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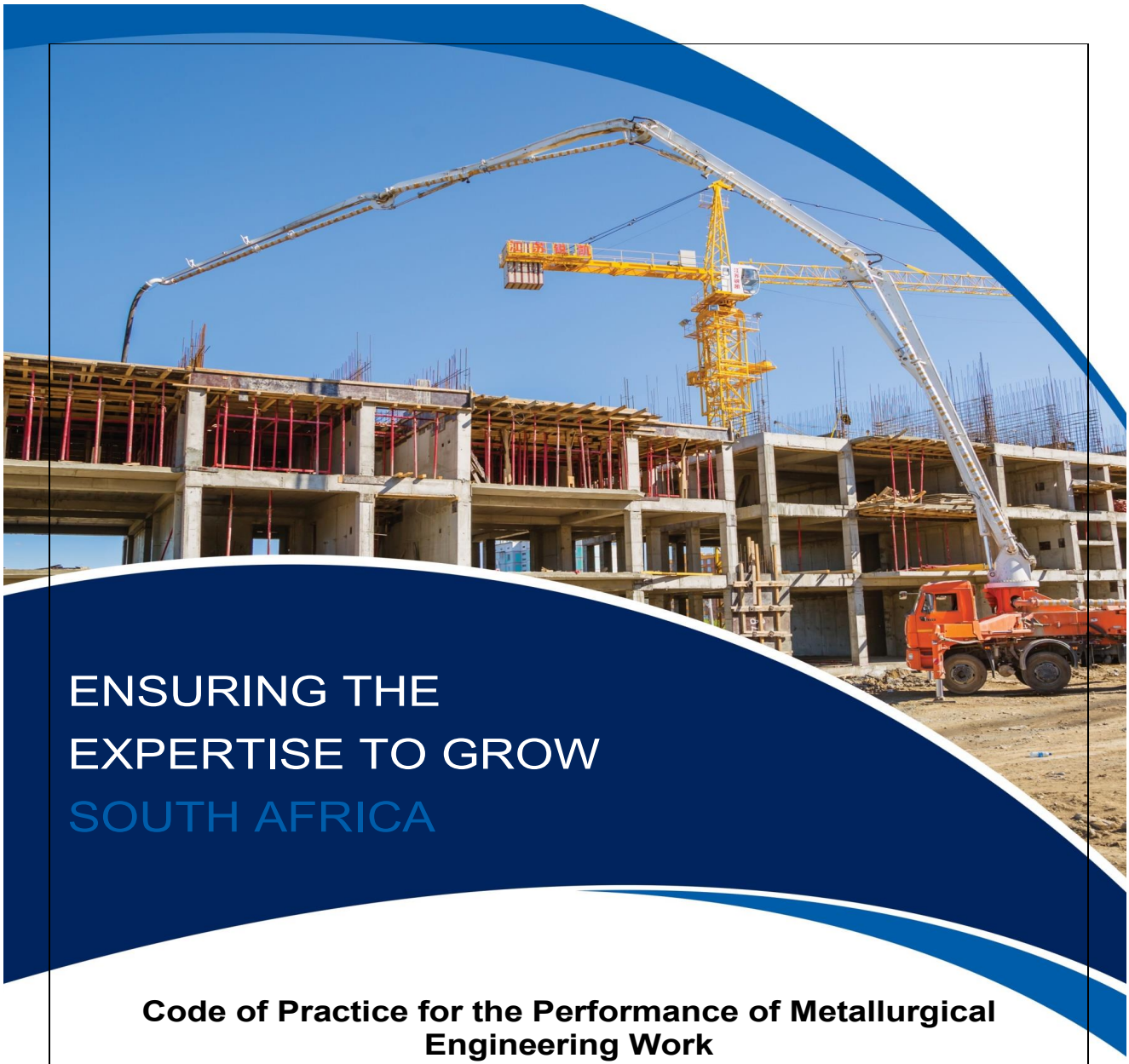

ENSURING THE
EXPERTISE TO GROW
SOUTH AFRICA

# Code of Practice for the Performance of Metallurgical Engineering Work

## R-02-COP-MET

## REVISION No. 0:01 December 2022

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ECSA

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## DEFINITIONS

**Act** means the Engineering Profession Act, 46 of 2000 "as revised".

**Code** means this code of practice document.

**Code of Conduct** means the Code of Conduct for Registered Persons: Engineering Profession Act, 46 of 2000.

**Competency** means a combination of knowledge, training, experience and applicable qualifications that enables an individual to perform a task or an activity successfully.

