 2010, total



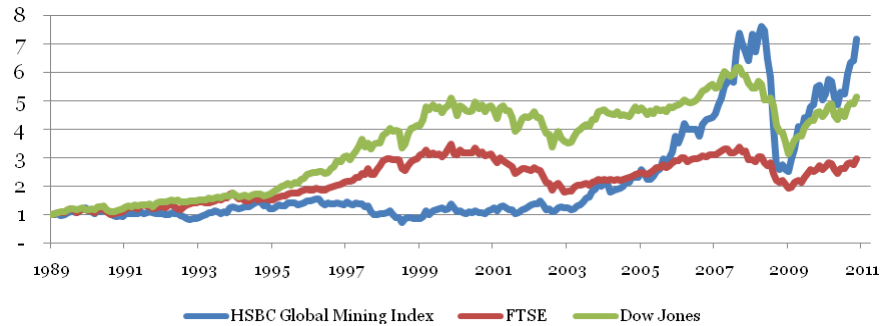
## Mining Sector – An Introduction

global energy demand will increase by 53 percent by 2035, with the bulk of the increase occurring in non-OECD countries: total energy demand in non-OECD countries will grow by 85 percent by 2035, compared to 18 percent demand growth in OECD countries. The dominant drivers of energy demand, the industrial and (personal) transport sectors, are expected to grow significantly in emerging economies over the coming decades.

### Global Mining Trends

2.9 Globally, the mining industry continues to grow, led by the strong growth in emerging markets. In 2010, the total year end market capitalization of the top 40 mining companies (by market capitalization) increased by 26% to USD 10 billion, with larger gains generally achieved by the smaller companies. While the industry was hit hard by the global financial crisis, mining companies have led the return and gone beyond.

**Global indices (February 1989 = 1)**



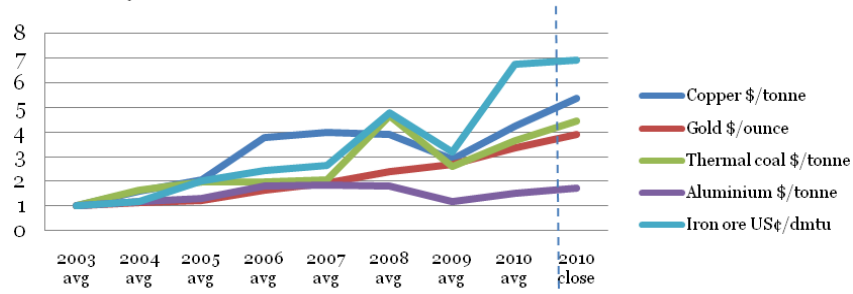
*Source: Bloomberg*

2.10 The analysis of top 40 mining companies shows that revenues crossed USD 400 billion mark for the first time in 2010 and the net profit rose to USD 110 billion. The highest revenue earning commodities were coal, copper, iron ore and gold. Emerging countries are leading the way as the demand for resources are driven by strong GDP growth. In 2010, the average Total Shareholder Return (TSR) of companies from emerging markets in the top 40 companies more than doubled the return from the traditional mining countries over the past four years.

The graph below depicts the trend of commodity prices over the past years:

## Technical Guide on Internal Audit of Mining and Extractive Industry

**Commodity Prices (2003 = 1)**



*Source: AME, PwC Analysis*

2.11 The supply is becoming increasingly constrained, as development projects become more complex and are typically in more remote, unfamiliar territory. There is the challenge of declining extraction grades, more geographically remote and/ or politically challenging regions and the increasing scale of projects required to generate economic returns. Supplying sufficient resources to meet the growing demand is a key challenge for the industry. To keep up with rising demand, the top 40 mining companies announced more than USD 300 billion of capital programs with maximum capital expenses in iron ore, coal, copper and gold.

2.12 It has been observed that there has been a global shift in mining deals with the share of Asian acquirers on a rise. For example, in 2010 (upto Sept), 21% of all deals involved an Asian acquirer, up from 10% a decade earlier. Further, the 35% of all deal targets (2010 to Sep) were in Africa, Middle East and Asia, up from 14% a decade earlier.

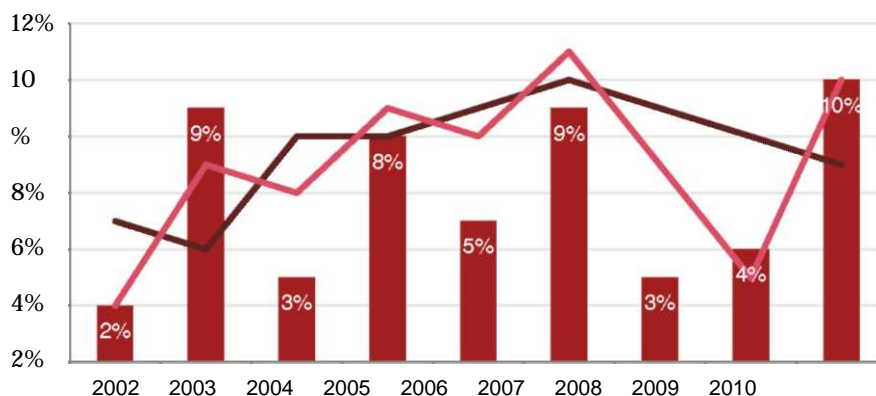
## Overview of Mining in India

### Minerals and its Contribution to GDP

2.13 Mining in India has been known to have existed with a long history. The tradition of mining in the region is ancient and has undergone modernization alongside the rest of the world since India gained independence in 1947. The economic reforms of 1991 and the National Mining Policy of 1993 further helped in the growth of the mining sector. India produces 87 minerals, which include 4 fuel, 10 metallic, 47 non-metallic, 3 atomic and 23 minor minerals (including, building and other materials). The mining sector in the country comprises of large state owned mining companies (listed), large integrated private mining-metal companies, and small fragmented independent holdings.

## Mining Sector – An Introduction

2.14 The sector has grown at an average rate of around 6% over the last 8 years. For the year 2010-11, Central Statistical Organisation (CSO) estimated mining and quarrying sector to account for 2.26% of GDP (at 2004-05 prices) with the contribution of ₹ 110,482 crore. If we consider the estimates of GDP at current prices, in 2010-11 the mining and quarrying sector is estimated to account for about 2.51% of GDP with the contribution of ₹ 182,278 crore. This indicates an increase of 18.2% compared to 2009-10.



*Source: Reserve Bank of India, Index of Industrial Production, Value of Mineral Production as published by Indian Bureau of Mines and Annual Reports of Ministry of Mines.*

## Availability of Resources

2.15 As discussed earlier, India is endowed with variety of minerals including metallic, non-metallic, fuel, atomic and minor minerals. The table below shows the reserves and resources availability of the selected metallic and non metallic minerals (as on April, 2010):

| Mineral | Unit              | Reserves <sup>1</sup> | Remaining <sup>2</sup> resources | Total resources |
|---------|-------------------|-----------------------|----------------------------------|-----------------|
| Bauxite | 000' tonnes       | 592,938               | 2,886,682                        | 3,479,620       |
| Copper  | Ore 000' tonnes   | 394,372               | 1,164,086                        | 1,558,458       |
|         | Metal 000' tonnes | 4,768                 | 7,518                            | 12,286          |

<sup>1</sup> Economically mineable part of measured and or indicated mineral resource; UNFC classification (111, 121 & 122)

<sup>2</sup> Total mineral resources excluding Reserves

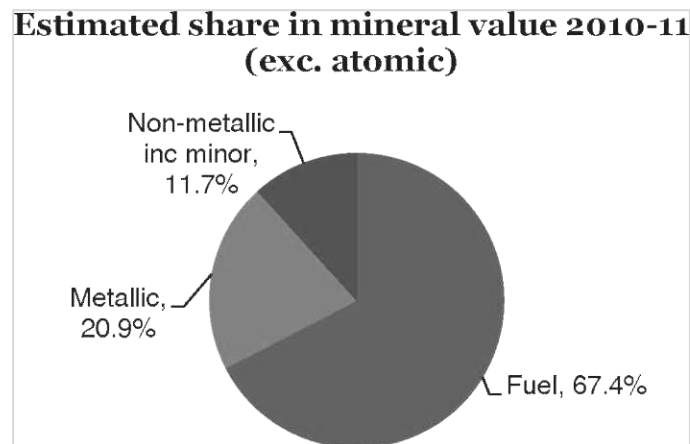
## Technical Guide on Internal Audit of Mining and Extractive Industry

|                   |                            |             |             |             |
|-------------------|----------------------------|-------------|-------------|-------------|
| Iron              | (Magnetite)<br>000' tonnes | 21,755      | 10,622,305  | 10,644,060  |
|                   | (Haematite)<br>000' tones  | 8,093,546   | 9,788,551   | 17,882,097  |
| Lead and zinc ore | 000' tonnes                | 108,980     | 576,615     | 685,595     |
| Manganese ore     | 000' tonnes                | 141,977     | 288,003     | 429,980     |
| Diamond           | carats                     | 1,045,318   | 30,876,432  | 31,921,750  |
| Dolomite          | 000' tonnes                | 738,185     | 6,992,372   | 7,730,557   |
| Mica              | Kg.                        | 190,741,448 | 341,495,531 | 532,236,979 |
| Nickel            | million tonnes             |             | 119         | 119         |
| Silver            | Ore tonnes                 | 187,558,668 | 279,426,291 | 466,984,959 |
|                   | Metal tonnes               | 8,039.47    | 19,588.68   | 27,628.25   |
| Tin               | Ore tonnes                 | 7,131       | 83,719,066  | 83,726,197  |
|                   | Metal tonnes               | 1,132       | 101,142     | 102,275     |

*Source: Indian Bureau of Mines*

## Current Level of Production

2.16 Considering the overall trend, the index of mineral production (base 1993-94=100) for the year 2010-11 is estimated to be 208.83 as compared to 193.36 for 2009-10 indicating growth rate of 7.4%.



*Source: Ministry of Mines, National Mineral Scenario*

## Mining Sector – An Introduction

If we look at the world production data, in 2009-10, India ranked second in barytes, chromite and talc/ steatite/ pyrophyllite, third in coal and lignite, fourth in iron ore and kyanite/ sillimanite, fifth in manganese ore, steel (crude) and zinc, sixth in bauxite, eighth in aluminium and tenth in magnesite.

The mineral production in the country is primarily dominated by the public sector. For e.g., in 2009-10, the public sector accounted for about three-fourth of the mineral production. It accounted for production 91% of coal, 86% of petroleum (crude), 77% of Natural gas (utilized), 58% of tin concentrate, 99% of Barytes, 84% of Kyanite, 74% of Silimanite and 60% of Magnesite. Small mines, which were mostly in the private sector, continued to be operated manually either as proprietary or partnership ventures.

## Sector-wise Usage Overview

### Coal

2.17 The commercial coal in the country is mainly consumed by the power, steel and cement sector. Other industries have a marginal impact on the long term demand for coal as they are relatively small players and can resort to alternative fuels.

The power sector is the largest consumer of coal in India. It accounts for nearly 66% (72% including captive) of the total demand. Of the 185.5 GW (November 2011) of installed power generation capacity, coal-based capacity constitutes 55% while it contributes to more than 70% of the power generated.

The second major consumer of coal is the steel industry accounting for about 14% of the total consumption. India has limited reserves of coking coal with only 16% of proven coal reserves being coking, which is a key raw material for steel production. Further, about 70% of the Directly Reduced Iron (DRI) production is based on coal. For 2011-12, coal demand is estimated at 69 MT of coking coal and 29 MT of non-coking coal for the steel industry (Planning Commission). The per capita steel consumption is only 49kg which is about one-fourth of the world's average. This suggests that the demand has significant headroom to grow as India invests in infrastructure and as the penetration of consumer durables increases which in turn will drive demand for both coking as well as non-coking coal.

The cement industry accounts for about 4% of the coal consumption. For FY 2011-12 the assessed coal requirement for the sector is 33 MT. In the

## Technical Guide on Internal Audit of Mining and Extractive Industry

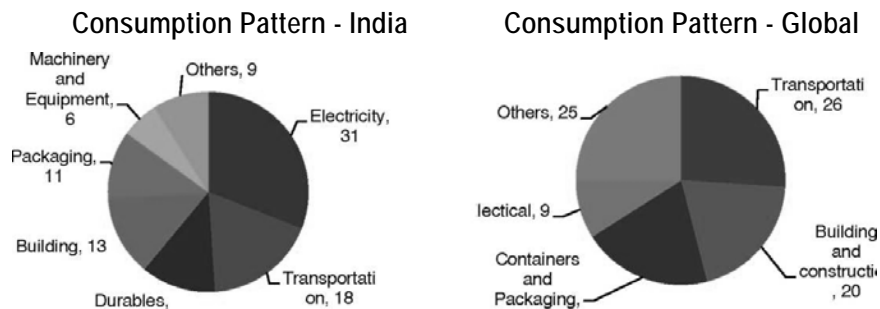
last few years, the consumption of coal to produce cement has reduced because of the dry process adopted to improve efficiency in cement kilns and increased use of fly ash and granulated slag in the production of cement. However, being queued after power and steel, the cement industry faces problems of inadequate coal supplies.

### Iron Ore

2.18 Iron ore is consumed in various industries such as, iron & steel, sponge iron, ferro-alloys, alloy steel, coal washery and cement. In FY 2010, the country consumed about 91 million tonnes iron ore. The main consumers for the ore are iron & steel industry including, sponge iron. These account for about 98% of iron ore consumption.

### Aluminum

2.19 The electrical sector is the largest consumer of aluminum where bulk of the aluminum is used in overhead conductors and power cables used in generation, transmission and distribution of electricity. The Indian consumption pattern is in contrast with the global consumption pattern.



*Source: Mineral year book, 2010*

Further, the per capita consumption of aluminum in India is very low (only 0.7 kg) compared to the world average (world average 12-15 kg).

### Copper

2.20 The key demand drivers for copper are telecom, power and infrastructure sector. Electrical, Electronics and Telecommunications sectors account for nearly 52% of copper usage in India. Per capita consumption in India is about 0.50 Kg as compared to 10 Kg in developed nations. It has been observed that with increased application of fibre optic cables and fast penetration of wireless communication through cell phones, Wireless in Local Loop and DTH Telecasting there has been reduction in copper demand in

## Mining Sector – An Introduction

telecom sector. The use of copper in building construction is gradually developing in the country, mainly in metro cities and industrial projects.

### Lead and Zinc

2.21 The lead consumption in the country is mainly by battery industry. It consumes about 74% of lead followed by pigments and compounds 9%, rolled and extruded products 8%, alloys 3%, cable sheathing 2% and rest 4% is consumed by other industries.

Zinc is corrosion resistant due to which it is used for protecting steel by way of galvanising. The galvanising industry consumes about 57% of zinc, followed by coatings 16%, die-casting alloys 14%, oxides and chemicals 7% and extruded products 6%.

### Type of Mines (Open Pit/ Underground)

2.22 The number of mines which reported mineral production (excluding minor minerals, petroleum (crude), natural gas and atomic minerals) in India was 2628 in 2010-11. Of these about 92% of mines are present in 11 states, i.e., Gujarat, Andhra Pradesh, Jharkhand, Madhya Pradesh, Rajasthan, Karnataka, Orissa, Tamil Nadu, Maharashtra, Chhattisgarh, and West Bengal. The table following shows the number of reporting mines in the last three years.

| No. of reporting sector  | 2008-09 | 2009-10 | 2010-11 |
|--------------------------|---------|---------|---------|
| All Minerals*            | 3150    | 2999    | 2628    |
| Coal (including Lignite) | 574     | 574     | 574     |
| Metallic Minerals        | 719     | 700     | 608     |
| Non-Metallic Minerals    | 1857    | 1725    | 1446    |

\*Excluding atomic minerals, petroleum (crude), natural gas (utilized) and minor minerals.

The number of reporting mines is decreasing due to closure or suspension of mining activities due to non-renewal of mineral concessions; non-renewal of environment and forestry licenses/ permits; uneconomic operations and scheduled closures.

## Technical Guide on Internal Audit of Mining and Extractive Industry

2.23 Mines are broadly classified into two categories:

(i) **Open Cast Mines (Surface Mines)**

Open cast mining involves extraction of mineral/ coal by excavating whole of the material lying between the mineral/ coal body and the surface. The waste rocks so mined are termed as Over Burden (OB).

(ii) **Underground Mines**

In underground mining an opening (inclined or vertical) is made from the surface to reach the required depth and then tunnels (galleries) are developed horizontally to reach the mineral/ coal body. Presently, there are 359 underground mines in coal and 85 underground mines in other minerals (excluding fuel, atomic and minor minerals).

## Methods of Mining

### Open Cast Mines

2.24 Methods of mining in open cast mines are as follows:

- (i) **Shovel - Dumper Mining** – The combination of shovel and dumper accounts for majority of the production from open cast mines in India. In this system, the shovel is used for loading the material on the dumper, which then hauls (transports) it to the assigned dumping point. This method enables fastest commencement of production. It is one of the most flexible mining method available.
- (ii) **Dragline Mining** – Dragline is used only for the removal of the overburden. It is, generally, used in mines having high stripping ratio, so as to reduce the cost of overburden removal. This method enables overburden removal at a very high rate, although it involves huge capital investment for the procurement of a dragline. The procurement and installation of a dragline may itself take up to 3.5 years.
- (iii) **Bucket Wheel Excavator Mining** – A Bucket Wheel Excavator (BWE) is used for continuous mining operations, generally in combination with conveyors. It is, generally, used when the mineral/ coal strata is relatively soft and amenable to direct extraction without the need of blasting. However, BWE can also be coupled with blasting operations as blasting loosens the material and increases productivity. In India, BWE is being used in lignite mining only. BWE is a continuous system of mining, wherein the excavated material is transported to the delivery point continuously and not in lots (as in case of shovel-dumper). A



## Mining Sector – An Introduction

BWE can cost about \$100 million and its assembly at the site may take up to 5 years. This method of mining is not easily amenable to changes in the mine plan during the mine life.

- (iv) **Mining using Surface Miner** – Surface miners eliminate the need for drilling and blasting and allows selective mining. The mineral/ coal can be cut and crushed in one machine pass with low manpower requirements. The excavated mineral/ coal is usually left behind in windrow fashion and can be loaded on demand. This technique of not loading simultaneously decouples the excavating and loading processes, and thus removes waiting time for trucks.

## Underground Mines

2.25 Following are methods of mining in underground mines:

- (i) **Room and Pillar Mining** – The room and pillar mining method is a type of open stoping used in near horizontal deposits in reasonably competent rock, where the roof is supported primarily by pillars. Ore is extracted from rectangular shaped rooms or entries in the ore body, leaving parts of the ore between the entries as pillars to support the hanging wall or roof. The pillars are arranged in a regular pattern, or grid, to simplify planning and operation. They can be any shape but are usually square or rectangular.
- (ii) **Shrinkage Stoping** – Shrinkage stoping is a vertical, overhand mining method whereby most of the broken ore remains in the stope to form a working floor for the miners. The broken ore in the stope is to provide additional wall support until the stope is completed and ready for drawdown. Stopes are mined upward in horizontal slices. Normally, about 35% of the ore derived from the stope cuts (the swell) can be drawn off ("shrunk") as mining progresses. The method is labor intensive and cannot be readily mechanized.
- (ii) **Sublevel Stoping** – Sublevel stoping, also known as blast hole or long hole stoping, is an open stoping, high-production, bulk mining method applicable to large, steeply dipping, regular ore bodies having competent ore and rock that requires little or no support. The method is often selected as an alternative to sublevel caving when dilution levels must be kept to a minimum. It is currently limited to steeply inclined ore bodies where both ore and country rock are competent

## Technical Guide on Internal Audit of Mining and Extractive Industry

and broken ore flows under the influence of gravity. Ore bodies should be regular, because the method is not selective.

