MINTEK SHAREHOLDER'S COMPACT 2021/22



mineral resources & energy Department: Minerals Resources and Energy REPUBLIC OF SOUTH AFRICA



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ACRONYMS

ACRONYM	FULL NAME	ACRONYM	FULL NAME
4IR	Fourth Industrial Revolution	MQA	Mining Qualifications Authority
AENE	Adjusted Estimates of National	MTEF	Medium-term Expenditure Framework
٨٥٥٨	Expenditure Auditor-General South Africa	MTSF	Medium-term Strategic Framework
AUJA	Broad-based Black Economic	NDP	National Development Plan
B-BBEE	Empowerment	NEMA	National Environment Management Act
CEO	Chief Executive Officer	NIPMO	National Intellectual Property
CNC	Computer Numerical Control	Ρ ΓΜΔ	Public Finance Management Act
CSFR	Client Satisfaction Frequency Rate	DCM	Platinum Group Motals
D&0	Derelict and Ownerless	F GIVI	Proferential Procurement Policy
DC	Direct Current	PPPFA	Framework Act
DMRE	Department of Mineral Resources and Energy	PURCO	Purchasing Consortium
DSI	Department of Science and Innovation	R&D	Research and Development
EPMA	Electron Probe Micro-analyser	RDI	Research, Development and Innovation
ERP	Enterprise Resource Planning	REE	Rare Earth Element
GDP	Gross Domestic Product	RMO	Risk Management Officer
GRAP	Generally Recognised Accounting Practice	RP	Radiation Protection
HIV	Human Immunodeficiency Virus	SACREF	Southern African Centralised Rare Earth
HR	Human Resources	OFT	
HVAC	Heating, Ventilation and Air Conditioning	SEI	Science, Engineering and Technology
HySA	Hydrogen South Africa	SEM	Scanning Electron Microscope
ICT	Information and Communication	SHEQ	Safety, Health, Environment and Quality
IP	Intellectual Property	SLA	Service-level Agreement
IPAP	Industrial Policy Action Plan	SMART	Specific, Measurable, Achievable, Realistic and Timely
IPR Act	Intellectual Property Rights from Publicly Financed Research and Development Act	SMME	Small, Medium and Micro Enterprises
KPI	Key Performance Indicator	ТВ	Tuberculosis
LTIFR	Lost Time Incident Frequency Rate	TRL	Technology Readiness Level
MEA	Membrane Electrode Assembly	UG2	Upper Group 2 Reef
MOTT	Mintek Office of Technology Transfer	VAT	Value Added Tax
MPRDA	Mineral and Petroleum Resources Development Act		

SHAREHOLDER'S COMPACT AGREEMENT



mineral resources & energy Department: Minerals Resources and Energy REPUBLIC OF SOUTH AFRICA



SHAREHOLDER PERFORMANCE AGREEMENT ("SHAREHOLDER'S COMPACT")

(2021/22)

Entered into by and between the

MINTEK BOARD

herein represented by Dr Vanguard Mkosana, the Chairperson of the Board (hereinafter referred to as "the Accounting Authority")

and

THE MINISTER OF MINERAL RESOURCES AND ENERGY

Mr Gwede Mantashe, in his capacity as Executive Authority being the responsible Cabinet member (hereinafter referred to as "the Executive Authority")





1. SHAREHOLDER'S PERFORMANCE AGREEMENT – AGREED PRINCIPLE

1.1 Introduction

- 1.1.1 The Mintek Board, as the Accounting Authority of a Schedule 3 public entity, is required to enter into an annual performance agreement with the Executive Authority – the Minister of Mineral Resources and Energy – as per Regulation 29 of the Treasury Regulations of the Public Finance Management Act (PFMA) No. 1 of 1999.
- 1.1.2 This Shareholder's Compact is the performance agreement for the financial year 2021/22, and derives its goals and objectives from Mintek's founding legislation, the Mineral Technology Act No. 30 of 1989. The Shareholder's Compact also includes the Corporate Plan, which is submitted in terms of Section 52 of the PFMA, and consists of the budget, strategic intent and financial plans for the next three years.
- 1.1.3 The Shareholder's Compact also comprises the overarching principles of the Mineral Technology Act No. 30 of 1989, the programmes and key performance objectives that have to be attained over the medium to long term, as well as targets and performance indicators that will be used to measure progress over the Medium-term Expenditure Framework (MTEF) period 2021–2024. It is aligned to the Strategic Plan of the Department of Mineral Resources and Energy (DMRE) and complements its programmes that are in support of the National Development Plan (NDP).