**Council** means the Engineering Council of South Africa established by Section 2 of the Act.

**Discipline** means the disciplines of engineering as recognised by the Engineering Council of South Africa.

**Engineering Work** means the process of applying engineering and scientific principles, concepts, contextual and engineering knowledge to the research, planning, design, implementation, maintenance, and management of work in the natural and built environments. It includes advisory services, assessment of engineering designs and determination of the risks posed by the design on workers, the public, and environment.

**Identification of Engineering Work** means the Identification of Engineering Work as gazetted.

**Overarching Code of Practice** means the Overarching Code of Practice for the Performance of Engineering Work as gazetted.

**Practice** means any engineering professional service, advisory service or creative work requiring engineering education, training and experience and the application of special knowledge of the mathematical, physical and engineering sciences, or creative work such as consultation, research, investigation, evaluation, planning, surveying, risk assessment and design, in connection with any public or private utility, structure, building, machine, equipment, process, work or project.

**Profession** means Engineering Profession.

**Registration Category** means a professional registration category as specified under Section 18(1)(a)–(c) of the Act, including Professional Engineer, Professional Engineering Technologist, Professional Certificated Engineer, Professional Engineering Technician, Candidate and Specified Category Practitioner.

**Registered Person** means a person registered under a category referred to in Section 18(1) of the Act.

**Specified Category** means those registration categories classified as such by ECSA, for example those related to fire protection systems, lifting machinery and medical equipment.

**Specified Category Practitioner** means a person registered in terms of section 18(1)(c) of the Engineering Profession Act, carrying out specifically defined engineering activities.

**Unregistered Person** means any person undertaking Engineering Work who is not registered in terms of the Act. This does not include persons registered by other statutory bodies who are part of teams undertaking Engineering Work.

## ABBREVIATIONS

| | |
|---|---|
| **ASTM** | American Society for Testing and Materials |
| **BEng** | Bachelor of Engineering |
| **BSc Eng.** | Bachelor of Sciences in Engineering |
| **BTech** | Bachelor of Technology |
| **BEng Tech** | Bachelor of Engineering in Technology |
| **DMS** | Dense Medium Separation |
| **ECSA** | Engineering Council of South Africa |
| **HMS** | Heavy Medium Separation |
| **ISO** | International Organization for Standardization |
| **OHS** | Occupational Health and Safety |
| **Pr.Eng.** | Professional Engineer |
| **Pr.Tech Eng.** | Professional Engineering Technologist |
| **Pr.Techni Eng.** | Professional Engineering Technician |
| **SHE** | Safety, Health, and Environment |
| **SAMREC** | South African Code for Reporting of Exploration Results, Mineral Resources and Mineral Reserves |
| **SAMVAL** | South African Code for Reporting of Mineral Asset Evaluations |
| **SANS** | South African National Standards |

## 1. INTRODUCTION

In terms of Section 27(1) of the Act, the Council must draw up a code of conduct for Registered Persons and may draw up a code of practice in consultation with the Council for the Built Environment, Voluntary Associations and registered persons. The Council is also responsible for administering the code of conduct and the code of practice and ensuring that these codes are available to all members of the public at all reasonable times. An "Overarching Code of Practice for the Performance of Engineering Work" was therefore developed and published in the Government Gazette, dated 26 March 2021, which further in this document is referred to as the "Overarching Code of Practice", for brevity. The Overarching Code of Practice applies to all engineering disciplines.

Section 18(1) of the Act provides four categories for registration of professionals and candidates, namely Engineers, Technologists, Technicians and Certificated Engineers. Section 18(2) prohibits persons so registered from practising in a category other than that in which they are registered.

In line with these requirements, the Metallurgical Engineering Code of Practice aims to supplement the Overarching Code of Practice. The Code also regulates the practice by classifying Metallurgical Engineering Work in terms of its complexity and stipulates the category of registration and the level of competence required for the execution of such work.