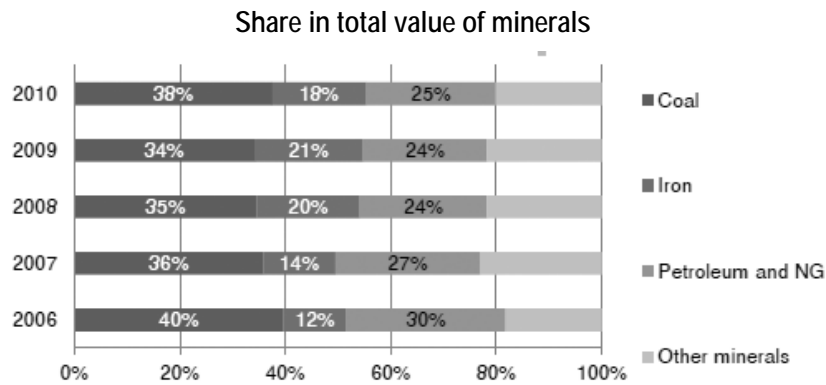
- (v) **Vertical Crater Retreat Method** – VCR (vertical crater retreat) mining is a horizontal, flat-back variation of sublevel stoping using spherical crater charges to break the ore. Blasting is carried out at the base of vertical holes, making horizontal cuts and advancing upward. Shrinkage can be utilized in the stopes for wall support. Because the method requires less development than sublevel stoping, it has the potential for lower costs and is finding increasing application not only for pillar recovery but also for primary stoping.
- (vi) **Cut and Fill Stopping** – Cut and fill stoping is an underground mining method in which a single excavation pass (cut) is completed and backfilled before another cut is made. Cut and fill mining is primarily utilized for steeply dipping vein deposits and large, irregularly- shaped deposits. The major elements of the cut and fill mining cycle include drilling, blasting, mucking, ground support, cleanout, raising up, backfilling.
- (vii) **Longwall Mining** – Longwall mining is a form of underground coal mining where a long wall of coal is mined in a single slice .The longwall panel is typically 3 to 4 km long and 250 to 400 m wide. Longwall panels are blocked out by the panel entries that are excavated in- seam on both sides of the main entries. Longwall mining is carried out in two types, namely advancing longwall and retreating longwall. Ore at the face cut by the shearer or plow is loaded onto the armoured flexible conveyor (AFC) and transported to the head entry T junction. Then ore is transferred from the AFC onto a stage loader, which in turn empties.

## Business Outlook

### Industry Overview

2.26 The mining and mineral sector has recorded a strong growth of 8.29% during 2009-10 over the previous year. This is significant over the historical growth (the last five years' average is a modest 4%). The mineral industry is valued at \$28.8 billion in production, of which coal and iron ore contribute more than 50%.

## Mining Sector – An Introduction



*Source: Indian Bureau of Mines*

2.27 In coal, India has the fourth largest reserve in the world at 265 billion tonnes. It is also the third largest producer of coal in the world and the annual production is growing at 6%. Currently, total coal production stands at about 550 million tonnes against demand of more than 600 million tonnes. By the end of twelfth five year plan, the coal production is projected to be more than 1 billion tonnes. In Iron ore, India has the fifth largest reserve base at 25.25 billion tonnes. It is also the fourth largest producer in the world; and the annual production is growing at 13%. India is the world's top producer of sheet mica and the sixth- largest producer of bauxite too.

2.28 Though mining sector is growing but the mining in India is closely linked with forestry and environmental issues. A significant part of the nation's known reserves are in areas which are under forest cover. Further, many of these reserves are also located on scheduled areas (indigenous lands). Further, only around 10% of the country's landmass has been explored and there is uncertainty around the exact quantity of unexploited reserves, but many believe the potential to be significant.

### Industry Structure

2.29 India's mining industry is a dominated by big companies and very small ones, with 5% of the mines in operation accounting for approximately 50% of total mineral output, highlighting a key focus area for supply and services providers entering the Indian market. The remainder of the market is highly fragmented, with a large number of small and inefficient mines, many of which are considered illegal by law enforcing agencies.

2.30 Though the mining industry is open to overseas competition and foreign investment, the investment volumes have been low till date. India's

## Technical Guide on Internal Audit of Mining and Extractive Industry

mining industry is being dominated by state-owned companies and public sector undertakings, such as Coal India, Steel Authority of India, National Aluminum Corp and National Mineral Development Corp. Coal India is the world's largest coal producer, accounting for 80% of India's domestic coal output.

Private companies too have been achieving success with Vedanta Resources and Tata Steel being two prime examples of Indian publicly traded companies from the lot. A number of coal, iron ore, bauxite, lead, zinc and uranium mines are currently under development in India, owned by Eastern Coalfields, Hindalco Industries, Uranium Corporation of India and Hindustan Zinc.

The list of global mining majors in India includes BHP Billiton, Rio Tinto, Vale and DeBeers. They have projects and exploration interests in India, but are not considered major players in the market at this stage. There are also roughly another 10-15 Australian, British and Canadian companies currently conducting exploration programs in India.

### General Challenges

2.31 Despite being home to a wealth of natural resources, the mineral output of India's mining industry has suffered as a result of procedural challenges, project delays and captive mining laws. Some of the challenges faced by mining sector are as follows:

#### (i) Procedural Delays

Given the current allocation process, the multi-layered and extensive regulatory approvals and local permission, coal projects in India can take as long as eight to 12 years to commission as compared to other countries where it takes five to-six years. The uncertainty and differences in the administration, interpretation and enforcement of the rules and regulations adds to the challenges in the Indian coal industry. This has the effect of delaying investment in the sector even as growth in end user sectors has resulted in unprecedented growth in demand for commodities.

#### (ii) Lack of Evacuation Infrastructure

Infrastructure is a key cost component in the mining value chain. It needs investment in development of railways, road and port facilities for cost-effective and timely movement of materials. An individual mine licensee or user cannot invest in these, but is impacted by the deficiencies. Thus, a

## Mining Sector – An Introduction

broader programme of infrastructure creation even by Build Own Operate and Transfer (BOOT) type projects is necessary.

### **(iii) Limited Fiscal Incentives**

The mineral exploration has not attracted the required attention over the years. The fiscal incentives for investment in mineral exploration are far unattractive compared to incentives and fiscal benefits for say, the oil and gas sector.

### **(iv) High Lead Time in Equipment Deliveries**

Delivery lead time for plant and mobile equipment has a significant impact on production volumes and operating costs. We need to offer mine operators fiscal and tax incentives to invest in larger and efficient technologies.

### **(v) Environmental Regulations and Sustainable Development**

Environmental regulations in India are becoming more stringent and Indian courts are very conscious of the need to enforce environmental laws. There are many environmental organizations and lobby groups in India, who have been able to successfully influence public sector policy to create a heightened focus on environmental protection. Rehabilitation and resettlement requirements are now regarded as extensive. The Government is now preparing a sustainable development framework for addressing these issues.

### **(vi) Captive Mining Policies**

India has long held a policy where mining operations could only be conducted by the government or government controlled enterprises. Over the years this policy position has evolved to allow captive mining by private companies who are engaged in the end production of iron, steel or power generation in selected regions.

This policy in itself has hindered the growth of mining in India. Many of the world's leading mining companies have a very limited presence in India as a result of this policy. This in turn has also led to a slow adoption of leading industry practices and technologies in India.

## Evaluation and Assessment in Mining

2.32 The mineral resource classification system being followed in India is the United Nations Framework Classification (UNFC) style of classification. All the minerals, including coal, are classified under various categories of this system depending upon the level of confidence in their measurement and classification.

## United Nations Framework Classification for Energy and Mineral Resources

### Introduction

2.33 The United Nations Framework Classification (UNFC) for Energy and Mineral Resources is a universally applicable scheme for classifying/evaluating energy and mineral reserves and resources. Most importantly, it allows a common and necessary international understanding of these classifications/ evaluations. The Classification is designed to allow the incorporation of currently existing terms and definitions into this framework and, thus, to make them comparable and compatible.

This approach has been simplified through the use of a three-digit code clearly indicating the essential characteristics of extractable energy and mineral commodities in market economies, notably

- Degree of economic/ commercial viability
- Field project status and feasibility
- Level of geological knowledge.

### Background

2.34 The UN-Economic Commission for Europe (UNECE) developed the United Nations Framework Classification for Resources/ Reserves (Solid Fuels and Mineral Commodities) to provide a basis for comparison of the various schemes in use around the world. The UNFC was developed because of a perceived need for an internationally acceptable reserve/ resource classification system.

The UNECE Working Party on Coal initiated the first version of the United Nations Framework Classification for Solid Fuels and Mineral Commodities in 1992, on the basis of a proposal made by the German Government. In 1997, after six years of efforts by the UN Task force, the ECOSOC recommended to all UN member countries to apply the Classification to their coal and

## Mining Sector – An Introduction

mineral sectors. Since then, the classification has been applied in more than 60 countries worldwide, a number of them introduced the UNFC as a national system, and others adapted their national systems to the UNFC principles.

In October 1998, the UNECE Task Force and CMMI Expert Group reached an agreement to integrate their respective definitions into a single, universally applicable set of definitions. The joint UN/ CMMI definitions for mineral reserves and resources were completed in November 1999.

The UNECE Committee on Sustainable Energy decided, at its eleventh session in November 2001, to create an Inter-governmental Ad Hoc Group of Experts on the Harmonization of Energy Reserves/ Resources Terminology.

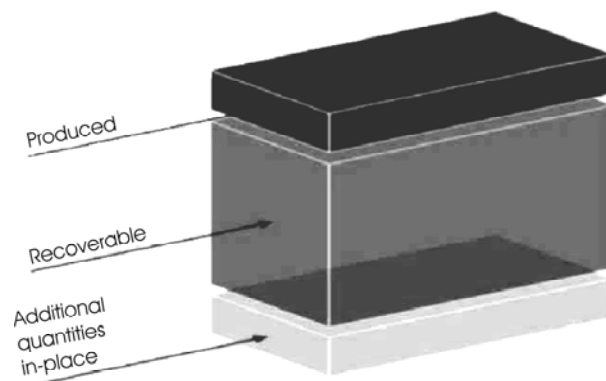
After completion of work of Ad Hoc Group of Experts, at its fifty-ninth session in February 2004, the UN Economic Commission for Europe endorsed the United Nations Classification for Energy and Mineral Resources and proposed to the ECOSOC that it recommend its application worldwide.

### Key Features

2.35 According to the United Nations Framework Classification (UNFC) for Energy and Mineral Resources, the total resources initially in-place of naturally occurring energy and mineral resources, are described in terms of three quantities, namely:

- Produced quantities
- Remaining recoverable quantities
- Additional quantities remaining in place

The main focus of the UNFC is on remaining recoverable quantities.



Total initial in-place resources

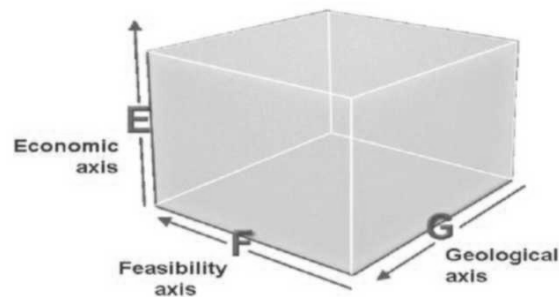
*Source: United Nations Framework Classification for Energy and Mineral Resources*

## Technical Guide on Internal Audit of Mining and Extractive Industry

### Classification

2.36 Total remaining resources are categorized using the three essential criteria affecting their recoverability:

- Economic and commercial viability (E).
- Field project status and feasibility (F).
- Geological knowledge (G).



### Principal Elements of the UNFC

Source: United Nations Framework Classification for Energy and Mineral Resources

2.37 The three criteria are easily visualized in three dimensions as shown in the figure below:

| UN International Framework             |                 | Detailed Exploration | General Exploration | Prospecting | Reconnaissance |
|--|-----------------|----------------------|---------------------|-------------|----------------|
|  | National System |                      |                     |             |                |
| Feasibility Study and/or Mining Report |                 | 1 (111)              | usually             |             |                |
|  |                 | 2 (211)              |                     |             |                |
| Prefeasibility Study                   |                 | 1 (121) + (122)      | not relevant        |             |                |
|  |                 | 2 (221) + (222)      |                     |             |                |
| Geological Study*)                     |                 | 3 (331)              | 3 (332)             | 3 (333)     | 3 (334)        |

Economic Viability Categories:

1: economic  
2: potentially economic

3: intrinsically economic (economic to potentially economic)

### UNFC International Framework

Three main categories are used to describe economic and commercial viability, three to describe field project status and feasibility and four to



## Mining Sector – An Introduction

describe the level of geological knowledge. Further, subdivision of the main categories is useful for special applications.

Resource quantities are then grouped into classes that are defined by categories E, F and G (each denoted by numerics resulting in codification of resources) represented by the sub-cubes as presented in the figure above. A class of quantities may be a single sub-cube, i.e. 111, or a collection of sub-cubes. Total resources are an example of such a class where all sub cubes are included in the class.

### Codification

2.38 Due to variation between terminologies in different systems and languages, it is recommended to use only three digit numeric codes for individual categories, so that they will be universally understood. For this to be possible, the sequence is always fixed, so that the quantity characterized as E1; F1; G1 may be written in number form as 111, independent of languages. In practice, only a limited number of combinations (classes) are valid.

Sub-categories may be added under the main categories when required. Categories and sub-categories shall be numbered. A sub-category shall be separated from the main category number by a decimal point, e.g., E1.1. In such cases the categories have to be separated by a semicolon to distinguish the different categories that are included in the codified unit, e.g. 1.1; 1; 1 for the subcategory defined by E1.1, F1 and G1.

### Qualified Person

2.39 The studies referred to in the UNFC must be undertaken by a person(s) with the appropriate qualifications to assess resources/ reserves of the type of commodity in question. The qualifications and experience required will vary from country to country. In certain circumstances licensing may be required.

### Mapping and Modeling

2.40 The UNFC style classification system describes the mapping and modeling techniques of the identified/ measured resources for mineral deposits that are classified into following three categories:

- Stratiform, Stratabound and Tabular deposits of Regular habits
- Stratiform, Stratabound and Tabular deposits of Irregular habits
- Dimensional stones

## **Technical Guide on Internal Audit of Mining and Extractive Industry**

The mapping and modelling are made on a pre-defined scale, varying from 1:1000 to 1:50000, depending on the type of mineralisation and also on the level of confidence, as per the codification system. However, in general, for other minerals than coal, a smaller (enlarged view) map has been prescribed owing to the fact that the mineral composition of the basic mineral present in the ore body varies from place to place which needs a higher level of precision to be dealt with so as to prepare a better mine plan based on the mineral content.

# Chapter 3

## Technical Aspects of Mining Industry

---

### Mine Planning and Mine Scheduling

#### Mine Planning – In General

3.1 For designing a mine plan and mine scheduling, all the data and information collected from the exploratory studies are collated at a single place. Software tools like, SURPAC, MINEX, MineSight, and other tools are available with the help of which a mine is designed, based on which the planning and scheduling is made.

In India, the mines have been categorised in the following two categories for the purpose of Mine Planning:

- Category A mines: Category A mines shall be such mines where the work is being carried out by deployment of heavy mining machinery for deep hole drilling, excavation, loading and transport is carried out with the help of heavy machinery.
- Category B Mines: Other than fully mechanized category A mines, where the number of average employment exceeds 150 in all or 75 in workings below ground.

There are minor differences in mine plans for category A and B mines

#### Components of a Mine Plan

3.2 Following are the components of a Mine Plan:

##### (i) Part A

- Geology and Exploration
  - Indicating general topography and geology.
  - Geological sections and year wise future program of exploration.
  - Indicate geological and recoverable reserves and grade. Availability of resources should also be indicated for the entire leasehold.
  - Indicate mineable reserves by slice plan / level plan method, as applicable, as per the proposed mining parameters.

## Technical Guide on Internal Audit of Mining and Extractive Industry

- Mining
  - Existing/ proposed method for developing/ working the deposit with all design parameters
  - Quantum of development and tonnage and grade of production expected pit-wise.
  - Year wise plans and sections.
  - Proposed rate of production when the mine is fully developed and expected life of the mine and the year from which effected.
  - Conceptual mining plan based on the geological, mining and environmental considerations.
  - In case of open cast mining, following are the further components specific to it:
    - o Mode of working
    - o Layout of mine workings, the layout of faces and sites for disposal of overburden / waste.
  - In case of underground mining, following are the further components specific to it:
    - o Mode of entry
    - o System of winding / hoisting
    - o Underground layout
    - o Method and sequence of stoping
    - o Mine ventilation
    - o Extent of mechanization (Drilling machine, loading equipment, haulage and transport and miscellaneous).
- Blasting
  - Broad blasting parameters
  - Type of explosives used
  - Powder factor in ore and overburden/ waste/ development heading/ stope
  - Whether secondary blasting is needed
  - Storage of explosives.

## Technical Aspects of Mining Industry

- Mine Drainage
  - Depth of water table
  - Progress of working related to above or below water table
  - Quantity and quality of water likely to be encountered
  - Pumping arrangements
  - Discharge of pumped out water.
- Stacking of mineral rejects and disposal of waste
  - Nature and quantity of top soil, overburden/ waste and mineral rejects likely to be generated during the next five years
  - Land chosen for disposal of waste with proposed justification
  - Manner of disposal, sequence of buildup of dumps along with the proposals for the stacking of sub-grade ore.
- Use of mineral
  - End-use of the mineral
  - Physical and chemical specifications stipulated by buyers
  - Details of blending of sub grade ore being practiced or need to be practiced.
- Other
  - Site services
  - Employment potential
    - Highly Skilled
    - Skilled
    - Semi-Skilled
    - Un-Skilled.
- Mineral processing
  - Nature of the processing / beneficiation (If required) indicating size grade of feed material and concentrate and recovery rate.
  - Disposal method for tailings
  - Schematic diagram of the processing procedure
  - Specify quantity and type of chemicals to be used

## Technical Guide on Internal Audit of Mining and Extractive Industry

- Quantity (cu.m./day) of water required, sources of supply of water
- Disposal of water and extent of recycling.

### (ii) Part B

- Environmental Management Plan
  - Existing land use pattern
  - Water regime
  - Flora and fauna
  - Quality of air, ambient noise level and water
  - Climatic conditions
  - Human settlements
  - Public buildings, places of worship and monuments
  - Attach plans showing the locations of sampling stations
  - Does area (partly or fully) fall under notified area under Water (Prevention & Control of Pollution), Act, 1974
  - Environmental Impact Assessment
    - o Land area
    - o Air quality
    - o Water quality
    - o Noise levels
    - o Vibration levels (due to blasting)
    - o Water regime
    - o Socio-economics
    - o Historical monuments etc.
  - Temporary storage and utilization of topsoil
  - Year wise proposal for reclamation of land
  - Programme of afforestation, year wise for the initial five years
  - Stabilization and vegetation of dumps along with waste dump management
  - Measures to control erosion/ sedimentation of water courses
  - Treatment and disposal of water from mine.

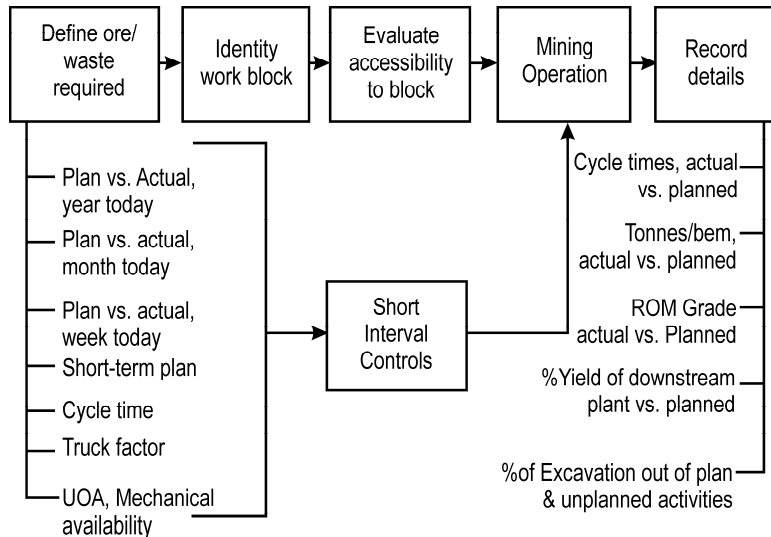
## Mine Scheduling

3.3 An approved mine plan contains the scheduling for all the time bound components, like Mine Development, Mine operations (year-wise/ month-wise), Mine Closure activities, Offtake of the Run of Mine (ROM)/ processed ore/ mineral.