1.2 Interpretation

In this Shareholder's Compact, unless otherwise indicated or contrary to the context, the words and phrases set out below shall have the meanings ascribed to them as follows:

- 1.2.1 An **Accounting Authority** of a national public entity is the Board of Directors appointed by the Executive Authority of that entity.
- **1.2.2 Board** refers to Mintek's Board of Directors.
- **1.2.3 Executive Authority** refers to the Minister.
- **1.2.4 Mindev** refers to Mindev (Pty) Ltd, a company with limited liability in terms of the Companies Act No. 71 of 2008, which is a wholly owned subsidiary of Mintek, and has its registered head office at the same address as Mintek.

- **1.2.5 Minister** refers to the Honourable Minister of Mineral Resources and Energy in his capacity as such.
- **1.2.6 Mintek** is a science council established in terms of the Mineral Technology Act No. 30 of 1989, with its principal place of business situated at 200 Malibongwe Drive, Randburg, South Africa.
- **1.2.7 Party** refers to either the Shareholder or Mintek, and **parties** mean both the Shareholder and Mintek.
- **1.2.8 PFMA** refers to the Public Finance Management Act No. 1 of 1999, as amended by Act No. 29 of 1999.
- **1.2.9 R&D** refers to research and development, as set out in the Mineral Technology Act No. 30 of 1989.
- **1.2.10 Shareholder** refers to the Government of the Republic of South Africa, represented by the Minister.
- **1.2.11 Shareholder's Compact** refers to the performance agreement between the Board and the Shareholder, together with all appendices attached hereto, as defined in the PFMA.

1.3 Nature of the Shareholder's Compact

- 1.3.1 The Shareholder's Compact is designed solely to regulate the relationship between the Shareholder and the Board, specifically in relation to the expected outputs and outcomes that are products of Mintek's work in fulfilling its mandate as articulated by the Mineral Technology Act No. 30 of 1989. It is a reflection of the expectations of each of the parties, expressed in terms of outcomes and outputs that need to be achieved during the financial year starting on 1 April 2021.
- 1.3.2 The Shareholder's Compact is not intended to do any of the following:
 - Interfere in any way with the normal company law principles and the normal relationship between the Shareholder, on the one hand, and the Board, on the other. In giving effect to those principles, the Shareholder would have communicated its expectations to the Board and management.
 - Create rights and expectations that third parties may rely upon. It is hereby specifically recorded that this Shareholder's Compact does not create, confer and/or afford any third-party rights or expectations in terms hereof.





- 1.4.1 This Shareholder's Compact will be effective for the period 1 April 2021 to 31 March 2022.
- 1.4.2 It is hereby recorded that the agreed principles, although subject to review annually, set out matters that are applicable beyond a period of a year. In the event that they are amended, the parties shall take into account initiatives already commenced on the basis of such principles.

1.5 Mandate, vision and mission of Mintek

- 1.5.1 Mintek derives its mandate from the Mineral Technology Act No. 30 of 1989. According to the Act, Mintek was established to meet a national imperative "to promote mineral technology, and to foster the establishment and expansion of industries in the field of minerals and products derived therefrom" through research, development and technology transfer.
- 1.5.2 In executing its mandate, Mintek bases its industryfocused interventions on an understanding of the level of development of each customer and the industry segments. This approach enables Mintek to design and implement fit-for-purpose programmes that can meet the needs of new, emerging, mature and declining industries.
- 1.5.3 Mintek forms strategic partnerships with industry players, academic institutions, research institutions, government, state-owned entities and communities. These partnerships also shape the products and services offered by Mintek.
- 1.5.4 The Shareholder acknowledges that, included in its mandate, Mintek has a developmental role that may require decisions that are not always optimal from a commercial perspective, but contribute to growth and development in South Africa and the rest of the continent.
- 1.5.5 The **vision** of Mintek is to be a leading partner in innovative mineral solutions.
- 1.5.6 The **mission** of Mintek is to lead research, development and innovation, utilising minerals to drive sustainable industry development and inclusive economic growth.

1.6 Strategic intent and objectives

1.6.1 The strategic intent of Mintek is closely aligned with national imperatives and priorities with specific reference to the following:



- a) Contributing to economic development, and addressing the triple challenges of poverty, unemployment and inequality, which Mintek does through fostering industrial growth and development.
- b) Maximising the utilisation of finite ore resources by also considering opportunities such as the reprocessing of old discards and tailings facilities. These discards may contain significant amounts of the original commodity, as well as a potential source of secondary commodities that have since become of interest.
- c) Promoting the use of minerals to make the final product, i.e. beneficiation activities and adding value to mineral and metal products. Mintek also intends to contribute by stimulating, as far as possible, transformation within the mining and minerals sectors.
- d) Promoting the transition from a resourcedominated economy to a knowledge-based economy.
- e) Supporting the development of a capable state through the development of institutional capacity to assist the minerals industry to leverage minerals for economic development, the development of the human capital required to capacitate the minerals industry, and the support of marginalised communities surrounding mining areas.
- 1.6.2 Mintek's approach to addressing its strategic intent is to focus on its core functions of research, development and innovation. These are combined with technical solutions that can be transferred to the minerals sector in support of the development and expansion of South African minerals-based industries. Over the short- to medium-term period, Mintek's activities will be driven towards the attainment of the five strategic outcomeoriented goals that are listed below.
 - a) Conduct relevant, applied research and technological innovation by pursuing a focused approach to research and technology development that emphasises high-impact scientific outputs and outcomes.
 - b) Foster the establishment of new industries and the expansion of existing ones, as well as address the challenges facing nascent, emerging, mature and declining industries.