## 2. POLICY STATEMENT

This Code is a statement of good practice for the performance of Metallurgical Engineering Work by Registered Persons. It is applicable to the entire Metallurgical Engineering profession. Section 27(3) of the Act requires Registered Persons to adhere to the requirements of this Code when they perform metallurgical work.

## 3. PURPOSE AND SCOPE OF DOCUMENT

The Code's purpose is to ensure that any person undertaking Metallurgical Engineering Work meets the prescribed requirements when practising and executing Metallurgical Engineering

Work within the jurisdiction of the Act. This Code sets appropriate levels of competence regulating the execution of Metallurgical Engineering Work and specifying technical standards and best practices.

This Code also applies when a Metallurgical Engineering Practitioner performs Metallurgical Engineering Work in the specified categories, such as those related to fire protection systems, lifting machinery and medical equipment. Additional codes of practice, specific to the specified category, may also apply in these contexts.

## 4. APPLICABLE LEGISLATIVE FRAMEWORK

Section 27 of the Act empowers the Council to draw up codes of practice in addition to codes of conduct and requires all registered persons to comply with such codes.

This Code should be read in conjunction with the Act and related documents, in particular the Code of Conduct for Registered Persons, the Overarching Code of Practice and the gazetted Identification of Engineering Work Regulations.

## 5. METALLURGICAL ENGINEERING WORK

The Metallurgical Engineering discipline operates primarily in the mining, minerals and metals sectors and utilises the knowledge of mathematics, chemistry, physics, mineralogy, underlying process fundamentals and process engineering to control and improve processes that separate, concentrate and recover minerals and their valuable metals from natural ores and/or secondary resources as well as transforming them into final usable products. Three career paths are available to the Metallurgist: Minerals Processing, Extractive Metallurgy and Physical Metallurgy/ Materials Engineering (**R-05-MET-PE**).

Minerals Processing is a branch of Metallurgical Engineering through which valuable minerals are separated from gangue ad/or other constituent minerals through specialised physical and physicochemical processes such as crushing and milling, flotation, jigging, scrubbing, magnetic separation, dense medium separation (DMS) and heavy medium separation (HMS), among others. The unit processes require crushing and grinding the ore to a fine size to liberate

and separate the individual mineral particles from the waste rock and other constituent mineral particles. Valuable minerals and metals such as gold, silver, copper, lead, zinc, molybdenum, iron, potash, phosphate and even sand for glass are often processed by unit processes such as physical separation and froth flotation (**R-05-MET-PE**).

Extractive Metallurgy involves the extraction of metals from their natural mineral deposits or intermediate compounds from ores by chemical or physical processes, including hydrometallurgical process stages, high temperatures or pyrometallurgical process stages and electro-metallurgical process stages. The aforementioned processes may produce pre- or crude metal products that can be subjected to further processing, refining and manufacturing through unit processes such as electrowinning, alloying, casting, rolling and extrusion (**R-05-MET-PE**).

Physical Metallurgy and Materials Engineering involves the processing and fabrication of metals and alloys into finished products using unit processes such as alloying, casting, forging, welding and heat treatment, among others, and controls the physical, chemical and mechanical properties. Physical Metallurgy and Materials Engineers in addition perform research, analysis, design, production, characterisation, failure analysis and application of materials, including metals and alloys, for engineering applications based on an understanding of the properties of matter and engineering requirements (**R-05-MET-PE**).

### 5.1 Engineering qualifications and supervision of Engineering Work

It is highly recommended that all Metallurgical Engineering Work be undertaken by registered Metallurgical Engineering Practitioners. In cases where work is to be performed by unregistered Metallurgical Engineering Practitioners, it is recommended that the following work allocation in Table 1 be considered under the direct supervision and control of registered Metallurgical Engineering Practitioners:

**Table 1: Engineering Qualifications and Supervision of Engineering work**

| Qualification | Level of Descriptors | Supervision |
|---|---|---|
| a) BEng/BSc Eng | Solving complex engineering problems and performing complex engineering activities | Pr.Eng. |

| Qualification | Level of Descriptors | Supervision |
|---|---|---|
| b) BTech/ BEng Tech Eng / Advanced Diploma | Solving broadly defined engineering problems and performing broadly defined engineering activities | • Pr.Eng.<br>• Pr.Tech. Eng |
| c) National Diploma | Solving well-defined engineering problems and performing well-defined engineering activities | • Pr.Eng.<br>• Pr.Tech. Eng<br>• Pr Techni Eng |