Some of the general time schedules prepared even during the pre-development stages of the mine are:

- Timelines for the processing plants construction – This would specify the various timelines required for the construction and commissioning of the ore processing plant. This would be aligned with respect to the mine production start date.
- Timelines for various infrastructure constructions – This timeline would include the developmental constructions on the surface.
- Material procurement planning – Material procurement and storage are equally important aspect of any type of industry. Plans would be made for the long-term consumables and for the daily consumables, depending on the requirement of the mine development and operation.

3.4 The mine scheduling aspect can be broadly segregated into various heads which have been defined in the process flow diagram below:



Process Flow Diagram of Mine Scheduling

## Mine Development

### Mine Development Strategy

3.5 If the mining deposit, after all the due diligence and exploratory studies, is found to be economically feasible, the mine is developed to achieve its desired production.

Depending on whether the mine is to be operated by Open Cast Mining Method or Underground Mining Method, as per the Letter of Allocation (LoA)/ Mining Lease for the mining area and subsequently the approved mine plan, the mine development strategy is made.

### Site Survey

3.6 The first step involved in the mine development activity would be to perform a general site survey. This would involve the survey of the whole mining area from the perspective of:

- Topographical survey
- Planimetric survey
- Contour survey

### Site Identification

3.7 This step would be followed to identify the main and the basic mine infrastructure and facilities. The identification would be carried based on the results and interpretation obtained from the site surveys. Following are the features of the mine that would require their respective allocation:

#### Comparison of Features of Opencast and Underground Mining Methods

| Open Cast Mining Method   | Underground Mining Method     |
|---|-------------------------------|
| Development of access roads to the ore/mineral, including mining haul roads         | Shafts location               |
| Box cut (This is the first opening designed from where the first OB removal starts) | Ventilation cooling plant     |
| Settling Ponds  | Main fan for mine ventilation |
| Site workshop   | Pit-head workshop             |
| Site base camp/ hutments  | Pit-head base camp/ hutments  |



## Technical Aspects of Mining Industry

| Open Cast Mining Method   | Underground Mining Method   |
|---|---|
| Dump Yard   | Recreation centre   |
| Recreation centre   | Pit-head office   |
| Site office   | Communication facilities  |
| Communication facilities  | Pit-head canteen  |
| Site canteen  | Pit-head store for PPEs   |
| Site store for PPEs   | Pit head store for spare parts and other ancillaries                          |
| Pit head store for spare parts and other ancillaries                      | Pit-head Light Room   |
| Site Light Room   | Pit-head Ore Processing Plant, including stock yard (processed ore/ tailings) |
| Site Ore Processing Plant, including stock yard (processed ore/ tailings) |   |
| Electrical substations  | Electrical substations  |
| Pumping stations (head, etc.)   | Pumping stations (head, etc.)   |
| Water supply arrangements   | Water supply arrangements   |
| Material (Ore/ Processed products) transportation facilities              | Material (Ore/ Processed products) transportation facilities                  |
| Wagon loading arrangement, including tipping arrangements                 | Wagon loading arrangement, including tipping arrangements                     |

### Mine Development Methodology - Opencast Mining/ Underground Mining

3.8 The following are the activities involved in mine development:

- **Forestry and Land Clearance** – The first and the foremost activity involved in the Mine Development activity is the Site Clearance, also known as Deforestation. This activity is performed by using heavy equipments like, dozers and graders. The activity is essential in the sense that it provides access to the mining area and the mining activities to be carried out.
- **Development of Mine** – For the development of mine, various plans showing the following are prepared. These plans are part of either

## Technical Guide on Internal Audit of Mining and Extractive Industry

Opencast or Underground mine depending on the method of working adopted.

- (a) **General Layout of the Surface** – This plan is prepared on a large scale plan, showing all key surface features, lease boundary, mining boundary, presence of any type of water body, presence of habitation, presence of civil or mechanical constructions, if any. All these features are incorporated if they are present inside the lease area or in the nearby vicinity of the mine. This is to ensure the specific precaution, for all the above mentioned features, that needs to be taken during the mine operation.
- (b) **Shaft** – Shafts are the most important capital openings of deep mines, providing all services for underground operations including fresh air, transportation of ore and supplies, personnel traffic, power (electricity and compressed air), communications, water supply, and drainage. Depending on the depth of the mine, shaft sinking may consume as much as 60% of the mine development time.

Mine technical data are used for determining the shaft location which is to be followed by plan for designing a 2-shaft mine, or a multiple-shaft mine. The number of shafts in a mine depends directly on the daily production rate and the dimensions of the mining area. To obtain a minimum cost per tonne of production, it is essential that an optimum balance between capital expenditure and operating costs be found.

- **Shaft Design** – The shaft sinking plan would include all the key features of a shaft design.
  - Description of the geologic column in the form of a table identifying the rock strata, their geotechnical parameters, and groundwater levels together with water heads, calculated inflow, and degree of chemical contamination, if any.
  - Determination of the shaft diameter, with justification.
  - Choice of shaft sinking technology and its justification.
  - Description of the shaft lining and a list of lining sections with the thicknesses.
  - The shaft foundations (footings), their locations and dimensions.

## Technical Aspects of Mining Industry

- The shaft collar, its depths and foundation, thickness and construction material, kind and number of openings with their function, and dimensions and elevations.
- The shaft sump, its depth, structural characteristics, pumping arrangement, and cleaning system.
- Surveying data for particular shaft elements.
- Calculations comprising ground and water pressure acting on lining, resulting lining thicknesses, shaft insets with their dimensions, and airflow capacity.
- Timetable of construction, with such elements as preparatory works, shaft sinking, lining erection, shaft equipment installation, and liquidation of construction arrangements.
- Cost specifications.
- Drawings of the general mine layout, with shaft location, plan of shaft site (construction stage), and shaft cross section with an outline of equipment and compartments.
- **Underground Mine Development Plan** – Underground mine development begins with the positive investment decision to mine and ends with the inception of full scale exploitation. It incorporates all activities, personnel, and equipment required for creation of underground access to a mineral deposit.
  - **Mine Access Road** – The basic mine approach road needs to be developed which provides the approach to the mining area. The roads are developed by using heavy machineries like, Excavators, Trucks, Graders, Dozers and Compactors along with the access roads, mining haul roads are also developed in parallel.
  - **Material Transportation and Winding Plan** – For the transportation of ore on the surface, various combinations of wagon system integrated with belt conveyor system is made. Ore is brought onto the surface from inside the mine using the material winding shaft. From the pit-head it is transported to the processing plant from where it would be transferred onto the wagons to be dispatched out of the mine.
  - **Stowing Plan** – Stowing in an underground mine is an equally important activity. This requires civil and mechanical construction

## Technical Guide on Internal Audit of Mining and Extractive Industry

in the form of bunkers, pipeline networks and chambers. Site allocation for this is, therefore, equally important, as all the stowing characteristics, like, fluid flow, head, throw, rate of stowing, would depend on the proper site allocation.

- **Ventilation Plan** – Ventilation plan of a mine is very important to maintain the acceptable working environment for the miners. The exhaustive plan would encompass designing the ventilation circuits during development, during mine operation and during mine closure. The Ventilation Plan consists of the following parameters for which different plans are prepared:
  - o Ventilation (air flow) route.
  - o Plan showing quality of air (humidity, temperature, percentage of methane on the general body of air, percentage of any other gases which needs to be measured) at various points in the mine.
  - o Ventilation stoppings to divert and channelize the air flow as per the mine design and requirements at various points in the mine.
  - o Placement of secondary ventilators (like, booster fans).
- **Electricity Supply Plan** – Electricity is a very vital source for energy in such mines. Proper lighting arrangements provide a hassle free and safe working environment inside the mine. Therefore, a site location for an electrical sub-station is very important. Power source, from the nearby main station is identified and electricity would be drawn from that source to the substation from where it is re-distributed inside the mine, or on the surface.
- **Water Supply Plan** – Water in any mine area is an essential commodity. Proper circulation of water for various purposes, like, water sprinkling, drinking would contribute towards Environmental Health and Safety issue. For this, we would, therefore, provide adequate water supply in the mine through water network system involving forcing pumps, water coolants, recirculation of fresh drinking water, separate water pipelines for drinking, water sprinkling, etc.
- **Pumping Plan** – Pumping forms an integral part of underground mining technology. The mine water, flowing in either from the

## Technical Aspects of Mining Industry

ground water or seeping in from the surface needs a continuous pumping so as to serve the following purposes:

- Provide a water-free working face.
- Avoid water logging in the areas where activities like, material transport, man transport, electrical substations, voids for stowing, pumping sub-stations, etc.

It is very essential to locate area for installation of the main pumps on the surface. Generally, an area with the highest of the altitude is selected for the station. The sump is created at a low lying area where water, either through pumping, or through gravity flows to it.

Various type of pumping system may be combined to counter the issues of water logging. The main pumping route is as per the following:

- Transfer from the working face to the nearby local sump.
- Transfer from the local sumps in the mine to the main sump area which may be near the shaft inset, having exhaust route for the mine air.
- Throw from the main pump to the surface.

All these activities require respective type of pumps which have been mentioned below:

- Pumps with high head, less throw.
- Pumps with high throw, less head.

These two types of pump may be moveable or may be fixed at one particular place, except for the main pump which throws the water out of the main pump to the surface which is stationary.

- **Ore processing Plans** – The Ore processing plans are important for production of saleable product as per market conditions as well as to control the environmental pollution. Ore processing plans will describe the process to be employed, material handling and handling of rejects.
- **Phasing and Planning for Procurement/ Operations** – Equipment selection and sizing is a major mining engineering activity. It follows the positive investment decision to mine and begins with selection of a mining method. Although equipment

## Technical Guide on Internal Audit of Mining and Extractive Industry

selection begins during the formulation of a “milestone diagram,” in which the minable reserve is parceled out into zones and distinguished by method of mining, suitability and production analyses for mining equipment are not conducted until after layout and sequencing are accomplished and before scheduling is undertaken.

With the advancement of mining industry, various technologies and software are being used for the purpose. Different types of plans are developed for their serving and their specific use during the starting of the mine, or during the operation stage.

## Key Activities in Mining

### Mining Operations

3.9 Mining, in general, involves the following operations:

- Site Preparation
- Drilling and Blasting
- Loading and Hauling
- Stockpile management
- Off take arrangements
- Equipment maintenance process

After which the mined material is further beneficiated to improve its quality and render it useful for use in various industries.

#### *Site Preparation*

3.10 This step involves preparing the site where bore holes are to be drilled. This may involve cutting trees, leveling, etc. Leveling is required to provide a stable ground to the drilling rig. Generally, a dozer is used for leveling in open cast mines.

#### *Drilling and Blasting*

3.11 Boreholes are drilled in which explosive is loaded for blasting in the next step. The pattern and number of the holes to be drilled is pre-decided so as to optimally utilize all of the blast energy, achieve proper fragmentation and restrict blast waves. In opencast mines drilling rigs are used for drilling, while in underground simple jackhammers, jumbo drills or specialized drilling

## Technical Aspects of Mining Industry

machines may be used depending on the level of automation and the desired level of production.

Followed by drilling of boreholes, explosives are loaded and the material is blasted so as to fragment it using shock waves and enable easier loading in the next step. The blasting pattern is carefully designed to control the blast and cause proper fragmentation, minimize fly rocks, prevent the surrounding rock structures, etc. In India, strict government guidelines govern the amount and type of explosives that can be used.

### *Loading and Hauling*

3.12 Following blasting, the blasted material is loaded onto haulage equipment (dumpers, tubs, conveyors, etc.) using shovels, LHD or SDL. After loading, the transport equipment (dumpers, tubs or conveyor) hauls the extracted material from the working area and dumps it in the designated stockyard/plant/dump.

### *Stockpile Management*

3.13 The Stockpile Management process is used to stock the product. In case of metalliferous mines, the stockpiling of the ROM and the processed ore are maintained separately. While in case of coal, the stockpiling is mainly made for the purpose of crushing, blending or washing, or combined.

The Stockpiling activity requires equipments like, crushers, dozers, trucks, excavators and in cases where the ROM needs to be treated to form the saleable product. Ore/Mineral Washeries are needed which treat the ROM chemically (or non-chemically). Another important activity from the Stockpile which takes place is the off take of the ROM/ processed ore/ mineral to the desired location/ end-use plant/ export destinations.

### *Off take Arrangements and Material Handling*

3.14 The mined/ processed material may be required to be off take from mine face; stockpile; railway siding or any other point. The choice of inland transportation mainly depends on the available and feasible infrastructure. The common mode for transportation includes railways, MGR, belt conveyor, stacker reclaimer, ropeways, trucks, etc. Quite often the combination of various modes is used for the arrangement. For example, the material from belt conveyors is discharged on to chutes and is then transported by stacker to stock yard.

(i) **Belt conveyor** – In this a rubber belt with two or more pulleys is used to transport the material. One or both of the pulleys are powered which move

## Technical Guide on Internal Audit of Mining and Extractive Industry

the belt and the material on the belt forward. Sometimes, series of belt conveyors few kilometers long are also used for transportation of material.

(ii) **Ropeway** – In this material is transported using an aerial ropeway moving at a constant speed. This mode can be used to transport material to long distances (few kilometers).

(iii) **MGR** – A merry-go-round (MGR) train is a block train of hopper wagons which both loads and unloads its cargo while moving. The locomotives used are fitted with electronic speed control which allows the driver to engage the system and the train proceeds at a fixed slow speed under the loading and unloading facilities.

(iv) **Stacker Reclaimer** – In the stacker reclaimer system, stacker is used to pile the bulk material while reclaimer is used to recover the material. For longitudinal stores the commonly used stacking methods are Chevron, Windrow and Cone Shell. In these methods a large number of layers are stacked on top of each other in the longitudinal direction of the pile.

In Chevron method stacker moves to and fro over the centre line of the pile. This result causes segregation of the material with fine particles in the central part of the pile and coarse particles on the surface and at the bottom of the pile. In Windrow method, number of positions across the width of the pile is used to deposit the material which ensures even distribution of fine and coarse particles across the pile. When homogenization is not the priority then Cone Shell method can be used. In this cone of material is formed from a fixed position and when the conical pile is full, a new cone is formed against the shell of the first one.

For circular stores generally continuous Chevron stacking method is used. The reclaimers are equipped with constant speed motors and the reclaimed material is carried by belt conveyors and discharged into a feed bin of a relatively large volume.

### ***Equipment Maintenance Process***

3.15 The Equipment maintenance process forms another important integral part of any mining operation. This is a specialized activity which involves expertise in the areas of machineries and their maintenance. As the mining operations completely rely on the machine and equipment availability and utilization, it is therefore, very important to select the correct type of equipments for the complete operations and subsequently the maintenance.

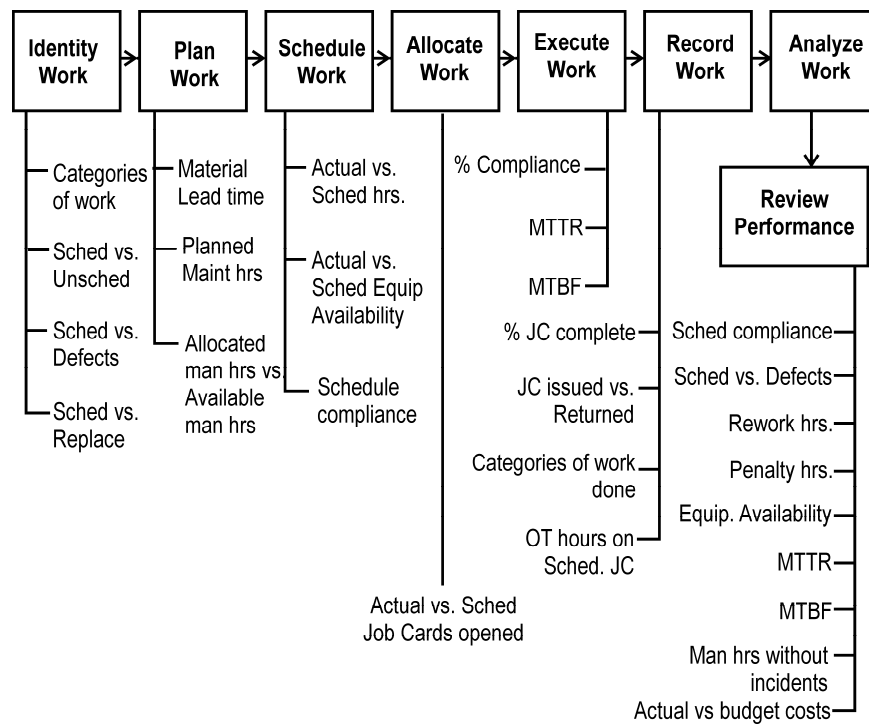


## Technical Aspects of Mining Industry

Broadly, the maintenance is carried out in the following different ways:

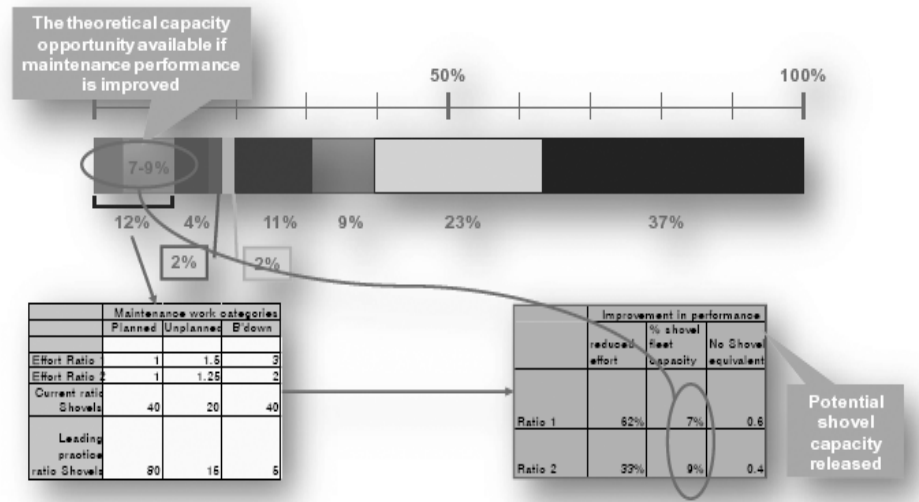
- **Regular maintenance** – This involves the regular machine check-ups on a daily and shift-to-shift basis and also involves attending of breakdowns.
- **Scheduled maintenance** – The machines/ equipments are sometimes withdrawn from their production activity and are checked thoroughly which may include change of filter oils, lube oils, hoses and other mechanicals smaller parts .
- **Over-hauling** – This activity involves the complete change of major mechanical/ electrical components of an equipment/ machine like gear, swing motors. This activity is performed after the machine has achieved its rated maximum hours of operations. The over-hauling activity almost renews the complete equipment/ machine.

3.16 The diagram below explains the maintenance procedures, generally, followed in the mining activity.



## Technical Guide on Internal Audit of Mining and Extractive Industry

3.17 A proper maintenance in any mining activity is very important as it affects the total production, productivity and the mining cost controls. A typical example showing potential impact on operational efficiency due to proper maintenance of shovel is depicted in the diagram below:



Example showing Potential Impact on Operational Efficiency due to Proper Maintenance

## Mineral Processing

3.18 Minerals are valuable natural resources of a country. They constitute the vital raw materials for many basic industries and are a major resource for development. The wide availability of coal/minerals in the form of abundant rich reserves has made it very conducive for the growth and development of the mining sector in India. India's mining sector has enough potential, but lack of planning, long-drawn official procedure of license procuring and to some extent insurgency are major obstacles in its growth. The Government of India (GOI) is planning to take up the mining sector's contribution in GDP from 3% to 9% in near future.

3.19 In continuation of the same, under National Mineral Policy (2008), Indian government has taken steps for utilization of lower grade materials. R & D organization will be encouraged for development of process routes for low grade ore beneficiation. This will result in effective utilization of the available natural resources. Therefore, coal/ mineral beneficiation will play a dominant role in growth rate of nation's economy. The extraction of minerals from the earth crust is carried out through mining operation followed by

## Technical Aspects of Mining Industry

mineral beneficiation. The GDP of a country is significantly influenced by per capita consumption of mineral resources. In India the per capita consumption is low as compared to the world's average.