- c) Develop a capable workforce that has the requisite skills, expertise and capabilities to drive and support rigorous scientific research and technological development in pursuit of Mintek's mandate of conducting research and fostering industry development and expansion. The workforce profile will reflect the demographic profile of South Africa.
- d) Ensure financial sustainability and secure Mintek's future by achieving a solid research portfolio that is funded through both private and public sources and commercialising Mintek's technologies.
- e) Develop and maintain a world-class research, development and innovation (RDI) infrastructure that supports Mintek's research, technology innovation and the development of products and services that encourage industry growth and expansion.

1.7 Key performance indicators

The key performance indicators (KPIs) outlined below will be used to measure Mintek's performance over the next financial year. The KPIs are linked to Mintek's core mandate and reflect outputs and outcomes of the work that will be done in the areas of R&D, innovation and technology development. Collectively, the KPIs provide a holistic view of the health of the organisation and the extent to which it is on the correct path towards fulfilling its mandate.

- 1.7.1 Publications include a set of metrics that are used to measure the quality of Mintek's research outputs and its contribution to knowledge generation in science and engineering, as well as the capabilities of Mintek's researchers. The metrics include the number of journal papers, conference papers, book chapters and books published in a given period.
- 1.7.2 Intellectual property measures are an indication of the novelty and innovativeness of Mintek's research, technologies and products. The portfolio includes invention disclosures, patents and trademarks.
- 1.7.3 Science, engineering and technology staff profile is a basket of measures that reflect Mintek's research capacity to deliver on its core mandate. The measures include the total number of SET employees, as well as the number of SET staff members with doctoral and master's degrees in the fields of science and engineering.
- 1.7.4 Transformation measures are an indication of the extent to which Mintek's SET staff members reflect the demographics of South Africa's population. The

measures include the percentage of female SET employees and the percentage of black SET employees as defined in the Employment Equity Act.

- 1.7.5 Revenue generation measures indicate Mintek's financial position and the extent to which the organisation can sustain itself through income generated from a wide range of sources. The measures include total income generated from the private sector, the voted funds from Parliament, the sale of products and services, and contract research. It also includes the net results, in rand value, which measure profitability.
- 1.7.6 Commercialisation measures are an indication of the quality of Mintek's outputs at the advanced stages on the Technology Readiness Level (TRL) scale. They include the number of prototypes, processes and models that have been demonstrated or validated in a relevant environment. They also measure the readiness of a model for technology transfer and ultimately manufacturing. In addition, the measures include income that is generated from the sale of products and services, as well as royalties and license fees, which are an indication of Mintek's ability to transfer technologies and products to market.
- 1.7.7 Audit opinion: An unqualified audit opinion from the Auditor-General South Africa (AGSA) is a measure that Mintek fairly represented its financial statement and financial position to the AGSA. It is confirmation that there were no material misstatements in the annual financial statements.

1.8 Roles and responsibilities

- 1.8.1 Mintek has a developmental role to play that may require decisions that are not always optimal from a commercial perspective, but contribute to growth and development in South Africa.
- 1.8.2 The Shareholder is empowered and thereby reserves the right to determine developmental initiatives, projects or activities that Mintek shall undertake or in which Mintek shall become involved in the national interest, subject to the requirement that such activities shall:
 - a) be funded from the parliamentary grant; and
 - b) not prejudice Mintek's operations, financial health and ongoing viability as a going concern.
- 1.8.3 If necessary, the Shareholder shall adjust Mintek's key performance measures to take into account Mintek's developmental role.
- 1.8.4 Any developmental project determined in terms of clause1.9.2 shall be deemed to have been approved in terms





of Section 54 of the PFMA, and no further approval shall be required in respect of such projects.