### 5.2 Category of registration and level of descriptors

Metallurgical Engineering has a diverse range of sub-disciplines operating in the mining, minerals and metals sectors in which Metallurgical Engineers could be employed, as seen in **Table 2**. Due to the diverse range of sub-disciplines and specialised skills characterising the profession, it is complex to define a set of predetermined training paths for a Metallurgical Engineer. Instead of predetermined paths, a set of guiding principles in **Table 3** is proposed whereby Candidate Engineers can shape the course of their careers. The nature of work involved in Metallurgical Engineering follows the general principles in **Table 3** across all sub-disciplines. Work performed by non-registered Metallurgical Engineers should be executed under the direct supervision and control of registered Metallurgical Engineering Practitioners as discussed in **Table 1**. In summary:

(a) The performance of Metallurgical Engineering Work requires solving industrial engineering problems and engaging in Metallurgical Engineering activities.

(b) Metallurgical Engineering Work encompasses several Metallurgical Engineering sub-disciplines, each dealing with a specific body of knowledge.

(c) Depending on the level of complexity, Metallurgical Engineering Work is carried out by Registered Persons possessing different levels of competence as typified by the various categories of registration given in Section 18(1) of the Act.

(d) Due to a common grounding in the mathematical and physical sciences, there are areas of overlap among the various sub-disciplines of Metallurgical Engineering and overlaps

with other professions and/or disciplines. These overlaps generally occur at a basic level and divergence increases with the degree of specialisation.

**Table 2: Different fields of metallurgy that extractive, physical and materials engineering may focus on**

| Minerals Processing and Extractive Metallurgy | Physical Metallurgy and Materials Engineering |
|---|---|
| • Minerals Processing Engineer | • Physical Metallurgist |
| • Extractive Metallurgist | • Materials Engineer |
| • Consulting Engineer | • Welding Engineer |
| • Pyrometallurgist | • Corrosion Engineer |
| • Hydrometallurgist | • Quality Assurance Engineer |
| • Electrometallurgist | • Consulting Engineer |
| • Process Engineer | • Process Engineer |
| • Researcher and Development Engineer | • Researcher and Development Engineer |
| • Academic Researcher or Lecturer | • Academic Researcher or Lecturer |

**Table 3: Metallurgy Engineering Work**

| Nature of Work | Activities |
|---|---|
| Investigation and problem analysis | • Collecting, analysing, and reporting data from new and existing processes, plant or equipment, and demonstrating the theoretical and practical knowledge to solve problems utilising the well-proven analytical techniques and tools. This includes the ability to use troubleshooting skills.<br>• Using troubleshooting methodologies, literature surveys, data analysis and root cause analysis tools to identify, analyse and solve complex problems engineering problems.<br>• Investigating properties of metals, alloys, ceramics, polymers, and other materials, and developing and assessing their commercial and engineering applications. |

| Nature of Work | Activities |
|---|---|
| Process plant, and equipment design and optimisation | • Collecting, analysing, and reporting data from new and existing processes, plant, or equipment, in line with design codes and standards.<br>• Applying the principles of complex Metallurgical Engineering practice, including the critical study of complex work methods and the development of more effective techniques for recognising real and significant problems and how to solve them.<br>• Process design and development, involving laboratory, pilot-scale or full-scale plant work to generate engineering data for the specification and design of broadly defined new metallurgical plants or the improvement of existing plants.<br>• Prepare complex process flow sheets, material and energy balances, and engineering designs, including specifications on design, sizing and selection of equipment, service requirements, materials of construction, economics and impact on the environment. Design plants or equipment by considering the following aspects: reliability, maintainability, usability, supportability, reducibility, disposability and affordability.<br>• Optimisation and control of a complex process or equipment to improve performance. Process optimisation involves providing solutions to the problem identified; this might be through improving the system/equipment operating parameters by modifying or installing new processes, equipment or systems. |
| Product Manufacturing and Characterisation | • Design new engineering materials, focusing on the relationship between composition, crystal and microstructure, processing and physical and mechanical properties.<br>• Analyse the properties and structure of engineering materials such as metals, alloys, ceramics and composites to improve performance or create new engineering materials that meet or exceed the desired mechanical, electrical, magnetic and chemical properties stipulated by specific design codes and standards.<br>• Design, develop, and test processes and protocols to evaluate and improve properties and performance of engineering materials, including assisting in the selection of materials for different products for new and existing applications.<br>• Apply physical and chemical manufacturing methods to transform engineering metals, alloys and composites into semi-fabricated |