Mineral resources of country are finite and non-renewable. The basic steps to extract a Washed Valuable Mineral from ROM Ore are mining and mineral beneficiation. Coal/ Mineral beneficiation can be described as a collection of one or more technologies involved in upgrading and recovering minerals from ores.

### Mineral Beneficiation

3.20 "As-mined" or "run-of-mine" Ore consists of valuable parts and gangue. Mineral processing, sometimes called ore dressing, mineral dressing or milling, follows mining and prepares the ore for extraction of the valuable metal in the case of metallic ores, and produces a commercial end product of products such as, iron ore and coal. Apart from regulating the size of the ore, it is a process of physically separating the grains of valuable minerals from the unwanted/ gangue minerals, to produce an enriched portion, or concentrate, containing most of the valuable minerals, and a discard, or tailing, containing predominantly the gangue minerals. Mineral beneficiation is generally defined as a combination of various processes, involving various steps such as, comminution, classification and concentration, to separate out the valuable mineral from the non-valuable mineral. Comminution involves size reduction activities like crushing, grinding etc for liberation of the valuable mineral particles from gangue mineral particle based on ore characteristics. After liberation, size specific activity; classification is carried out to produce different size fractions. In continuation of the same concentration operation (if required) is carried out to separate the valuable mineral from the gangue mineral through different separation techniques like, gravity separation, magnetic separation, electrostatic separation, flotation, heavy media separation, etc.

3.21 A step by step description of the major beneficiation processes is given as follows:

#### (i) *Comminution*

As the mined minerals are finely disseminated and associated with the gangue/unwanted particles, the liberation of the same from gangue particles is achieved through comminution. In this process step, particle size of the ore is progressively reduced until the valuable particles can be separated by available methods. Explosives are used in mining to remove ores from their

## Technical Guide on Internal Audit of Mining and Extractive Industry

natural beds, and blasting can be regarded as the first stage in comminution. Comminution in the Coal washery/ Mineral processing plant, or "mill", takes place as a sequence of crushing and grinding processes.

### (a) Crusher

Crushing reduces the particle size of run-of-mine ore to such a level that grinding can be carried out until the mineral and gangues are substantially produced as separate particles. Crushing is the first mechanical stage in the process of comminution in which the main objective is the liberation of the valuable minerals from the gangue. It is, generally, a dry operation and is usually performed in two or three or more stages such as, primary, secondary and tertiary crushing, etc.

Primary crushers are heavy-duty machines, used to reduce the run-of-mine ore down to a size suitable for transport and for feeding the secondary crushers or AG/SAG mills. They are always operated in open circuit, with or without heavy-duty scalping screens (grizzlies). There are two main types of primary crusher in metalliferous operations jaw and gyratory crushers, although the impact crusher has limited use as a primary crusher and will be considered separately.

Secondary crushers are much lighter than the heavy-duty, rugged primary machines. Since they take the primary crushed ore as feed, the maximum feed size will normally be less than 15 cm in diameter and, because most of the harmful constituents in the ore, such as tramp metal, wood, clays, and slimes have already been removed, it is much easier to handle. Similarly, the transportation and feeding arrangements serving the crushers do not need to be as rugged as in the primary stage. Secondary crushers also operate with dry feeds, and their purpose is to reduce the ore to a size suitable for grinding. In those cases where size reduction can be more efficiently carried out by crushing, there may be a tertiary stage before the material is passed to the grinding mills. Tertiary crushers are, to all intents and purposes, of the same design as secondaries, except that they have a closer set. The bulk of secondary crushing of metalliferous ores is performed by cone crushers, although crushing rolls and hammer mills are used for some applications.

## Technical Aspects of Mining Industry

### (b) Grinding Mill

Grinding is the last stage in the process of comminution; in this stage the particles are reduced in size by a combination of impact and abrasion, either dry or in suspension in water. It is performed in rotating cylindrical steel vessels which contain a charge of loose crushing bodies (the grinding medium) which is free to move inside the mill, thus comminuting the ore particles. According to the ways by which motion is imparted to the charge, grinding mills are generally classified into two types: tumbling mills and stirred mills.

In tumbling mills, the mill shell is rotated and motion is imparted to the charge via the mill shell. The grinding medium may be steel rods, balls, or rock itself. Tumbling mills are typically employed in the mineral industry for coarse-grinding processes. The basic types of tumbling mills are rod mill, ball mill and autogenous mill. Structurally, each type of mill consists of a horizontal cylindrical shell, provided with renewable wearing liners and a charge of grinding medium. The drum is supported so as to rotate on its axis on hollow trunnions attached to the end walls. The diameter of the mill determines the pressure that can be exerted by the medium on the ore particles and, in general, the larger the feed size the larger needs to be the mill diameter. The length of the mill, in conjunction with the diameter, determines the volume, and hence the capacity of the mill. The feed material is usually fed to the mill continuously through one end trunnion, the ground product leaving via the other trunnion, although in certain applications the product may leave the mill through a number of ports spaced around the periphery of the shell. All types of mill can be used for wet or dry grinding by modification of feed and discharge equipment.

In stirred mills, the mill shell with either a horizontal or a vertical orientation is stationary and motion is imparted to the charge by the movement of an internal stirrer. Fine grinding media inside the mill are agitated or rotated by a stirrer, which typically comprises a central shaft to which are attached pins or discs of various designs.

### (ii) *Industrial Screening*

Industrial sizing is extensively used for size separations from 1000 mm down to micron sizes, although the efficiency decreases rapidly with fineness. Dry screening is generally limited to material above 5mm in size, while wet

## Technical Guide on Internal Audit of Mining and Extractive Industry

screening down to around 250 micron is common. Although there are screen types that are capable of efficient size separations down to 40 micron, sizing below 250 microns is also undertaken by classification. Selection between screening and classification is influenced by the fact that finer separations demand large areas of screening surface and, therefore, can be expensive compared with classification for high-throughput applications. The types of screening equipment are many and varied. Likewise, there are a wide range of screening objectives. The main purposes in the minerals industry are:

- (a) Sizing or Classifying, to separate particles by size, usually to provide a downstream unit process with the particle size range suited to that unit operation;
- (b) Scalping, to remove the coarsest size fractions in the feed material, usually so that they can be crushed or removed from the process;
- (c) Grading, to prepare a number of products within specified size ranges. This is important in quarrying and iron ore, where the final product size is an important part of the specification;
- (d) Media recovery, for washing magnetic media from ore in dense medium circuits;
- (e) Dewatering, to drain free moisture from a wet sand slurry;
- (f) Desliming or de-dusting, to remove fine material, generally below 0.5 mm from a wet or dry feed;
- (g) Trash removal, usually to remove wood fibres from a fine slurry stream.

There are numerous different types of industrial screens available. The dominant screen type in industrial applications is the vibrating screen, of which there are many sub-types in use for coarse and fine-screening applications. There are also numerous other screen types in wide use for both coarse and fine screening applications. The major screen types, based on their method of operation are inclined or circular motion screen, Grizzly screen, Horizontal screen, Resonance screen, Dewatering screen, Banana screen, circular screen, flip-flow screen, Trommels, etc.

### **(iii) *Classification***

Classification is a method of separating mixtures of minerals into two or more products on the basis of the velocity with which the grains fall through a fluid medium. In mineral processing, this is usually water, and wet classification is generally applied to mineral particles which are considered too fine to be

## Technical Aspects of Mining Industry

sorted efficiently by screening. Since the velocity of particles in a fluid medium is dependent not only on the size, but also on the specific gravity and shape of the particles, the principles of classification are important in mineral separations utilising gravity concentrators. Classifiers also strongly influence the performance of grinding circuits.

Many different types of classifier have been designed and built. They may be grouped, however, into two broad classes depending on the direction of flow of the carrying current. Horizontal current classifiers such as, mechanical classifiers are essentially of the free-settling type and accentuate the sizing function; vertical current or hydraulic classifiers are usually hindered-settling types and so increase the effect of density on the separation. The major available classifiers in the industry are teeter bed separator, hydrocyclones, spiral/ rake classifier, flotex, hydrosizer, etc.

### **(iv) Gravity Concentration**

Gravity methods of separation are used to treat variety of materials, ranging from coarse to finer sizes. Gravity concentration methods separate minerals of different specific gravity by their relative movement in response to gravity and one or more other forces, the latter often being the resistance to motion offered by a viscous fluid, such as, water or air. The major gravity separation equipment can be described as follows:

#### **(a) Jigs**

In the jig the separation of minerals of different specific gravity is accomplished in a bed which is rendered fluid by a pulsating current of water so as to produce stratification. The aim is to dilate the bed of material being treated and to control the dilation so that the heavier, smaller particles penetrate the interstices of the bed and the larger high specific gravity particles fall under a condition probably similar to hindered settling.

#### **(b) Pinched Sluices**

Pinched sluices of various forms have been used for heavy mineral separations for centuries. In its simplest form, it is an inclined launder about 1 m long, narrowing from about 200 mm in width at the feed end to about 25 mm at the discharge. Pulp of between 50 and 65% solids enters gently and stratifies as it descends; at the discharge end these strata are separated by various means, such as by splitters, or by some type of tray.

## Technical Guide on Internal Audit of Mining and Extractive Industry

### (c) **Richert Cone**

The Reichert cone is a wet gravity concentrating device designed for high capacity applications. Its principle of operation is similar to that of a pinched sluice, but the pulp flow is not restricted or influenced by side-wall effect, which is somewhat detrimental to pinched-sluice operation.

### (d) **Spirals**

It is composed of a helical conduit of modified semi-circular cross-section. Feed pulp of between 15% and 45% solids by weight and in the size range 3 mm to 75 micron is introduced at the top of the spiral and, as it flows spirally downwards, the particles stratify due to the combined effect of centrifugal force, the differential settling rates of the particles, and the effect of interstitial trickling through the flowing particle bed. These mechanisms are complex, being much influenced by the slurry density and particle size.

### (e) **Wet Gravity Tables**

When a flowing film of water flows over a flat, inclined surface the water closest to the surface is retarded by the friction of the water absorbed on the surface; the velocity increases towards the water surface. If mineral particles are introduced into the film, small particles will not move as rapidly as large particles, since they will be submerged in the slower moving portion of the film. Particles of high specific gravity will move more slowly than lighter particles, and so a lateral displacement of the material will be produced. The flowing film effectively separates coarse light particles from small dense particles, and this mechanism is utilized to some extent in the shaking table concentrator, which is perhaps the most metallurgically efficient form of gravity concentrator, being used to treat the smaller, more difficult flow-streams, and to produce finished concentrates from the products of other forms of gravity system.

### (f) **Dense Medium Separation (DMS)**

Dense medium separation (or Heavy Medium Separation (HMS), or the sink-and-float process) is applied to the pre-concentration of minerals, i.e., the rejection of gangue prior to grinding for final liberation. It is also used in coal preparation to produce a commercially graded end-product, clean coal being separated from the heavier shale or high-ash coal. In principle, it is the simplest of all



## Technical Aspects of Mining Industry

gravity processes and has long been a standard laboratory method for separating minerals of different specific gravity. Heavy liquids of suitable density are used, so that those minerals lighter than the liquid float, while those denser than it sink. Several types of separating vessel are in use, and these may be classified into gravitational ("static-baths") and centrifugal (dynamic) vessels.

### (g) Flotation

Flotation is a physico-chemical separation process that utilises the difference in surface properties of the valuable minerals and the unwanted gangue minerals. The theory of froth flotation is complex, involving three phases (solids, water, and froth) with many sub-processes and interactions, and is not completely understood. The process of material being recovered by flotation from the pulp comprises three mechanisms:

- Selective attachment to air bubbles (or "true flotation").
- Entrainment in the water which passes through the froth.
- Physical entrapment between particles in the froth attached to air bubbles (often referred to as "aggregation").

### (h) Magnetic Separators

Magnetic separators exploit the difference in magnetic properties between the ore minerals and are used to separate either valuable mineral from non-magnetic gangue. Magnetic separators can be classified into low- and high intensity machines, which may be further classified into dry-feed and wet-feed separators.

The different types of magnetic separators can be listed as drum separators, counter current separators, cross belt separators, high intensity separators, high gradient separators, super conducting separators, etc.

### (i) Electrical Separation

Electrical separation utilises the difference in electrical conductivity between the various minerals in the ore feed. Since almost all minerals show some difference in conductivity it would appear to represent the universal concentrating method. In practice, however, the method has fairly limited application, and its greatest use is in separating some of the minerals found in heavy sands from beach or

## Technical Guide on Internal Audit of Mining and Extractive Industry

stream placers. There are different types of electrical separators as plate/ screen separators, high tension separators, etc.

### (j) Dewatering

With few exceptions, most mineral-separation processes involve the use of substantial quantities of water and the final concentrate has to be separated from a pulp in which the water solids ratio may be high. Dewatering, or solid-liquid separation, produces a relatively dry concentrate for shipment. Partial dewatering is also performed at various stages in the treatment, so as to prepare the feed for subsequent processes. Dewatering methods can be broadly classified into three groups:

- **Sedimentation** – Rapid settling of solid particles in a liquid produces a clarified liquid which can be decanted, leaving thickened slurry, which may require further dewatering by filtration. The settling rates of particles in a fluid are governed by Stokes' or Newton's laws, depending on the particle size. Very fine particles, of only a few microns diameter, settle extremely slowly by gravity alone, and centrifugal sedimentation may have to be performed. Alternatively, the particles may be agglomerated, or flocculated, into relatively large lumps, called flocs, that settle out more rapidly. The different types of thickeners (cable/ high rate or tray thickeners, etc) and centrifuges are used for sedimentation and recovery of the water from the concentrate.
- **Filtration** – Filtration is the process of separating solids from liquid by means of a porous medium which retains the solid but allows the liquid to pass. Cake filters are the type most frequently used in mineral processing, where the recovery of large amounts of solids from fairly concentrated slurries is the main requirement. Those where the main requirement is the removal of small amounts of solid from relatively dilute suspensions are known as screening or clarification filters. Cake filters may be pressure, vacuum, batch, or continuous types.
- **Thermal Drying** – The drying of concentrates prior to shipping is the last operation performed in the mineral-processing plant. It reduces the cost of transport and is usually aimed at reducing the moisture content to about 5% by weight. Dust

## Technical Aspects of Mining Industry

losses are often a problem if the moisture content is lower.  
Example: Rotary thermal dryer

### (k) Tailings Disposal

The disposal of mill tailings is a major environmental problem, which is becoming more serious with the increasing exploration for metals and the working of lower grade deposits. Apart from the visual effect on the landscape of tailings disposal, the major ecological effect is usually water pollution, arising from the discharge of water contaminated with solids, heavy metals, mill reagents, sulphur compounds, etc. Waste must, therefore, be disposed of in both an environmentally acceptable and, if possible, economically viable manner. Disposal is governed by legislation and may involve long-term rehabilitation of the site. The nature of tailings varies widely; they are usually transported and disposed of as slurry of high water content, but they may be composed of very coarse dry material, such as the float fraction from dense medium plants.

Due to the lower costs of mining from open pits, ore from such locations is often of very low grade, resulting in the production of large amounts of very fine tailings. The tailings disposal could be to a natural/ man-made tailings dam or in an abandoned mines or coarse tails can be used for back filling, etc.

### Beneficiation Practices in India

3.22 The beneficiation process was introduced in the country during 1960s in the form of wet processing of ore confined to mainly washing only. Wet processing modified the earlier practice of multistage crushing and screening with addition of scrubbing of crushed ore in rotary drum scrubber, followed by washing of scrubbed ore with high pressure water jet wet vibrating screen to produce clean lumps.

During the period 1970 to 2000, no significant development took place in beneficiation techniques in India, but the search for suitable process routes for further up gradation was on. Many processing techniques such as, magnetic separation, multi-stage hydrocyclone, teeter bed separator, air pulsated jig, spiral concentrator, heavy media separation, flotation, etc. were tested in the R & D laboratories during this period.

3.23 In the past few years, many test laboratories in India have tested the feasible process route for beneficiation of Ore to maximize the recovery of valuable parts. In order to obtain washed upgraded concentrate, proper

## Technical Guide on Internal Audit of Mining and Extractive Industry

liberation of mined Ore from gangue particles is the essential pre-requisite. For liberation of low grade material, grinding to finer size is required. After liberation, these low grade materials can be beneficiated suitably/ economically with the available techniques. The major size specific process equipment tested so far for beneficiation are Jig, Teeter bed separator, Heavy media separation, Multistage cyclone, Spiral concentration, Falcon separator, Knelson separator, Wet tables, Magnetic separation, and Froth flotation etc. One or combination of more than one of the above technologies can be used for beneficiation.

With the use of advance Mineral Beneficiation techniques in India would serve many purposes at the same time as:

- The Ore reserve base of the country will increase substantially by taking low grade in-situ deposits and dumped material as well as slimes accumulated in the tailings ponds/ dams into its realm, which can be utilized/ extracted through advanced beneficiation techniques.
- It will help the country in optimization and conservation of limited resources.

The mining industry will be in a position to address environmental issues and concerns arising due to tailings disposal and stacking of sub grade material in form of dumps. The adoption of low grade ore/ slimes beneficiation process would increase the life of tailing ponds, thereby, addressing the issue of ever increasing area required for tailings disposal and dumping of low grade ore.

## Mine Closure

### Afforestation and Mine Closure

3.24 "Progressive Closure Plan" and "Final Closure Plan" should be in the format and as per the guidelines issued by the Indian Bureau of Mines. The Mine Closure Plan (progressive and final) shall be approved along with the approval of Mining Plan/ Feasibility Report / Project Report as applicable.

Progressive Mine Closure Plan would include various land use activities to be done continuously and sequentially during the entire period of the mine operations from the day one of the mining operations. Such a plan ensures that the land and the other affected areas are being continuously recovered (or afforested) to the planned state from the very first day of mining operations.

## Technical Aspects of Mining Industry

Whereas the Final Mine Closure activities would start towards the end of mine life, generally during the last 4-5 years of the mine life. This type of plan ensures the full and the final closure of the mine. In case of Opencast mine, this is, generally, followed by finally covering the mined out area by top soil and subsequently followed by plantations or creating some kind of place for flora and fauna to develop, as per the Ministry Guidelines and the approved plan. While in case of Underground mining activity, this is followed by abandoning the complete mining activity and finally followed by the shaft closures, as per the Ministry Guidelines and the approved plan.

3.25 Mine closure encompasses rehabilitation process as an ongoing programme designed to restore physical, chemical and biological quality disturbed by the mining to a level acceptable to all concerned. It must aim at leaving the area in such a way that rehabilitation does not become a burden to the society after mining operation is over. It must also aim to create as self-sustained ecosystem.

Mine closure operation is a continuous series of activities starting from day one of the initiation of mining project. Therefore, progressive mine closure plan will be an additional chapter in the present mining plan and will be reviewed every five years in the Scheme of Mining. As progressive mine closure is a continuous series of activities, it is obvious that the proposals of scientific mining have included most of the activities to be included in the progressive mine closure plan. Therefore, reference to relevant paragraphs and a gist of the same in progressive mine closure plan will be sufficient.

### Closure Plan

3.26 The mine closure plan consists of the following parameters and objectives:

- **Mined-Out Land** – Describe the proposals to be implemented for reclamation and rehabilitation of mined-out land including the manner in which the actual site of the pit will be restored for future use. The proposals should be supported with relevant plans and sections depicting the method of land restoration / reclamation / rehabilitation.
- **Water Quality Management** – Describe in detail the existing surface and ground water bodies available in the lease areas and the measures to be taken for protection of the same including control of erosion, sedimentation, siltation, water treatment, diversion of water courses , if any, measures for protection of contamination of ground water from leaching, etc. Quantity and quality of surface water bodies

## Technical Guide on Internal Audit of Mining and Extractive Industry

should also be indicated and corrective measures proposed to meet the water quality conforming to the permissible limits should also be described. Report of hydrological study carried out in the area may also be submitted. The water balance chart should be given. If there is potential of Acid Mine Drainage then the treatment method should be given.

- **Air Quality Management** – Describe the existing air quality status. The corrective measures to be taken for prevention of pollution of air should be described.
- **Waste Management** – Describe the type, quality and quantity of overburden, mineral reject etc. available and their disposal practice. If no utilisation of waste material is proposed, the manner in which the waste material will be stabilised should be described. The protective measures to be taken for prevention of siltation, erosion and dust generation from these waste materials should also be described. If toxic and hazardous elements are present in the waste material the protective measures to be taken for prevention of their dispersal in the air environment, leaching in the surface and ground water etc, should be described.
- **Top Soil Management** – The top soil available at the site and its utilisation should be described.
- **Tailing Dam Management** – The steps to be taken for protection and stability of tailing dam, stabilisation of tailing material and its utilisation, periodic desilting, measures to prevent water pollution from tailings, etc., arrangement for surplus water overflow along with detail design, structural stability studies, the embankment seepage loss into the receiving environment and ground water contaminant if any should be given.
- **Infrastructure** – The existing infrastructural facilities available such as, roads, aerial ropeways, conveyer belts, railways, power lines, buildings and structures, water treatment plant, transport, water supply sources in the area, etc. and their future utilisation should be evaluated on case to case basis. If retained, the measures to be taken for their physical stability and maintenance should be described. If decommissioning proposed, dismantling and disposal of building structures, support facilities and other infrastructure like, electric transmission line, water line, gas pipeline, water works, sewer line, telephone cables, underground tanks, transportation

## Technical Aspects of Mining Industry

infrastructure like roads, rails, bridges, culverts etc., electrical equipments and infrastructures like, electric cables, transformers to be described in connection with restoring land for further use.

- **Disposal of Mining Machinery** – The decommissioning of mining machineries and their possible post mining utilisation, if any, to be described.
- **Safety and Security** – Explain the safety measures implemented to prevent access to surface openings, excavations, etc., and arrangements proposed during the mine abandonment plan and up to the site being opened for general public should be described.
- **Disaster Management and Risk Assessment** – This should deal with action plan for high risk accidents like, landslides, subsidence flood, inundation in underground mines, fire, seismic activities, tailing dam failure, etc. and emergency plan proposed for quick evacuation, ameliorative measures to be taken, etc. The capability of lessee to meet such eventualities and the assistance to be required from the local authority should also be described.

### *Time Scheduling for Abandonment*

3.27 The manpower and other resources required for completion of proposed job should be described. The schedule of such operations should also be supplemented by PERT (Programme Evaluation & Review Technique), Bar chart, etc.

### *Abandonment Cost*

3.28 Cost to be estimated based on the activities required for implementing the protective and rehabilitation measures including their maintenance and monitoring programme.

### *Financial Assurance*

3.29 In the mine closure plan, the manner in which financial assurance has been submitted and its particulars have to be indicated. The financial assurance can be submitted in one of the following forms:

- Letter of Credit from any Scheduled Bank
- Performance or surety bond

## Technical Guide on Internal Audit of Mining and Extractive Industry

- Trust fund build up through annual contributions from the revenue generated by mine and based on expected sum of amount required for abandonment of mine
- Any other form of security or any other guarantees acceptable to the authority

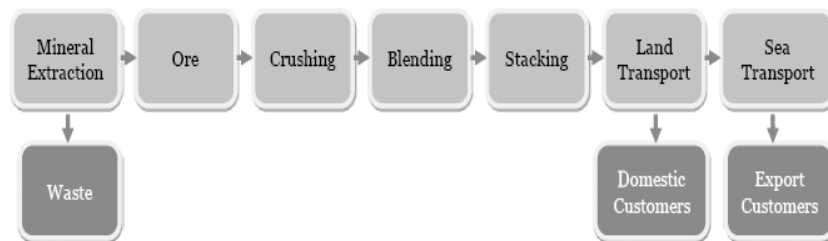
The lessee shall submit the financial assurance before executing the mining lease deeds. In case of an existing mining lease, the lessee shall submit the financial assurance along with the progressive mine closure plan. Release of financial assurance shall be effective upon the notice given by the lessee for the satisfactory compliance of the provisions contained in the mine closure plan.

## Process Monitoring

### Budgeting, Cost Recording and Reconciliation Process

3.30 Many mining operators effectively fix their mine plans and budgets on an annual basis and often there are poor linkages between the mine plan, the budget and the real drivers of cost and value. Such operations struggle to determine the cost and margin impact of significant changes to production particularly when they scrambled to quickly reduce the production and unit cost. On the contrary, those mining companies which manage their performance effectively based on the understanding of the cost and value drivers across all areas of mine production and processing are able to quickly respond to both the sudden changes in the price and economy.

The mining supply chain is as follows:



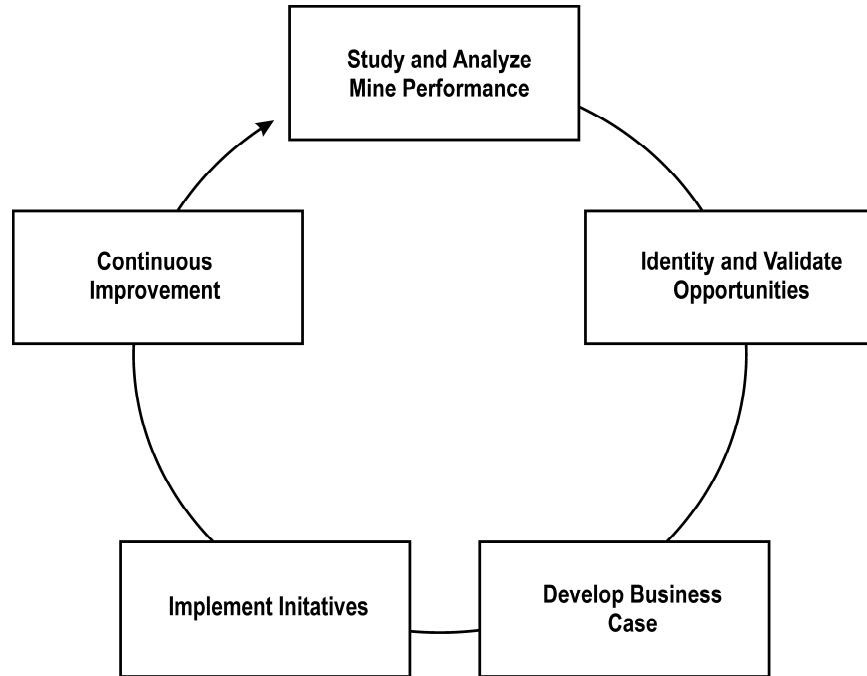
### Mining Supply Chain

For monitoring the mining performance, key areas in the mining supply chain are identified and supervised. Budgeting, cost recording and reconciliation help in analyzing and identifying the scope of improvement in the operations.

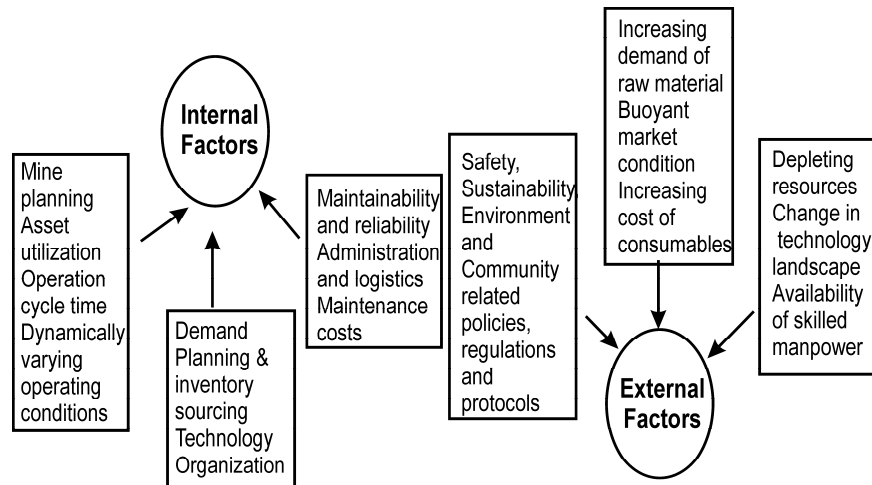


## Technical Aspects of Mining Industry

The following approach may be followed:



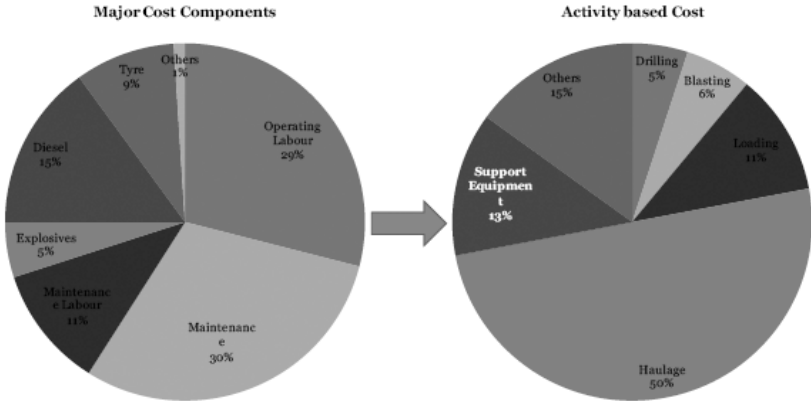
To study and analyse the performance, various internal and external factors influencing the mining operations need to be considered. Some of the key factors influencing the operations are mentioned below:



Further, it is very much necessary to analyze the distribution of operating costs in various components and activities. This helps in identifying the major

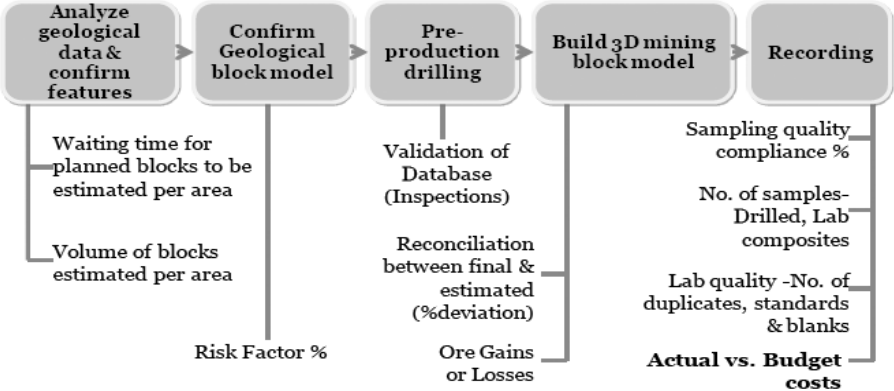
Technical Guide on Internal Audit of Mining and Extractive Industry

focus areas where if costs are reduced, may result in significant reduction in the overall production costs. For e.g., a major part of the operating costs is incurred towards maintenance and labor while if we consider activity-wise breakup the major chunk is towards haulage activity.



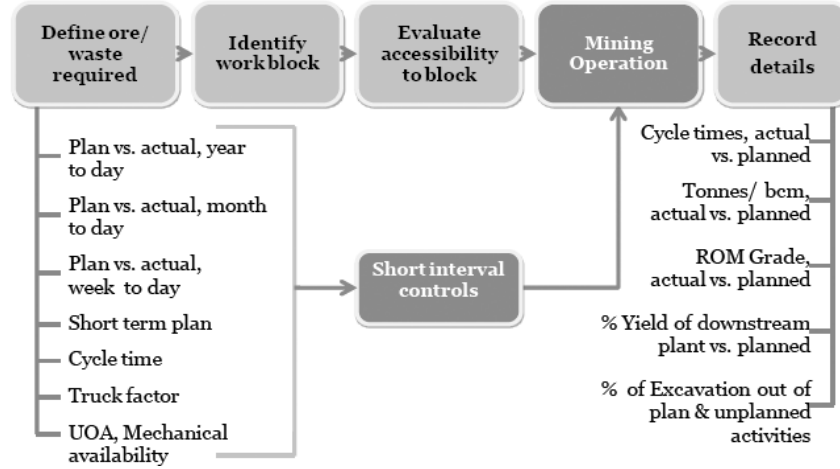
3.31 The activity-wise methodology for performance analysis is presented in the charts below:

Geological Modeling for Production

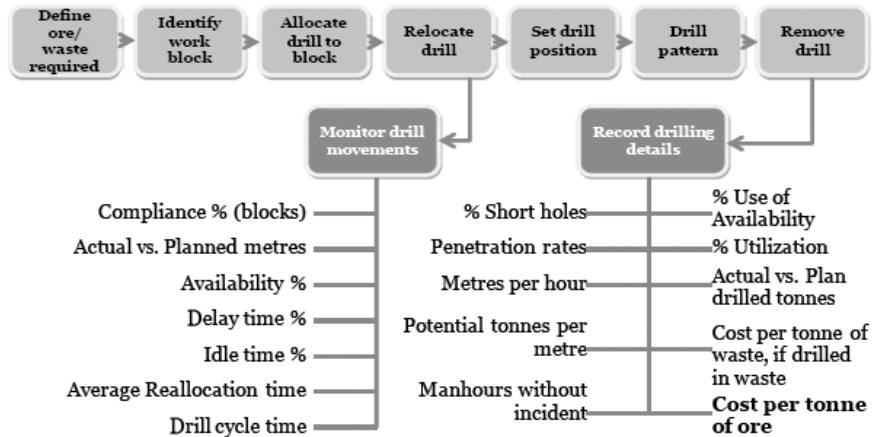


## Technical Aspects of Mining Industry

### Activity - Production planning

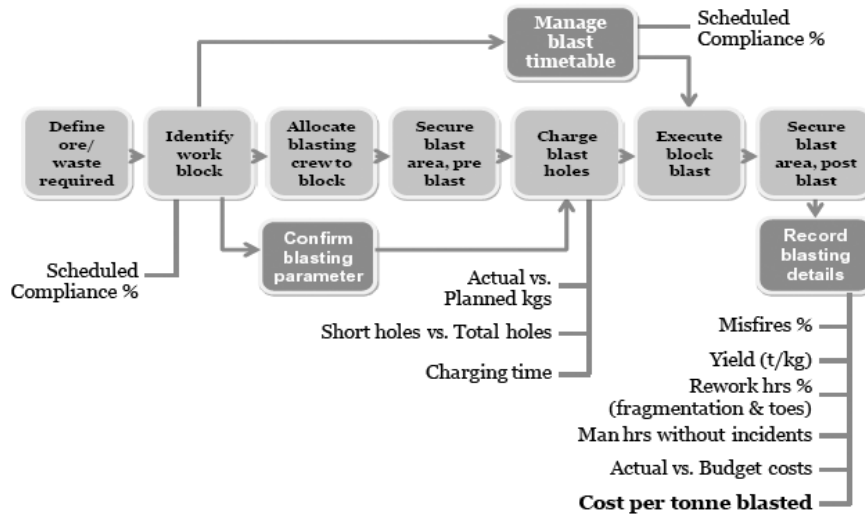


### Activity - Blasthole drilling

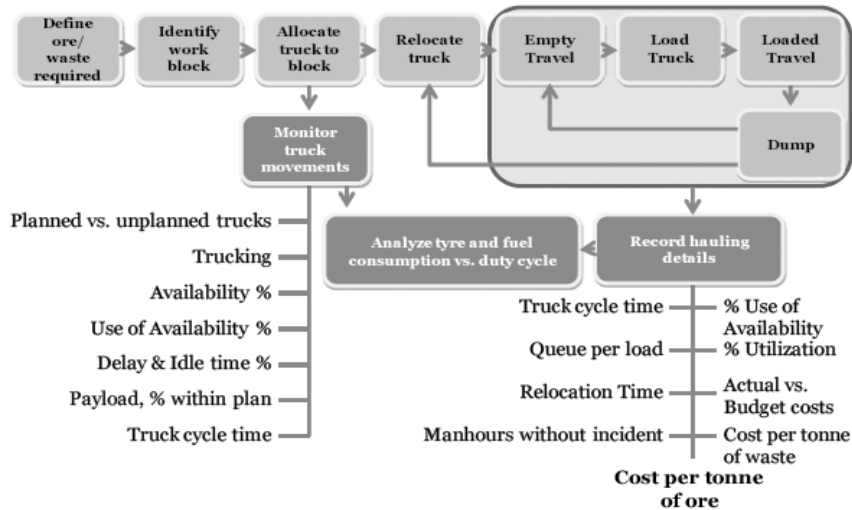


Technical Guide on Internal Audit of Mining and Extractive Industry

Activity - Blasting



Activity - Hauling



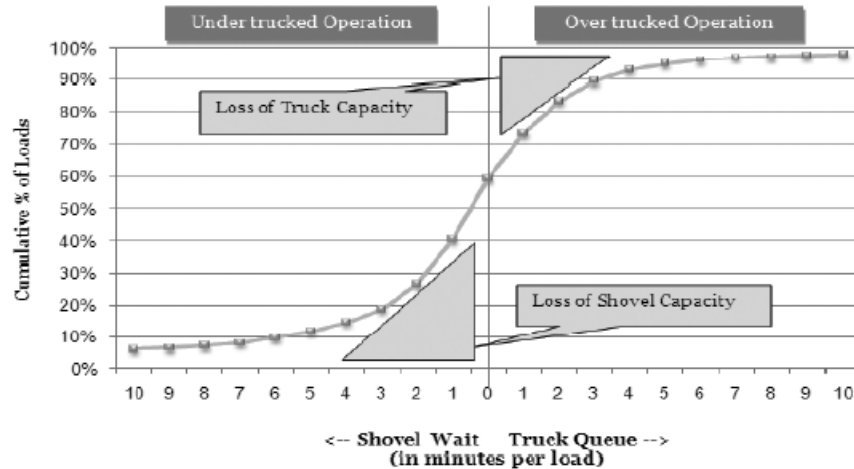
Variance Analysis

3.32 Variance analysis is a process of comparing performance against a benchmark or optimum level. Each equipment or process is expected to operate at targeted/ benchmark level. Variance analysis is aimed to identify the gaps between the target and actual level of operation which in turn reflects the scope of improvement. During the monitoring of operations, large

## Technical Aspects of Mining Industry

data is recorded (e.g., hourly, shift wise, daily, weekly, monthly, etc.). This data is analyzed to arrive at the deviation from the benchmark or targeted level.

3.33 An example of trucking analysis in shovel truck operation based on cycle time data collected at a mining operation is shown in figure below:



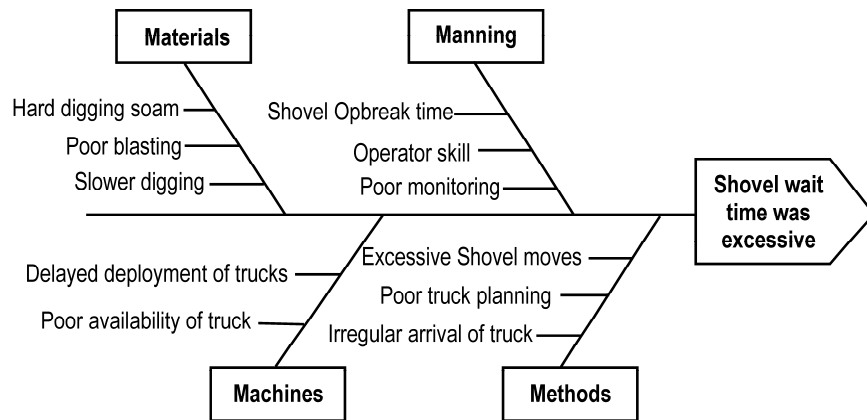
### Trucking Analysis in Shovel Truck Operation

The above analysis shows that about 60% time shovels were waiting for trucks. In any shovel-truck operation there will be some amount of shovel wait and truck queue due to randomness and dynamic nature of operation. However, proper resource matching, monitoring and control can reduce the losses during operation.

3.34 In case of mismatch (below benchmark level), it is possible to conduct root cause analysis from the data generated and/or recorded.

For example, the following figure shows the root cause analysis of the loading capacity loss in the trucking analysis.

## Technical Guide on Internal Audit of Mining and Extractive Industry



## Quality Management Process

3.35 The quality and the characteristics of the coal/mineral delivered should meet the required quality parameters. For example, in coal the parameters for assessing the quality are calorific value, moisture, ash, volatile matter, sulfur content, etc. In addition to the chemical composition, the size of the material delivered is also an important aspect of quality.