| Nature of Work | Activities |
|---|---|
| | or finished manufactured products using forming, finishing and manufacturing methods such as alloying, casting, forging, heat treatment and surface coating.<br>• Quality control based on international manufacturing standards such as ISO, ASTM. |
| Project development and management | • Project task definition, including idea / problem analysis / definition need, conceptual design, basic and detailed engineering. This includes desktop research and feasibility studies to identify and select the preferred solution and develop the solution.<br>• Designing, developing, constructing, commissioning and handing over of equipment and processing plants.<br>• Project controls, including cost control, estimating resources, capital and operating and/or lifecycle costs, planning and scheduling, and project risk management.<br>• Stakeholder management, including stakeholder liaison and communication and overall control of the engineering team and interfacing with client/legal entities.<br>• Project resource management, including responsibilities relating to procurement and contracts management in line with standard codes of practice.<br>• Managing project change and project risk. |
| Plant construction, commissioning, and hand over | • Plant construction, including site establishment and management, assembling of plant equipment in accordance with drawings and installation designs.<br>• Plant commissioning – preparation of start-up, shutdown, and emergency procedures. Measurement and analysis of actual performance data versus design parameters, responsibility for performance of the plant, optimising plant performance, reviewing all safety standards, operability of the plant, sound labour relations and practices and managerial aspects.<br>• Plant hand-over – including 'as-built' documentation, construction, planning and execution of punch-out and hand over. |
| Plant operation and maintenance | • Process plant operation, especially with direct and increasing responsibility for certain sections of the plant.<br>• Quality control in respect of measurement and specifications. |

| Nature of Work | Activities |
|---|---|
| | • Plant records and operating costs.<br>• Process control and management.<br>• Inter-relationships between engineering personnel and management, and among members of the engineering team, especially between production and maintenance.<br>• The impact the operation may have on the environment.<br>• Application of economic analysis of production processes to effect optimal performance.<br>• Management of the technical aspects metallurgical operations using tools such as on-line process monitoring, sampling, chemical analysis, data analysis and process modelling.<br>• Management and supervision of production staff in metallurgical operations.<br>• Application of chemical, metallurgical and process engineering fundamentals to production processes.<br>• Undertaking fault findings in plant equipment and taking corrective action to ensure safe operation.<br>• Ensuring that appropriate SHE systems and practices are implemented within the department / organisation.<br>• Ensuring that plant availability, utilisation and operability throughput and recovery targets are being met.<br>• Ensuring that all plant operations run efficiently against industry best practice and appropriate standards by updating, recording, archiving and analysing all plant related data.<br>• Ensuring that appropriate metallurgical input is provided for business plans and forecasts (e.g., monthly, quarterly and annual forecasts).<br>• Ensuring that cost and cash flow targets are met.<br>• Compiling or updating appropriate policies and procedures or work instructions to align with design bases. These include policies and procedures applicable to the following: main processing plant, final recovery, slimes dam and tailings dump, return water dam and plant water supply, and maintenance bases / system / equipment life cycle plans. |
| | |

| Nature of Work | Activities |
|---|---|
| Safety, Health, Environmental and Quality (SHEQ) Management | • Coordinate the analysis of samples taken from metallurgical process streams to ensure safe and economic operation and advise operations personnel on process changes required to obtain desired products, processes and quality control.<br>• Continuously apply a thorough understanding of safety, health, environment and quality policies and procedures as prescribed by legislation and/or internal company policies, and proactively identify, monitor and mitigate potential risks in accordance with legislation and best practice.<br>• Ensure the OHS Act and other relevant standards are followed. |
| Plant decommissioning | • Dissemble equipment – this can be a process undertaken from one pilot plant to another depending on exploration period and requirements of the mineral processing or mining plant.<br>• Evaluate and undertake design and analysis of the new site requirements for optimum performance.<br>• Ensure decommissioning strategy and safety procedures are followed by understanding the chemical and physical characteristics of the equipment or plant.<br>• Undertake and compile procedures for plant de-commissioning and consolidation for shutdown or closure.<br>• Ensure the regulatory and statutory application and authorisation process is acquired. |