3.36 For analysis of the quality, there is provision for sampling systems at various key points where material is kept/ stored (like, stockpile, delivery point, railway siding, etc.). The sampling may be performed manually or using automated sampling systems. The sampling is done in accordance with the standard sampling procedures such as Bureau of Indian Standards as this helps in ensuring proper and uniform sampling. The frequency of the sampling is pre-determined. All samples are tested and analyzed at the delivery point (or any other point as decided) laboratory manned by any certified agency. The arrangement is done to send the samples collected from the online automatic mechanical sampler or manually, under proper seal and security to the laboratory as soon as possible after the sampling. Generally, the detailed procedure for the analysis is agreed prior to the start of the production. The collected samples are divided into two splits - one split is analyzed by the laboratory for the purpose of providing the daily composite specification certificate and the second split of each sample is sealed and placed in a suitable air tight container, properly marked so as to provide unquestionable identification and retained by the laboratory for some fixed days unless a dispute has been raised. If any dispute arises regarding the results of the testing of the first split, the second split can be tested.

## Technical Aspects of Mining Industry

3.37 If the mining company is supplying material to another party it is better to have the representatives from all the involved parties to witness the sampling for transparency purpose. Generally, it has been observed that there are penalty provisions if the supplied material is of inferior quality than required. In such cases the control on quality is more important as inferior quality may have significant financial impact also. For ensuring more control over quality, the foreign material detectors (like, metal detectors in coal) may be installed for segregating the impurities.

# Chapter 4

## Overview of Policies and Regulations

---

### Existing Policies and Regulations

#### Constitutional Mandate and Regulatory Framework

4.1 The Constitution allocates the subject of mineral development and regulation to state governments (entry number 23, State list (List II) of Seventh Schedule) subject to the law of Parliament (entry number 54, Union List (list I) of Seventh Schedule). The role of Union Government is limited by the boundaries set by such law, which in this case is The Mines and Minerals (Regulation and Development) Act, 1957 and rules and regulations framed thereunder. As mandated by The Mines and Minerals (Regulation and Development) Act, 1957, the Union Government has framed rules for regulating grant of mineral in respect of all minerals other than atomic minerals and minor minerals. The State Governments have framed the rules for minor minerals. The Ministry of Mines, Government of India administers the The Mines and Minerals (Regulation and Development) Act, 1957 in India.

4.2 Further, Constitution allocates the subject of development and regulation of mineral resources in the territorial waters, continental shelf, exclusive economic zone and other maritime zones of India to the Union Government. The Union Government, through Ministry of Mines, exercises this right through The Offshore Areas Mineral (Development & Regulation), Act, 2002. The Ministry of Coal, under Union Government, administers rules and regulation including the Coking Coal Mines (Nationalisation) Act, 1972 and the Coal Mines (Nationalisation) Act, 1973, for development of coal resources in the country. Department of Atomic Energy, under Union Government looks after the development and regulation of atomic mineral resources through The Atomic Energy Act, 1962.

4.3 The Constitution allocates the subject of regulation of labour and safety in mines to the Union Government (entry number 55, Union List (list I) of Seventh Schedule). The Union Government, through Ministry of Labour and Employment, exercises this right through Mines Act, 1952 and rules and regulation framed there under. Administration of environment and forestry



## Overview of Policies and Regulations

issues through various acts including the Air Act, Water Act and Forest Conservation Act, etc. are carried out by both Union and State government.

4.4 The Mines and Minerals (Regulation and Development) Act, 1957 had already been amended several times and as further amendments may not clearly reflect the objects and reasons emanating from the new National Mineral Policy, it is considered necessary to reformulate the legislative framework in the light of the new National Mineral Policy, 2008 by repealing the Mines and Minerals (Regulation and Development) Act, 1957. The salient features of the Mines and Minerals (Development and Regulation) Bill, 2011, *inter alia*, are as follows:

- (a) it provides for a simple and transparent mechanism for grant of mining lease or prospecting licence through competitive bidding in areas of known mineralization, and on the basis of first-in-time in areas where mineralization is not known;
- (b) it enables the mining holders to adopt the advanced and sophisticated technologies for exploration of deep-seated and concealed mineral deposits, especially of metals in short supply through a new mineral concession;
- (c) it enables the Central Government to promote scientific mineral development, through Mining Plans and Mine Closure Plans enforced by a central technical agency namely the Indian Bureau of Mines, as well as the Regulatory Authorities and Tribunals;
- (d) it empowers the State Governments to cancel the existing concessions or debar a person from obtaining concession in future for preventing the illegal and irregular mining;
- (e) it empowers the Central Government and State Governments to levy and collect cess;
- (f) establishment of the Mineral Funds at National and State level for funding the activities pertaining to capacity building of regulatory bodies like Indian Bureau of Mines and for research and development issues in the mining areas;
- (g) it provides for reservation of an area for the purpose of conservation of minerals;
- (h) it enables the registered co-operatives for obtaining mineral concessions on small deposits in order to encourage tribals and small miners to enter into mining activities;

## Technical Guide on Internal Audit of Mining and Extractive Industry

- (i) it empowers the Central Government to institutionalise a statutory mechanism for ensuring sustainable mining with adequate concerns for environment and socio economic issues in the mining areas, through a National Sustainable Development Framework;
- (j) it provides for establishment of the National Mining Regulatory Authority which consists of a Chairperson and not more than nine members to advise the Government on rates of royalty, dead rent, benefit sharing with District Mineral Foundation, quality standards, and also conduct investigation and launch prosecution in cases of large scale illegal mining;
- (k) it provides for establishment of the State Mining Regulatory Authority consisting of such persons as may be prescribed by the State Government to exercise the powers and functions in respect of minor minerals;
- (l) it provides for establishment of a National Mining Tribunal and State Mining Tribunals to exercise jurisdiction, powers and authority conferred on it under the proposed legislation;
- (m) it empowers the State Governments to constitute Special Courts for the purpose of providing speedy trial of the offences relating to illegal mining;
- (n) it empowers the Central Government to intervene in the cases of illegal mining where the concerned State Government fails to take action against illegal mining;
- (o) it provides for stringent punishments for contravention of certain provisions of the proposed legislation; and
- (p) to repeal the Mines and Minerals (Development and Regulation) Act, 1957.

## List of Central Acts and Rules, Regulations and Policies

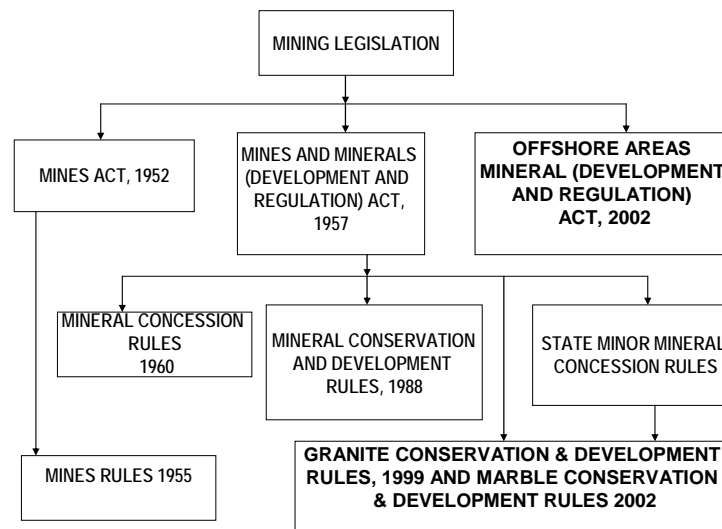
4.5 The Mines and Minerals (Development & Regulation) Act, 1957, ('MMDR') and the Mines Act, 1952, together with the rules and regulations framed under them constitute the basic laws governing the mining sector on land in India. For territorial waters, continental shelf, exclusive economic zone and other maritime zones of India, the Offshore Areas Mineral

## Overview of Policies and Regulations

(Development and Regulation) Act, 2002 has been enacted and is effective with effect from 31st January, 2003.

The relevant rules in force under the MMDR Act, are the Mineral Concession Rules, 1960, the Mineral Conservation and Development Rules, 1988, Granite Conservation and Development Rules, 1999 and Marble Development and Conservation Rules, 2002. The health and safety of the workers is governed by the Mines Rules, 1955, framed under the Mines Act, 1952.

The Mineral Concession Rules, 1960 outline the procedures and conditions for obtaining a Reconnaissance Permit or a Prospecting Licence or a Mining Lease, for all minerals other than petroleum and natural gas and also other than those minerals notified as 'minor' minerals. The Mineral Conservation and Development Rules, 1988 lay down the guidelines for ensuring mining on a scientific basis, while at the same time, conserving the environment. The provisions of Mineral Conservation and Development Rules are, however, not applicable to coal, atomic minerals and minor minerals. The State Governments have powers to formulate the Minor Mineral Concession Rules and grant mineral concessions for such minerals under such rules.



4.6 Important Acts, rules and regulations for Atomic Minerals are as follows:

- (i) Atomic Energy Act, 1962
- (ii) Atomic Energy (Radiation and Protection) Rules, 2004.

## Technical Guide on Internal Audit of Mining and Extractive Industry

4.7 Important policies are as follows:

- (i). National Mineral Policy, 2008
- (ii) New Coal Distribution Policy, 2007
- (iii) National Steel Policy, 2005

4.8 Some other enactments are as follows:

- (i) Marble Development and Conservative Rules, 2002
- (ii) Mining Leases (Modification of Terms) Rules, 1956
- (iii) Mines Rescue Rules, 1985
- (iv) Goa, Daman and Diu Mining Concessions (Abolition and Declaration as Mining Leases) Act, 1987
- (v) CESS and other Taxes on Minerals (Validation) Act, 1992

4.9 Other Acts, Rules, Regulations and Policies are as follows:

- (i) Some Environmental Acts applicable to mining projects are as follows:
  - (a) The Environment (Protection) Act, 1986
  - (b) The Air (Prevention and Control of Pollution) Act, 1981
  - (c) The Water (Prevention and Control of Pollution) Act, 1974
  - (d) National Green Tribunal Act, 2010
  - (e) The Indian Forest Act, 1927
  - (f) The Forest (Conservation) Act, 1980
  - (g) The Wild Life (Protection) Act, 1972
  - (h) The Public Liability Insurance Act, 1991
- (ii) Contract Labour (Regulation & Abolition) Act, 1970 is applicable for employment of contract labour in mining projects.

### **The Mines and Minerals (Development and Regulation) Act, 1957**

4.10 The Mines and Minerals (Development and Regulation) Act, 1957 provides for the regulation of mines and the development of minerals under the control of the Union. This Act provides that no person shall undertake any reconnaissance, prospecting or mining operations in any area, except under and in accordance with the terms and conditions of reconnaissance

## Overview of Policies and Regulations

permit or of a prospecting licence or, as the case may be, a mining lease, granted under this Act and the rules made thereunder.

Further, it provides that any State Government may, after prior consultation with the Central Government and in accordance with the Rules under Section 18, undertake reconnaissance, prospecting or mining operations with respect to any mineral specified in the First Schedule in any area within that State which is not already held under any reconnaissance permit, prospecting licence or mining lease.

4.11 Section 4A of the Act provides that "Where the Central Government, after consultation with the State Government, is of opinion that it is expedient in the interest of Regulation of Mines and Mineral Development, Preservation of natural environment, control of floods, prevention of pollution or to avoid danger to public health or communications or to ensure safety of buildings, monuments or other structures or for conservation of mineral resources or for maintaining safety in the mines or for such other purposes, as the Central Government may deem fit, it may request the State Government to make a premature termination of prospecting licence or mining lease in respect of any mineral other than a minor mineral in any area or part thereof, and, on receipt of such request, the State Government shall make an order making a premature termination of such prospecting licence or mining lease with respect to the area or any part thereof."

### **The Mines Act, 1952**

4.12 The Mines Act, 1952 amends and consolidates the law relating to the regulation of labour and safety in mines. It lays down that every mine should make effective provisions for drinking water, conservancy, medical appliance, etc. It requires that in every mine there shall be arrangements for the conveyance to hospitals or dispensaries of persons who, while employed in the mine suffer bodily injury or become ill. It also prescribes rules for weekly day of rest and compensatory days of rest for persons working in mines. Further, it limits the hours of work below ground to forty eight hours in any week or for more than eight hours in any day.

### **The Offshore Areas Mineral (Development and Regulation) Act, 2002**

4.13 The Offshore Areas Mineral (Development and Regulation) Act, 2002 provides for development and regulation of mineral resources in the territorial waters, continental shelf, exclusive economic zone and other maritime zones of India and provides for matters connected therewith or

## **Technical Guide on Internal Audit of Mining and Extractive Industry**

incidental thereto. The Act shall apply to all minerals in the offshore areas including any minerals prescribed under the Atomic Energy Act, 1962 except mineral oils and hydrocarbons related thereto.

### **The Coal Mines (Nationalisation) Act, 1973**

4.14 The Coal Mines (Nationalisation) Act, 1973 provides for the acquisition and transfer of the right, title and interest of the owners in respect of the coal mines specified in the Schedule with a view to re-organising and reconstructing such coal mines so as to ensure the rational, co-ordinated and scientific development and utilisation of coal resources consistent with the growing requirements of the country, in order that the ownership and control of such resources are vested in the State and thereby so distributed as best to subserve the common good, and for matters connected therewith or incidental thereto.

### **Coal Mine (Nationalisation) Act (CMNA) 1973**

4.15 CMNA recognises that all the coal resources within India belong to Union Government.

#### **Eligibility for Unrestricted Coal Mining**

The eligibility to undertake coal mining in the country has been laid down in Section 3 (3) of the Coal Mines (Nationalisation) Act, 1973. As per the provisions of the Act, the parties eligible to undertake coal mining in India without the restriction for captive consumption are:

- (a) The Central Government, a Government Company (including a State Government Company), a Corporation owned, managed and controlled by the Central Government.
- (b) A person to whom a sub-lease has been granted by the Government or a company/corporation having a coal mining lease where the coal reserves covered from the sub-lease are in isolated small pockets or are
- (c) not sufficient for scientific and economic development in a coordinated manner and the coal produced will not be required to be transported by rail.

#### **Default Lessee**

- (a) Coal India Limited (CIL), Singareni Collieries Company Limited (SCCL) and Neyveli Lignite Corporation (NLC) enjoy the status of central agencies for coal mining.

## Overview of Policies and Regulations

- (b) Subsidiaries of CIL have statutory rights for mining of coal which falls within the areas of respective subsidiaries.
- (c) SCCL have mining rights for coal mining in Godavari Valley coalfields (State of Andhra Pradesh).
- (d) NLC have mining rights for lignite mining in India.

### Provisions for Captive Coal Mining in India

4.16 Under the provisions of Section 3 (3) (a) (iii) of the Coal Mines (Nationalisation) Act, 1973, a Private Company engaged in the following activities is allowed to undertake coal mining operations for captive consumption:

- (a) Production of iron and steel
- (b) Generation of power
- (c) Washing of coal obtained from a mine
- (d) Cement manufacturing
- (e) Surface and Underground Coal Gasification and Coal-to-Liquids conversion
- (f) Such other end use as the Central Government may by notification, specify.

Definition of "Captive" was enhanced in 2006 and any company with a firm supply agreement with approved end-users is allowed to undertake coal mining operations.

### List of Important Stakeholders having significant Impact on Mining Sector

4.17 List of important stakeholders having significant impact on mining sector are as follows:

- I. Ministry of Mines
- II. Ministry of Coal
- III. Department of Atomic Energy
- IV. Central Ministry for Tribal Welfare
- V. Ministry of Environment and Forest
- VI. Ministry of Labor and Employment

## Chapter 5

# Internal Audit – Concepts

---

### Internal Audit – Definition

5.1 The definition of internal audit as per the "*Preface to the Standards on Internal Audit*" issued by the Institute of Chartered Accountants of India is as follows:

*"Internal audit is an independent management function, which involves a continuous and critical appraisal of the functioning of the entity with a view to suggest improvements thereto and add value to and strengthen the overall governance mechanism of the entity, including the entity's strategic risk management and internal control system."*

Thus, internal audit activity can play an important role and support the board and management in fulfilling an essential component of their governance mechanism. The internal auditor furnishes analysis, appraisals, recommendations, counsel and information concerning the activities reviewed. The internal auditor can suggest ways for reducing costs, enhancing revenues, and improving profits.

5.2 Key features identified on the basis the above definition of internal audit are as follows:

- Internal auditor should be independent in the performance of his duties, so that he can carry out his work freely without admitting interference, and as objectively as possible. Independence permits him to render impartial and unbiased judgements, which are essential to the proper evaluation of management and controls. It also allows internal auditor to view the financial actions, procedures and decisions in an independent way.
- Internal audit is a management function, thus, it has the high level objective of serving management's needs through constructive recommendations in areas such as, internal control, risk, utilization of resources, compliance with laws, management information system, etc.
- Role of internal audit is continuously changing and it differs from organization to organization. Internal audit aims at meeting the need of the organization.



## Internal Audit – Concepts

- An effective internal audit function plays a key role in assisting the board to discharge its governance responsibilities. Thus, it contributes in accomplishment of objectives and goals of the organization through ethical and effective governance.
- Risk management relates to how an organization sets objectives, then identifies, analyzes, and responds to those risks that could potentially impact its ability to realize its objectives. Internal audit plays an important role in assisting organization to evaluate the effectiveness of risk management.
- Internal auditing activity is primarily directed at improving internal control. Internal audit is performed to review and evaluate whether the internal controls are designed and operating effectively and provide recommendations for improvement

## Internal Audit – Objectives

5.3 The overall objective of an internal audit, as defined in the Preface to the Standards on Internal Audit are:

- to suggest improvements to the functioning of the entity; and
- to strengthen the overall governance mechanism of the entity, including its strategic risk management as well as internal control system.

Internal audit *inter alia* helps:

- To understand and assess the risks and evaluate the adequacies of the prevalent internal controls.
- To review and ascertain availability and compliance with policies and procedures of the various processes involved (that compliance activities have been properly planned, organized and directed).
- To review operations or programs for consistency with established management goals and objectives.
- To ascertain compliance with applicable legal laws, and regulations (that compliance activities have been properly planned, organized and directed).
- To determine if assets are safeguarded and verify the existence of those assets (that activities associated with asset acquisition,

## Technical Guide on Internal Audit of Mining and Extractive Industry

recording, storage, use and disposal have been properly planned, organized and directed).

- To determine resources are used efficiently and economically (i.e., that the organization is doing things the best way) utilised. The objective then, is to determine whether operating standards have been established for measuring economy and efficiency, whether deviations from operating standards are identified, analyzed and communicated to those responsible for corrective action, and whether effective corrective action has been taken.
- To determine the adequacy of information systems security and control.
- To review and ensure adequacy, reliability, accuracy and timeliness of financial and management information systems.
- To determine whether operational problems are identified and reported for correction.
- Identify areas for systems improvement and strengthening controls.

### Internal Control – Definition

5.4 Internal control is a process, effected by an entity's board of directors, management and other personnel, designed to provide reasonable assurance regarding the achievement of objectives in the following categories:

- effectiveness and efficiency of operations
- reliability of financial reporting
- compliance with applicable laws and regulations.

5.5 Standard on Internal Audit (SIA) 12, "*Internal Control Evaluation*" defines internal control as a system consisting of specific policies and procedures designed to provide management with reasonable assurance that the goals and objectives it believes important to the entity will be met. "Internal Control System" means all the policies and procedures (internal controls) adopted by the management of an entity to assist in achieving management's objective of ensuring, as far as practicable, the orderly and efficient conduct of its business, including adherence to management policies, the safeguarding of assets, the prevention and detection of fraud and error, the accuracy and completeness of the accounting records, and the timely preparation of reliable financial information.

## Internal Audit – Concepts

The internal audit function constitutes a separate component of internal control with the objective of determining whether other internal controls are well designed and properly operated.

### Internal Audit Team

5.6 With increased expectation of the audit committee and the management requiring internal auditors not only to provide reasonable assurance on organizational governance, as well as to meet ever increasing demands of management and other stakeholders, internal auditor must excel as internal to ensure that the controls over key systems and business processes are robust and effective.

5.7 The skill set, depth of knowledge and size of the audit team should be determined by the nature/ scope of services expected by the audit committee and management in order to meet organizational needs. Audit activity should comprise individuals with diverse backgrounds, skill sets and experience to provide adequate control review to support the business on a broad range of risk and internal control matters. Increasingly internal audit activities are performed by multi-disciplinary teams that include engineers, accountants, management graduates, environmental specialist, and information technology audit experts and so on.

A sufficient number of individual possessing the requisite degree of proficiency in the relevant disciplines is a major determinant of the effectiveness with which an internal audit of mining sector is performed.

### Legal Requirements for Conducting Internal Audit

5.8 Earlier, internal audit was largely voluntary and management used to appoint internal auditors as and when they felt the need. However, now with increased complexities in business, frauds and scams internal audit has become essential for most organisations. Internal Audit has now gained so much importance that conducting internal audit has been made mandatory by regulators for listed and other specified companies.

## Technical Guide on Internal Audit of Mining and Extractive Industry

5.9. The following are the legal and regulatory requirements with regard to carrying out internal audit and to establish an effective internal control system in an organization:

### **(i) The Companies (Auditor's Report) Order, 2003 (CARO)**

Clause 4(vii) – In the case of listed companies and/or other companies having paid-up capital and reserves exceeding ₹ 50 lakhs as at the commencement of the financial year concerned, or having an average annual turnover exceeding five crores rupees for a period of three consecutive financial years immediately preceding the financial year concerned, whether the company has an internal audit system commensurate with its size and nature of its business”

Clause 4(iv) - “Is there an adequate internal control system commensurate with the size of the company and the nature of its business, for the purchase of inventory and fixed assets and for the sale of goods and services? Whether there is a continuing failure to correct major weaknesses in internal control system.”

### **(ii) Requirements of Clause 49 of the Listing Agreement**

Few important requirements worth mentioning included in the provisions of Clause 49 of the Listing Agreement defined by The Securities and Exchange Board of India (SEBI) and applicable to listed entities are as below:

#### **(a) Review by Audit Committee**

The Audit Committee is required to review:

- With management the adequacy of internal control systems;
- The adequacy of internal audit function, if any, including the structure of the internal audit department, staffing and seniority of the official heading the department, reporting structure coverage and frequency of internal audit including the appointment, removal and terms of remuneration of the Chief Internal Auditor;
- Discussion with internal auditors on any significant findings and follow up there on;
- Reviewing the findings of any internal investigations by the internal auditors into matters where there is suspected fraud or irregularity or

## Internal Audit – Concepts

a failure of internal control systems of a material nature and reporting the matter to the board;

- The finding of any internal investigations by the internal auditors into matters where there is a suspected fraud or irregularity or a failure of internal control systems of a material nature and reporting the matter to the Board;
- Internal audit reports relating to internal control weaknesses.

### (b) Certification by CEO & CFO

The CEO & CFO shall certify to the Board that:

- They accept responsibility for establishing and maintaining internal controls and that they have evaluated the effectiveness of the internal control systems of the company and they have disclosed to the auditors and the Audit Committee, deficiencies in the design or operation of internal controls, if any, of which they are aware and the steps they have taken or propose to take to rectify these deficiencies.
- They have indicated to the auditors and the Audit committee;
- Significant changes in internal control during the year;
- Significant changes in accounting policies during the year and that the same have been disclosed in the notes to the financial statements; and instances of significant fraud of which they have become aware and the involvement therein, if any, of the management or an employee having a significant role in the company's internal control system.

### (iii) Others

- Section 292A of the Companies Act, 1956, requires public companies having paid up capital not less than Rs. 5 crores to constitute a committee of the Board, i.e., the Audit Committee. In terms of sub section 5 of the said Section, the internal auditor is required to attend and participate at the meetings of such Audit Committees.
- The Securities and Exchange Board of India has mandated complete internal audit on a half-yearly basis for stock brokers/ trading members/ clearing members.
- Companies those seeking listing in US stock exchanges, NASDAQ, NYSE, etc., need a strong internal audit function to meet the stringent

## Technical Guide on Internal Audit of Mining and Extractive Industry

corporate governance and internal control requirements of those stock exchanges.

### Standards on Internal Audit

5.10 Internal Audit Standards Board (IASB)<sup>3</sup> of ICAI was formed in 2004 with one of the primary objective to review the existing internal audit practices in India and to develop Standards on Internal Audit (SIAs). The SIAs aim to codify the best practices in the area of internal audit and also serve to provide a benchmark of the performance of the internal audit services. The SIAs are issued under the authority of the Council of the Institute.

While formulating the SIAs, the Board will take into consideration the applicable laws, customs, usages and business environment and generally accepted auditing practices in India. The Board may also, where it considers appropriate, take into consideration the international practices in the area of internal audit, to the extent they are relevant to the conditions existing in India. Preface to the Standards on Internal Audit also lays down the detailed scope and procedure for issuance of SIAs.

5.11 The Board has till date issued seventeen SIAs covering various important aspects of an internal audit activity including planning, gathering evidence, documentation, sampling, using the work of other experts, evaluating internal controls and risk management systems, reporting and assuring quality.

List of Standards of Internal Audit issued by the Internal Audit Standard Board:

- SIA 1 Planning an Internal Audit
- SIA 2 Basic Principles Governing Internal Audit
- SIA 3 Documentation
- SIA 4 Reporting
- SIA 5 Sampling
- SIA 6 Analytical Procedures
- SIA 7 Quality Assurance in Internal Audit

---

<sup>3</sup> Earlier known as Committee on Internal Audit.

## Internal Audit – Concepts

- SIA 8 Terms of Internal Audit Engagement
- SIA 9 Communication with Management
- SIA 10 Internal Audit Evidence
- SIA 11 Consideration of Fraud in an Internal Audit
- SIA 12 Internal Control Evaluation
- SIA 13 Enterprise Risk Management
- SIA 14 Internal Audit in an Information Technology Environment
- SIA 15 Knowledge of the Entity and its Environment
- SIA 16 Using the Work of an Expert
- SIA 17 Consideration of Laws and Regulations in an Internal Audit

## Stages in Internal Audit

### Audit Planning

5.12 The internal plan should be consistent with the goals and objectives of the internal audit function as listed in the internal audit charter and the overall organisational goals and objectives. The internal audit charter defines the purpose, roles and responsibilities and authority of the internal auditors.

In case the internal audit activity is outsourced, the internal auditor should ensure that the plan is consistent with terms of the letter of engagement.

5.13 At the onset of the internal audit activity, it is important to formulate the risk based audit plan. Every company that is in business has to take risks. Risks are those unforeseen situations the outcome of which may have an adverse affect on achievement of the organisationals goals and objectives. Hence, it is important that internal audit focuses on areas which are critical to organisational goals and objectives. Risk assessment helps internal auditor to identify those focus areas. Risk assessment activity includes identification of risk and its evaluation in terms of risk appetite and impact on organisational objectives. Weights and ranks based on criteria which will form the basis of ranking the audit areas to finally arrive at the score and shortlist the auditable areas. The role of internal auditor in the risk assessment activity will vary from organisation to organisation.

## Technical Guide on Internal Audit of Mining and Extractive Industry

5.14 On completion of risk assessment activity and identification of audit areas, detailed audit plan is prepared. Key elements and components of audit plan are as follows:

- The audit plan should describe the coverage or the details of work to be performed in each auditable area.
- Internal audit plan should also reflect the time and cost budget allocated by management.
- The coverage of the areas should be aligned and fit into the budget assigned.
- The audit schedule should be included in the audit plan. Audit schedule would also depend on the management and audit committee perception and prioritisation of the areas.
- Audit plan should also demonstrate the audit objectives.
- Audit team and the resource allocation should also be included in the audit plan. Resource allocation should take into consideration the skills set required, involvement of specialists, resource availability.
- Tentative start and completion dates.
- Audit plan should be reviewed periodically.

Annual audit plan for an organization should be approved by the audit committee.

### Field Work

5.15 Internal audit process would include the following:

**(i) Preliminary Understanding**

Prior to start of audit and opening meeting with the process owners, it is important to gain an initial understand of the area to be audited, the potential risks and objectives. Typically the internal audit team should consider:

- (a) Organisation structure
- (b) Company's financials
- (c) Existing internal control process documentation
- (d) Previous year's internal audit reports
- (e) Policies and procedures documented for the processes covered under audit
- (f) Applicable legal laws and regulations.



## Internal Audit – Concepts

### (ii) Initial Meeting

The objective of the initial meeting is to develop an effective approach for the assignment by discussing and getting an agreement on the following:

- (a) Scope of review
- (b) Process owners expectations
- (c) Identification and availability of process owners
- (d) Coordinate timing and milestones
- (e) Roles and responsibilities
- (f) Internal auditor should take this opportunity to get an insight on the systems and processes and its risks and objectives, and identify the areas of concerns and special focus that should be addressed.

### (iii) Audit Programme

On the basis of scope of review and the information and understanding gathered, a detailed audit programme is prepared. At this time, the audit programme should be prepared considering the proposed procedures, checkpoints, budgeting and basis for controlling the audit. A well defined audit programme ensures focused approach, prevents the auditor from going off the scope and ensures completion of audit in an efficient and effective manner.

The audit programme may be updated during the course of audit in cases required.

### (iv) Internal Control Design Review

The internal auditor will review the internal control structure to assess the design of internal control. At this stage the internal audit team, the system or processes to understand the flow of transactions. In order to complete the control design review effectively, it is important to consider the following:

- (a) The objective of the proces / systems;
- (b) Key stages in the process or system;
- (c) Risks that may prevent achievement of process or system objectives;
- (d) Control defined and implemented to manage the risks;

## Technical Guide on Internal Audit of Mining and Extractive Industry

- (e) The auditor may use various tools and techniques to complete the system or process review. The stage helps auditor to identify high risks and the control designs which need to be evaluated for effectiveness and efficiency.

### (v) Transaction Testing

Transaction testing involves testing of controls to assess their operating effectiveness. Operating effectiveness means that the controls are consistently operating the way it has been designed and intended to operate. During this stage we obtain audit evidence as to whether the controls are operating effectively or ineffectively. There are various testing techniques which either individually or in combination may be used to obtain audit evidence.

While doing transaction testing, it may not be possible and also not required to perform the audit procedures on the entire population (i.e., all the transactions which were undertaken), hence, sampling is required. Sampling means performing the audit procedures to less than 100% of the population. Internal auditor needs a consistent approach to draw a sample from the population and draw a conclusion based on the sample. Sampling becomes extremely critical as it should represent the entire population. Again, there are various methods of sampling. The manner in which the population is filed or distributed will determine the kind of selection techniques to be used to select the sample.

### (vi) Observation Finalization and Closing Meeting

On completion of review of design of controls and the transaction testing, the team should start finalising the observations noted. It is important that the issues noted should be discussed with the process owners and the management on an ongoing basis to obtain initial confirmation on the factual accuracy of the data. However, a formal discussion and agreement on the observations with the management, generally, happens at the completion of testing.

During the closing meeting the audit team should obtain management agreement on the issues and findings and the remediation plan to address the control gaps. The remediation plan should include the actions to be taken by management, a timeline to implement the actions and the individual responsible for implementation.

### (vi) Reporting

The preparation and issuance of internal audit report is one of the most important stage of the entire internal audit process as this the means by which the auditor's work is communicated to management. It is a formal document summarizing the work done and reports the findings and recommendations. The internal audit report contains a clear and concise written expression of audit findings, recommendations based on the policies, procedures, risks, controls and transaction testing taken as a whole alongwith management responses.

The internal audit report generally contains the following:

- (a) Report title
- (b) Distribution List
- (c) A brief background on the area audited, its scope, objectives and review period
- (d) Brief overview of the audit area
- (e) Summary of population and sample
- (f) Summary of critical observations which highlight the critical observations, control weakness and exceptions
- (g) Detailed finding and observations
- (h) Implication and risk rating
- (i) Recommendations/ suggestions
- (j) Management responses
- (k) Place of signature
- (l) Report date
- (m) Risk rating matrix

The format of the report will vary from organization to organization. However the basic and important content of the report will remain the same as indicated above.

The audit report must be written in a neutral tone and flawless in its accuracy, logic, clarity, grammar and spelling.

During the audit, initially a draft report is prepared for final management responses and confirmation on audit issues and its recommendations. On receipt of the management confirmation, the

## Technical Guide on Internal Audit of Mining and Extractive Industry

final report is issued. The final report is generally issued in print form and addressed to the agreed authority.

### (vii) Audit Documentation

Audit documentation refers to the working papers prepared or obtained by the internal auditor and retained by him in connection with the performance of internal audit. The internal auditor should document matters, which are important in providing evidence that the audit was carried out in accordance with the Standards on Internal Audit, scope agreed with management and support his findings or the report submitted by him. In addition, the working papers also help in planning and performing the internal audit, review and supervise the work and most importantly, provide evidence of the work performed to support his findings or report.

At the end of the assignment, the internal auditor should finalise the audit programme and the related working papers which can be both in electronic form and paper files.

### (viii) Audit Committee Presentation

In addition to the distribution discussed earlier, the contents of the audit report, client response, and follow-up report may also be communicated and presented to the Audit Committee periodically. The audit committee presentation should contain the status of audit plan and its current status, budgets and its current status alongwith the critical audit issues.

### (ix) Follow up Audit

Generally, the follow up audit is undertaken after a year of issue of final report to give substantial time to management for implementation. As a part of follow up audit, initially the management responses should be obtained with regard to the action taken and implementation status of the audit observations. There could be situations wherein no action has been taken by management as agreed in the final report. The review will be carried out only where management has listed down actions taken for resolving the issue. All the observations alongwith unresolved issues will be reported as a part of follow up audit report. The similar cycle of discussion, closing meeting and report finalization will be followed during this stage. The follow up audit report will be issued to the original addressees and any other official, if deemed necessary.

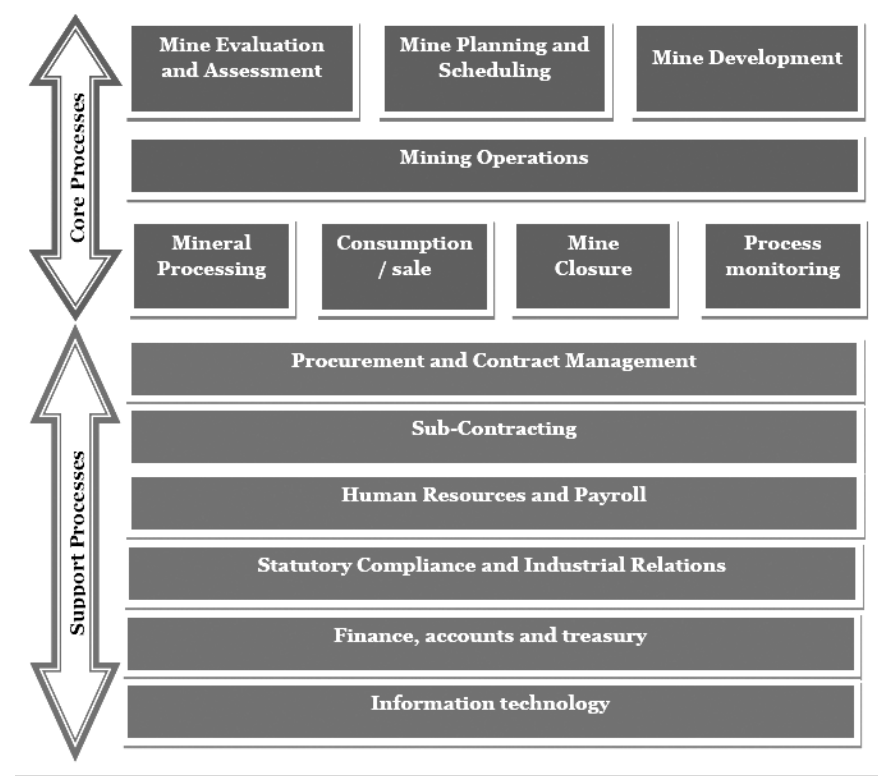
# Chapter 6

## Relevance and Role of Internal Audit in Mining Industry

---

6.1 A generic process framework comprising of the core mining processes and the relevant support processes is depicted below. The key focus areas for internal audit in each of the processes, as depicted in the framework, have been detailed later in the document.

Core processes are integral part of a mining company and outline the broad areas of operation for a mining company. Support processes enable functioning of the core processes by aligning their objective and functioning with the primary objective of the core processes. Although, these support processes are common across various industries, certain key factors specific to the mining operations have been enumerated in detail for better understanding.



## Mine Evaluation and Assessment

6.2 The key focus areas for internal audit in mine evaluation and assessment are as follows:

- Standardization of factors and processes to ensure completeness of the factors on which the evaluation and assessment is carried out:
  - (a) Geological factors;
  - (b) Technical factors;
  - (c) Social and Political factors;
  - (d) Environmental factors;
  - (e) Regulatory aspects;
  - (f) Economic factors, etc.
- Quantity considered in resource estimation (available quantity, recoverable quantity or additional quantity remaining in place).
- Assumptions made during the evaluation and assessment process and documentation of the same for future monitoring and tracking purposes.
- Team composition formed for mining, ensuring skills sets related to the factors to be assessed.
- Checklist for ensuring completeness of information to be gathered for effective decision making.
- Timeline for conducting the assessment and the validity of the assessment carried out.
- Documentation and approval of the assessment carried out.
- Mineral content at various places of the mine to assist during the mine planning and scheduling process.
- Commercial and operational implications of the technique of mining feasible, Open cast/ underground, depending upon the mine modeling and the ore body.
- Evaluation of logistics infrastructure and cost for ore transportation within the mine and sale to external customers/ captive consumption (access to ports, railways, etc).

## Relevance and Role of Internal Audit in Mining Industry

- Formal risk assessment document to assess and document the risk envisaged and the possible mitigants proposed.
- Capital investment estimation and revenue estimations made and the key assumptions made in the same.
- Impact of rehabilitation and possible issues in the same.

## Mine Planning and Scheduling

6.3 The Key focus areas for mine planning and scheduling audit are as follows:

- Linkage of the assumptions made during the evaluation and assessment stage with the mine plan and schedule.
- Planning technique and template used.
- Adequacy of critical components of the mine plan:
  - (a) Mining layout and topography;
  - (b) Mining technique;
  - (c) Mechanization and equipments required;
  - (d) Manpower requirement and planning (skilled and unskilled);
  - (e) Environmental management plan.
- Approval and documentation of the mine plan and communication to the relevant stakeholders.
- Existence of adequate mining licenses and lease agreements.

## Mine Development

6.4 The key focus areas related to mine development are as follows:

- Template and components of a mine development plan:
  - (a) Surface layout, shaft planning and designing;
  - (b) Transportation, stowing, storage and disposal plan;
  - (c) Waste management plan;
  - (d) Grade control and segregation;
  - (e) Preventive maintenance;
  - (f) Mineral processing plan and infrastructure;

## Technical Guide on Internal Audit of Mining and Extractive Industry

- (g) Mine evacuation plan;
- (h) Electricity and water;
- (i) Ventilation and pumping (for underground mine).
- Approval and documentation of the development plan and communication to the relevant stakeholders.