## 6. COMPETENCY REQUIREMENTS

Reference should be made to the *Overarching Code of Practice* for “General Requirements" and “Requirements for Registered Persons”; and to the gazetted *Identification of Engineering Work* for “Core Competencies Required to Perform Identified Engineering Work”.

### 6.1 Competence required to perform Metallurgical Engineering Work

Any person who performs any Metallurgical Engineering Work must comply with the Act and with any other requirement contemplated in the Engineering Profession Act, namely:

- to be registered with ECSA in the appropriate professional registration category applicable to the level of service performed or if not registered, perform under direct supervision and control of a Registered Person; and possess the necessary core competency in the competency areas to perform such core service as a Professional Engineer, Professional Engineering Technologist, Professional Certificated Engineer, Professional Engineering Technician, or a Specified Category Practitioner.

### 6.2 Competency Evaluation

In addition to their category of registration with reference to the complexity of the work, the level of experience of Metallurgical Engineering Registered Persons should meet or exceed the requirements of the risk competency model shown in **Table 4**. In the model, risk may include (where appropriate) risk to the health and safety of people and society, the natural and built environment, property, financial interests and related project timescales.

**Table 4: Competency model**

| Level of experience | Level of supervision | Responsibility | Allowable risk |
|---|---|---|---|
| Candidate | Direct and frequent supervision | Aid and support for engineering activities | Low |
| Competent | General supervision | Guide and provide input for engineering activities | Medium |
| Registered person | Work independently | Oversee and guide engineering activities | High |

### 6.3 Risk Categorisation

The level of experience of Registered Persons needs to be read in conjunction with the risk matrix presented in **Table 5** and **Figure 1** below.

**Table 5: Level of risk associated with the competency model**

| Level of risk | Impact of risk | | | Risk matrix value |
|---|---|---|---|---|
| | Safety (People) | Environment (Spillage/Pollution) | Reputation (Company) | |
| Low | Minor injury<br>No lost time | Minor | • Warning<br>• No media coverage | 1–5 |
| Medium | Result in permanent disability | Major | • Major financial penalties<br>• Local media coverage | 6–12 |
| High | Result in fatalities | Catastrophic | • Hefty financial penalties<br>• International media coverage | 15–25 |

The above risk values are based on the 5 by 5 risk matrix presented in Figure 1 below.

| Likelihood | | Consequence | | | | |
|---|---|---|---|---|---|---|
| | | Negligible 1 | Minor 2 | Moderate 3 | Major 4 | Catastrophic 5 |
| | 5 Almost certain | Moderate 5 | High 10 | Extreme 15 | Extreme 20 | Extreme 25 |
| | 4 Likely | Moderate 4 | High 8 | High 12 | Extreme 16 | Extreme 20 |
| | 3 Possible | Low 3 | Moderate 6 | High 9 | High 12 | Extreme 15 |
| | 2 Unlikely | Low 2 | Moderate 4 | Moderate 6 | High 8 | High 10 |
| | 1 Rare | Low 1 | Low 2 | Low 3 | Moderate 4 | Moderate 5 |

**Figure 1: Risk matrix**

## 7. PRACTICE REQUIREMENTS

### 7.1 Minimum practice requirements

All Metallurgical Engineering Work must be carried out or services rendered:

- in accordance with the requirements of the applicable acts and regulations
- in an ethical and responsible manner in accordance with the Code of Conduct
- in accordance with accepted norms and standards in the industry.

### 7.2 Compliance with acts and regulations

Registered Persons must always ensure compliance with the appropriate acts and associated regulations. Notable national acts that may be applicable to Metallurgical Engineering Work include the following:

- Engineering Profession Act, as amended
- Occupational Health and Safety Act and Regulations, 85 of 1993: Driven Machinery Regulations, Pressurised Equipment Regulations
- Minerals and Energy Acts, e.g., Mineral and Petroleum Act, 28 of 2002
- Mine and Safety Act, 29 of 1996 (see www.dmr.gov.za: Design of underground dam walls, plugs and barricades, Regulations on use of water for mining)
- National Environmental Management Act, 107 of 1998
- National Environmental Management Waste Act, 59 of 2008
- Project and Construction Regulations Management Professions Act, 48 of 2000
- Nuclear Energy Act, 46 of 1999
- National Water Act, 36 of 1998: Various measures relating to pollution of a water resource; Waterworks process controller
- National Water Act, 54 of 1956: Determination of persons permitted to design dams.

### 7.3 Application of codes and/or standards

All Metallurgical Engineering Work must be carried out in accordance with the best practices represented by the relevant national and international standards, industry standards, codes of practice and best practice guidelines.

Standards and codes must be applied as and when required by government regulation, customer or end-user requirements and as an accepted industry norm. It is the duty of the engineering Registered Person to ensure that all standards and codes used abide by the applicable acts and regulations (considering that more than one country's legal frameworks may be relevant).

Standards and codes may be used in place of regulations where it can be proven that the requirements of the standard or code meet and/or exceed those prescribed by regulations and/or law. Any deviations from the standards or codes requested by the customer or end-user should be communicated to the appropriate stakeholders, supported by evidence that the deviation will not negatively impact the performance and safety of the system or device.

Various national and international bodies are recognised and accepted within industry to develop and publish standards related to Metallurgical Engineering, notably:

- SANS codes for Specification for Piping Design / Material (ANSI), see www.sabs.co.za.
- SANS 10248, 1023: Waste Classification and Management Regulations (e.g., tailings and waste spillage) from South Africa Constitution Act, 108 of 1996 and Hazardous Substance Act, 5 of 1973.
- ISO 9001: 2015 – Quality Management Systems
- SAMREC (South African Code for Reporting of Exploration Results, Mineral Resources and Mineral Reserves) e.g., 10320:2004.
- SAMVAL (South African Code for Reporting of Mineral Asset Evaluations) from www.sans.co.za.

## 8. ADMINISTRATION

The Council is responsible for the Administration of this Code of Practice, including its publication, maintenance, and distribution.

The Council must ensure that the code of practice and all amendments thereto are available on the ECSA Website and must upon request, provide a copy thereof.

The Council must take all reasonable steps to introduce the Code of Practice to the general public.

## REVISION HISTORY

| Revision number | Revision date | Revision details | Approved by |
|---|---|---|---|
| Rev 0. Draft A | 04 July 2022 | Proposed by the working group to ECSA | Working Group |
| Rev0. Draft B | 20 July 2022 | Broader Consultation draft | Working Group |
| Rev.0 Draft C | 06 September 2022 | Incorporation of comments received from Broader consultation | Working Group |
| Rev.0 Draft D | 16 September 2022 | Steering Committee recommendation to submit to RPSC for approval | Steering Committee |
| Rev 0. | 13 October 2022 | Approval by RPSC | RPSC |
| Rev.0 | 01 December 2022 | Ratification | Council |

The Code of Practice for:

**Performance of Metallurgical Engineering Work**

Revision 0 dated 01 December 2022 and consisting of 21 pages has been reviewed for adequacy by the Business Unit Manager and is approved by the Executive: Research, Policy and Standards (**RPS**)

Business Unit Manager — 02 December 2022 — Date

Executive: RPS — 18 April 2023 — Date

This definitive version of this policy is available on our website.

## REFERENCES


[1] Engineering Council of South Africa. Rules of Conduct for Registered Persons Engineering Profession Act, 2000. Board Notice 256 of 2013. Government Gazette No. 37123 of 13 December 2013.

[2] Engineering Council of South Africa. **R-05-MET-PE**: Discipline Specific Training Guide for Registration as a Professional Engineer in Metallurgical Engineering.

[3] Engineering Council of South Africa. **R-02-STA-PE/PT/PN** Competency Standard for Registration in Professional Categories as **PE/PT/PN**.