## Mining Operations

6.5 Mining operations include the following:

- Site Preparation
- Drilling and Blasting
- Excavation, Loading and Hauling
- Stockpile management
- Equipment maintenance process
- Environment, health and safety requirements

6.6 The key focus areas for internal auditor in mining operations are as follows:

- Site Preparation
  - Comparison of budget vs actual for the site preparation activity (time and cost)
  - Handling and disposal of debris, considering the environment norms
  - Consideration of afforestation norms
  - Basis of defining and checking adherence to the leveling norms.
- Drilling and Blasting
  - Existence and approval of a drilling and blasting plan
  - Physical custody and access controls over stock of explosives
  - Consumption records of explosives and reporting as per the regulatory requirements, wherever applicable
  - Equipment utilization analysis
  - Equipment breakdown analysis
  - Replacements/ repair of drilling machines



## Relevance and Role of Internal Audit in Mining Industry

- Safety protocols prior to and during the blasting process
- Consumables utilization and record maintenance
- Manpower utilization and record maintenance
- Sand consumption for restoration post blasting/ drilling, wherever required
- Fuel and electricity consumption during the drilling process
- Adherence to drilling plan.
- Excavation, Loading and Hauling
  - Type and technique of excavation – plan and approval
  - Excavation efficiency analysis – time and cost
  - Pre-excavation risk assessment and the engineer's report are in place
  - Safety training and protocols during the excavation process
  - Analysis of under cutting/ over cutting
  - Signage and security for access restriction at the excavation site
  - Testing and calibration of weight sensors on the conveyor belt used while loading
  - Availability of haulage equipment (loaders, dumpers, etc)
  - Transit losses during haulage and tolerance definition
  - Calibration of the distance reading and fuel consumption reading meters in the haulage equipment
  - Vehicle fitness test and documentation
  - Vehicle capacity planning and route analysis
  - Haulage delay and penalty, in case of outsourced service provider
  - Selection parameters for outsourced haulage equipment provider
  - Existence and maintenance of weigh bridge at the mining site
  - Existence and adherence to the weighment procedure
  - Analysis of the difference in tare weight of same/ similar vehicles

## Technical Guide on Internal Audit of Mining and Extractive Industry

- Controls over automated recording of tare and gross weight and time difference between the tare weight and gross weight
- Loading/ unloading time taken analysis
- Calibration of the weighbridge and records maintenance
- Commercial implications of lease vs buy for the equipments utilized in the process
- Equipment utilization analysis
- Fuel utilization analysis
- Analysis of additional cost of transporting the overburden – link to strip ratio and excavation technique employed
- % of revenue generating ore and overburden during excavation
- Stockpile Management
  - Technique of stocking employed – heap clearance of ore to ensure grade wise classification/ segregation
  - Heap wise record maintenance and updation
  - Heap stacking, height norms
  - Receipt through mother heap and issue through child heaps
  - Standard weights for the child heaps
  - Verification of the stockpile on a periodic basis by an independent surveyor
  - Assumptions considered by the surveyor in the stockpile assessment and basis of assessment – volumetric, eye estimation, etc
  - Sampling of the material lying in various heaps for testing the quality of the ore
  - Layout and design for stockpile management ensuring optimum utilization of the area and maintaining easy accessibility for movement of materials
  - Storage conditions - Open storage / covered storage, weather protection, access controls, safety for hazardous material storage, etc

## Relevance and Role of Internal Audit in Mining Industry

- Stock reconciliation: (quality and quantity)
  - o Grade wise
  - o Metal content wise
  - o Heap wise
- Grade wise and metal content wise record maintenance, recording the accounting/ operational system.
- Equipment Maintenance
  - Existence of a preventive maintenance plan for all the equipments (loaders, haulers, excavators, drilling machines, PPE, hopper wagons, etc)
  - Maintenance budget vs actual
  - Periodicity of replacement of spare parts and handling of the discarded spares
  - Replacement of spare parts from OEM / alternate sources
  - Breakdown analysis of the equipments and ascertaining the root cause
  - Light and air equipment maintenance for underground mines
  - Uptime of the conveyor belts, automatic feeders, etc
  - Handling of discarded wheels/ tyres – exploring rotation of front and rear tyres
  - Downtime taken for preventive maintenance
  - Use of consumables in maintenance activity and control over stock for the same
  - Parameters for selection of outsourced service provider for maintenance activity
  - Maintenance of the railway sidings, wagons, engines, etc operating inside the mine
  - Access road upkeep and maintenance – additional fuel / time spent due to road conditions
  - Replacement periodicity for the conveyor belts, pumps, ropeway pulley, etc.
  - Environment, Health and Safety

## Technical Guide on Internal Audit of Mining and Extractive Industry

- Existence of policies and monitoring framework for safety and environment compliance
- Adequacy of procedures for generating awareness on the company policies – training session, etc.
- Compliance with procedures for updating the company policies and procedure for safety and environment using internal/ external reviews and evaluation exercise
- Compliance with roles and responsibilities of the Safety committee, if any
- Compliance with laid down procedures for evaluation of environment/ safety measures, equipment and policies:
  - o Frequency
  - o Reporting
  - o Corrective action
- Assignment of responsibilities at various levels for safety compliances
- Compilation and reporting on safety/ environment performance information
- Compliance with laid down procedures for Mock Drills
- Accidents/ mishaps reporting
- Root cause analysis
- Corrective actions
- Inventory management procedures for safety material
- Existence of dedicated staff for ensuring compliance with health and safety policies and procedures
- Procedures for ensuring compliance with critical requirements under various statutes
- Loss time injury frequency (LTIF) monitoring and reporting

## Relevance and Role of Internal Audit in Mining Industry

### Mineral Processing

6.7 The key faces areal for mineral processing for internal auditor are as follows:

- Stages of processing required and the yield at various stages (Crushing, grinding, screening, separation, etc)
  - o Normal loss
  - o Abnormal loss
  - o Handling loss
  - o Storage and transportation loss
- Recording of input and output at various stages
- Measurement technique at various stages
- Stage wise consumables management
- Stage wise waste management
- Outsourcing of processing activity
  - Costing calculation and ROI calculation for the outsourced service provider
  - Yield as per contract and actual yield
  - Sub-contracting order maintenance for input and output comparison
  - Labor employment by the service provider
  - Record maintenance protocols of the service provider
- Sampling
  - Sampling at various stages of processing
  - Maintenance of chemical properties of the heap
  - Sampling procedure and techniques adopted
  - In-house v/s lab test for sampling
  - Sample retention and record maintenance – approval of samples and results
  - Sampling technique – taking ore for sampling from the heap
  - Evaluation of the service provider

## Technical Guide on Internal Audit of Mining and Extractive Industry

- Declaration of saleable ore post processing
  - Categorization of saleable ore post processing (fines / lumps)
  - Maintenance of chemical properties of lumpy grade material
  - Segregation of saleable ore from intermediary ore

## Consumption/ Sale

6.8 Captive consumption includes following important areas:

- Planning of dispatch from the mine to the plant
- Communication and approval for the dispatch plan
- Dispatch plan adherence
- Wagon and vessel arrangement
- Demurrage analysis – wagon loading/ unloading time vs free time made available by the lessor (say railways)
- Wagon Weighment
- Quality and quantity reconciliation – transit losses and adulteration
- Security during transit – wagon seals, wagon covers, etc.

6.9 Sale includes following important aspects :

- Material specifications as per contract and as per the pick list (mixing of different grades)
- Tolerance allowed as per the contract and the error/ calculation margin kept as a buffer
- Weighment protocol as per contract;
  - o Weighment at load port / discharge port
  - o Assaying and umpiring – selection of service providers – independent / joint selection
- Tolerance allowed as per contract vs actual – appropriateness of the mixing / tolerance defined
- Handling of rejection at the discharge port
- Transportation mode selection and lead time management considering the delivery schedule

## Relevance and Role of Internal Audit in Mining Industry

- Reference of terms in the contract
- Price fixation and relation with the commodity indices.

### Mine Closure

6.10 In case of mine closure, following aspects are important:

- Restoration/ Reclamation/ Rehabilitation
  - Method adopted for restoration/ reclamation/ rehabilitation – documentation and approval
  - Adherence to the plan and escalations, if required
  - Budget vs actual for expenses related to restoration/ reclamation/ rehabilitation.
- Inventory and Waste Management
  - Disposal of inventory at the site
  - Management of waste at the site
  - Disposal of hazardous/ toxic waste.
- Infrastructure disposal/ sale
  - Dismantling plan for infrastructure – losses/ damage during dismantling
  - Sale of equipments – condition assessment and valuation
  - Utilization of infrastructure at other sites/ captive use
  - Record maintenance and linkage with asset register
  - Calculation and approval of profit/ loss on sale
  - Classification of usable asset and scrap – basis, documentation and approval.
- Safety and Security
  - Mine abandonment plan
  - Disaster management plan.
- Licensing / leasing condition and regulatory compliance
  - Adherence to conditions for closure as per the mining license / leasing agreement

## Technical Guide on Internal Audit of Mining and Extractive Industry

- Release of any guarantees or other financial assurance instruments given
- Release of security deposits, if any
- Submission of notices, as may be required
- Adherence to the regulatory requirements during closure.

## Process Monitoring

6.11 Following aspects are important in case of process monitoring:

- Management information system (MIS):
  - Type of MIS prepared and circulated
    - Operational and technical
    - Commercial
    - Financial
    - Regulatory Compliance
  - Parameters in each of the above MIS and basis of selecting/ computing the same
  - Basis of preparing the MIS and the cut-off procedures adopted
  - Circulation list of the MIS
  - Formal review of the MIS and documenting the action plans
  - Follow up of the action plans
- Reconciliations
  - Critical reconciliations prepared and process of reviewing the same
    - Metal reconciliation (Mined, processed, dispatched, stored)
    - Fuel consumption reconciliation
    - Equipment usage reconciliation
    - Electricity and water consumption reconciliation.
  - Assumption used in reconciliation (Basis, review and updation)
  - Reconciliation templates and consistency
  - Reconciliation review, approval and escalation matrix



## Relevance and Role of Internal Audit in Mining Industry

- Corrective action on reconciliation
- Determining acceptable thresholds for reconciliation

## Human Resource and Payroll

6.12 Aspects relating to human resource and payroll are as follows:

- Planning and scheduling of mine workers ensuring availability in all the shifts considering the restrictions of working in a mine, specially underground mines
- Maintenance and updation of employee rosters for various shifts ensuring that all workers are timely updated in the rosters and details maintained therein
- Recording the attendance of employees shift wise
- Overtime approval and recording by the shift in charge
- Daily updation and reconciliation of hours worked by the workers in all the shifts
- Process of approval and recording the leave availed by the workers
- Employee master data maintenance and updation for the new workers being appointed
- Timely updating of employee master data, blocking of employee sub-ledgers subsequent to separation
- Adherence to maximum permissible working hours including overtime hours
- Timeliness and correctness of computation of salaries and wages and accounting
- Timeliness of payment of salaries and wages
- Adherence to Minimum Wages Act
- Controls over payments of wages in cash to workers (list of workers to be paid, preparation of pay packets for workers, identification of worker for payments, acknowledgement from worker, control over non disbursed pay packets, its tracking and reconciliation)
- Policy for bonus meeting legal requirements
- Performance evaluation and rating process
- Computation of incentive and bonus including festive bonus

## Technical Guide on Internal Audit of Mining and Extractive Industry

- Availability of workers related insurance policies
- Claims received, approved and paid against the insurance policies
- Review of loans and advances given to workers
  - Eligibility
  - Approval
  - Recording
  - Recovery in form of deduction from salary
- Full and final settlement in case of termination including gratuity payment
- Statutory compliance including Provident Fund, ESI, Gratuity, Professional Tax, TDS, Payment of Bonus Act, Workmen Compensation Act, etc.
- Reimbursement of employee expenses as applicable
- Accounting for annual benefits like gratuity, pension, bonus, etc.
- Reconciliation of month on month salary and wages payments
- Existence of policies and procedures for recruitment, attendance and leave, payroll processing & disbursement, termination and separation, loans and advances, terminations
- Manpower budgets and its monitoring.

## Sub-Contracting Process

6.13 Following aspects of sub-contacting process are important:

- Manpower requirement planning for sub-contracting to ensure continuous and timely availability of the mine workers:
  - Defining the levels of workers required basis the skills set
  - Scheduling the requirements as per the shift s working hours
  - Approval / authorisation to the labour requirements
- Selection and appointment of sub contractors for supply of mine workers
  - Identification of labour contractor keeping in view the workers skills set and levels
  - Documenting the parameter for selection of sub contractor

## Relevance and Role of Internal Audit in Mining Industry

- Evaluation and finalization of sub contractor
- Availability of agreements with labour contactors containing necessary terms and conditions
- Formation of agreements in standard formats and obtaining legal clearance to the agreements to ensure inclusion of all necessary and applicable legal requirements related to mining companies
- Approval of agreements by appropriate authority
- Monitoring and analysis of supply of mine worker by the sub contractor as per the agreement
- Maintenance and updation of separate register for workers on contract basis for various shifts ensuring that all workers are timely updated in the rosters and details maintained therein
- Recording and approval to the attendance of workers shift-wise by the company official in addition to sub-contractor supervisor
- Overtime approval and recording by the shift in charge
- Daily updation and reconciliation of hours worked by the workers in all the shifts
- Adherence to legal requirements with regard of permissible working hours
- Monitoring adherence to PF, ESI, etc. requirements by labour contractor prior to release of payments
- Adherence to Contract Labour Act, Mine Act, etc. requirements
- Reconciliation of the labour contractor bills with the internal attendance records
- Correctness of computation of payment to labour contractors
- Periodic performance evaluation of labour contractors, particularly, with respect to timeliness and quality of manpower supply
- Monitoring the corrective actions required as per the performance evaluation
- Existence of policies and procedures for labour sub contracting.

## Finance, Accounts and Treasury Activities

6.14 Important aspects of finance, accounts and treasury activities are as follows:

### (i) *Cash and Bank*

- Existence and compliance to documented procedure and schedule of authority exists for various cash and bank related areas:
- Cash disbursements/ payments / receipts / deposits
  - Bank Receipts/ Payments
  - Receipt and deposit of Cheques
  - Physical verification of cash
  - Bank Reconciliation Statement
  - Accounting
- Segregation of duties with respect to operating bank accounts and processing receipts and payments
- Authorized signatory for bank accounts are presently working with the company
- Bank and cash entries, its appropriateness of accounting and authorisations
- Deposit of cheque and cash in banks
- Periodic physical verification of cash
- Controls over cheque inventory
- Bank reconciliation statements
- Stale cheque and its accounting
- Payments and receipts through RTGS, EFT, ECS, etc.
- Control on issue and receipts of cheques, demand drafts, LCs, etc.
- Bank balance confirmation process
- Cut-off process
- Book closure process
- General ledger code creation and maintenance process.

## Relevance and Role of Internal Audit in Mining Industry

### (ii) *Loans and Borrowings*

- Approvals to borrowings by authorized individuals as per Board resolutions.
- Adherence to the process defined for loans and borrowings
- Periodic review of borrowing limits to eliminate, decrease or enhance borrowing limits and authority
- Basis of borrowing decisions - formal analysis prepared that includes contracts reviewed by treasury, legal, tax and accounting
- Loans details of independent confirmation
- Recording and accounting of loans and borrowings
- Reconciliation of debt details with the general ledger
- Tracking and monitoring of the loan covenants
- Amortization of material debt issuance costs
- Interest expense accrual computation and accounting
- Repayment of interest and principal amount and accounting of the same
- Registration of charges as per the loan agreements
- Adherence to RBI guidelines and also FEMA requirements in case of international borrowings.

### (iii) *Insurance*

- Identification of the insurance policies applicable for the company
- Process to arrive at and periodic review of the coverage and value/ upper limits of the policy
- Basis of selection of the third party to advise on insurance policies
- Agreements with the insurance advisors appointed by the company
- Policies obtained to cover the various assets and liabilities as identified by the company
- Tracking process to ascertain timely renewal of insurance policies
- Process for identification and submission of insurance claims
- Follow up mechanism for pending insurance claims.

## Technical Guide on Internal Audit of Mining and Extractive Industry

### (iv) *Working Capital and Trade Finance*

- Adherence to Board resolution defining the approving authority for Trade Finance viz., letter of credit, bank guarantees, buyers credit, etc.
- Tracking, monitoring and adherence to the trade finance limits
- Supporting documents and linking with purchase requirements for availing trade finance
- Bank agreements defining the limits of various trade finance instruments
- Interest expense accrual computation and accounting
- Repayment of interest and principal amount and accounting of the same
- Working capital arrangement with banks and the related agreements
- Adherence to the limits and covenants as per bank agreements
- Authorization process before utilizing any working capital
- Physical custody and existence of the agreements and bank guarantees

## Procurement and Contract Management

6.15 Following are important aspects of procurement and contract management:

### (i) *Contract Formation*

- Existence of documented procedure and delegation of authority for procurement process
- Procurement budgets preparation and monitoring
- Material requirement planning process for long term consumables and daily consumables requirement for mine operation
  - Basis of preparation, source and approvals to production plan/ capacity which is the basis for material requirement planning
  - Relevant factors/ logics that has been used for planning, consistency with prior periods, accuracy of source data and adherence to timelines

## Relevance and Role of Internal Audit in Mining Industry

- Monitoring over monthly production plans and deviations, if any with reasons are approved
- Comparison of actual procurement with the planning
- Process of raising purchase requisition as per the requirements ascertained during the planning process
- Approval of purchase requisitions
- Mandatory fields in purchase requisition forms
- Vendor identification and selection process
  - Mode of obtaining bids/ quotations from approved vendors
  - Process for issue of request for quotations
  - Process of handling the receipt of quotations
  - Analysis of quotations to identify the most suitable vendor
  - Consideration of quality aspects/ legal requirements as applicable for the material
  - Negotiation process
  - Approval to vendor selection.
- Purchase order creation and issuance
  - PO raised only against approved PRs
  - System controls over raising of POs against unapproved PRs
  - Quantity in PR and PO
  - Delivery schedule
  - PO raised on approved vendors
  - PO linked to purchase budgets
  - Purchase price agreed during vendor negotiation
  - Approval to PO as per the authority matrix
  - Inclusion of relevant and necessary terms and conditions in the PO
  - Process of communication of PO to vendors
  - Payment terms
  - PO amendments

## Technical Guide on Internal Audit of Mining and Extractive Industry

- PO cancellations.

- Monitoring over open POs and PRs
- Vendor advance process
- Performance and bank guarantees issuance process
- Lead time analysis.

### **(ii) *Contract Execution***

- Goods receipt note/ service receipt note preparation process
- System controls over edits allowed while creating GRN/ SRN and auto flow of data from PO
- Weighment/ count process at time of receiving the materials
- Quality inspection process
- Certification for receipt of service
- Rejection process
- Return process for rejected goods
- Accounting at various stages
- Physical storage of materials
- Inventory analysis (ABC classification and inventory holding norms)
- Item master database maintenance

### **(iii) *Contract Monitoring***

- Monitoring process for ensuring ongoing compliance with terms and conditions of the contract
- Vendor performance evaluation process
- Amendments to contracts

### **(iv) *Contract Closure***

- Process of receipt and review of vendor bills
- Bill parking and posting process
- Accounting for liability
- Control over processing of duplicate payments
- Advance adjustment



## Relevance and Role of Internal Audit in Mining Industry

- Payment due date tracking process
- Payments as per the PO terms and conditions
- Cheque generation and EFT payment process
- Debit notes and credit notes issuance process
- Creditors ledgers and aging
- Payments to vendors
- Segregation of duties between PR, PO, GRN and payment processing
- Provisions and book closure
- Vendor balance confirmation and reconciliation.

### (v) *Vendor Management*

- Vendor master database maintenance
- Vendor development process
- Approved vendors
- Vendor creation/ amendment/ deletion process.

## Statutory Compliance and Industrial Relations

6.16 Following are important aspects related to statutory compliance and industrial relation:

### (i) *Statutory Compliance*

- Statutory compliance related policies and procedures
- Availability of statutory compliance checklist including all the requirements of the applicable acts (as listed above and including health, safety and environment related legislations)
- Process of updation of checklist
- Monitoring and review process to ensure adherence to the checklist
- Escalations and corrective action process
- Self certification of statutory compliance checklist periodically.

## Technical Guide on Internal Audit of Mining and Extractive Industry

### (ii) *Health, Safety and Environment (HSE)*

- HSE related legal requirements and management policy including and not limited to the following
  - Worker health and safety management
  - Soil and land management
  - Water management
  - Air quality management
  - Noise and vibration management
  - Waste and hazardous material management
  - Waste rock management
  - Erosion management
  - Cultural heritage management
  - Socio economic management
  - Review mechanism for adherence to the requirements and policy including self certification process.

### (iii) *Industrial Relations*

- Adherence to the collective bargaining agreement with labour unions
- Incident reporting process for effective resolution
- Labour welfare policy and compliance
- Workers grievance and Redressal mechanism.

## Information Technology

6.17 Following aspects of information technology are important:

- Existence of information security policies and procedures
- Scheduling and batch processing procedures
- Change control process to scheduled jobs and appropriate authorization
- IT help desk process
- System, application and network access control
- Review of Personal Computers

### Relevance and Role of Internal Audit in Mining Industry

- Local Area Networks (including wireless)
- Program development process including post-implementation reviews
- Program change management process
- Existence and adherence to service level agreements
- Disaster recovery plans / Business Contingency Plans to facilitate recovery from operational failures
- Data back up process
- Storage of back up media
- Anti-Viruses process
- Physical security of servers and IT equipments
- Insurance policy.