- 1.8.5 The Board shall develop a definition of what constitutes a major developmental project and what the applicable criteria are, and agree upon such definition and applicable criteria with the Shareholder prior to the commencement of the project.
- 1.8.6 The Board and the Shareholder shall agree on an amount to be set aside for developmental projects.
- 1.8.7 The Board hereby does the following:
 - a) Undertakes to oversee and contribute to the development of the strategic intent and management of the business in accordance with such strategic intent, corporate plan, the Mineral Technology Act and any applicable legislation. The directors shall exercise their skill and fiduciary duties to ensure that management pursues the objectives and targets as set out in the Corporate Plan.
 - b) Commits itself to the achievement of the vision, mission, goals and objectives, and strategic intent of Mintek, and always acts within its powers and in the best interest of Mintek.
 - c) Accepts its responsibility to direct and guide the business in a proper manner in keeping with good governance practices, the PFMA, the Mineral Technology Act, the Shareholder's Compact, and – in particular – in compliance with the Materiality Framework agreed to with the Shareholder, which is annexed hereto as Appendix II.
 - Recognises the importance of speedy decision making and will use its best endeavours to prevent undue delays with regard to critical decisions.

1.8.8 Subsidiaries

- a) The performance of Mindev will be regulated by Mintek in its capacity as Shareholder in line with the broad policy and direction from the Shareholder. Mintek shall enter into a Shareholder's Compact with each of the main subsidiaries formed or to be formed, which compacts shall be regarded by the Shareholder as compliant with the PFMA.
- In addition, Mintek will ensure that Mindev and all its subsidiaries shall comply with the policies of the Shareholder, and that they adhere to

acceptable governance practices in terms of reporting and accountability, as well as the Materiality Framework annexed hereto as Appendix II.

1.9 Undertakings by the Shareholder

The Shareholder undertakes, for the duration of this agreement, to do the following:

- 1.9.1 Give reasonable notice before the introduction of any new or additional requirements during the validity period of this Compact. In addition, the parties shall, in such an event, amend the key performance indicators and targets, failing which, no new requirements or targets may be introduced.
- 1.9.2 Allow the Board the space to exercise its discretion regarding matters falling within its authority, as provided for in this agreement, the PFMA and the Mineral Technology Act No. 30 of 1989.
- 1.9.3 Respond speedily to critical decisions or the proper constitution of the Board, and fill vacancies that arise in the Board within a reasonable time.
- 1.9.4 Ensure that the Mintek Board or any of its directors are not in breach of any legal duty.

1.10 Mineral Technology Act

1.10.1 The Shareholder, in consultation with the Board, shall ensure that the Shareholder's Compact and the Compact between Mintek and its subsidiary shall be consistent with the Mineral Technology Act No. 30 of 1989 and the Memorandum and Articles of Association of any of the main subsidiaries.

2. SUBSIDIARIES – MINDEV

Mindev is a wholly owned subsidiary of Mintek that was registered in 2001 with the aim of having an agile entity or vehicle that would facilitate joint ventures and/or participation with various partners in order to commercialise Mintek's technologies.

In line with the Companies Act No. 71 of 2008, Mindev registered its Memorandum of Incorporation with the Companies and Intellectual Property Commission and was issued with a certificate of confirmation by the Commission in 2012. It is currently in full compliance with all legislative requirements.

Mindev has, over the years, entered into various joint ventures and commercial dealings that were mostly successful, resulting in net reserves of R39.5 remaining on its last operating activities. Mindev continues to evaluate possible investment opportunities, even though nothing has come to fruition over the years, effectively making it dormant from both an investment and an operational perspective.





Mintek is still of the view that Mindev should be retained in order to maximise the commercial value of Mintek's fully developed technologies in future. Mintek will continue to invest all Mindev's funds and provide for all resultant taxes due and the interest earned.

3. OPERATING ENVIRONMENT

3.1 Mintek's products and services

In achieving its strategic impact of fostering the establishment and expansion of the minerals industry, Mintek produces a number of outputs. These outputs are consolidated as the suite of products and services that Mintek offers. The suite covers the full spectrum of the RDI value chain from basic and fundamental research through to Intellectual Property (IP) commercialisation and technology transfer.

In brief, Mintek's products and services consist of the following key components:

a) Metallurgical technology and processes

A significant proportion of Mintek's RDI outputs are consolidated into technology packages, and bespoke/ optimised processes. This IP is usually protected in the form of patents and is exploited via licence agreements. Examples of these are the SAVMIN[™] Acid Mine Drainage treatment technology and the ConRoast Platinum Group Metals (PGM) smelting technology.

b) Products

Some of Mintek's RDI outputs are encapsulated in tangible products. These include end-user consumer products such as nanotechnology-enabled medical point-of-care diagnostic kits. They also include physical equipment such as cyanidemeasuring equipment or turnkey furnaces, as well as virtual solutions such as process control software.

c) Services

Some of Mintek's outputs are delivered in the form of services. These range from routine services like chemical or mineralogical analysis, to non-routine services like process optimisation and evaluation.

Mintek offers comprehensive metallurgical feasibility study services to companies evaluating the opportunity to develop new mineral deposits. These services leverage Mintek's RDI capability and infrastructure to foster the development of the industry.

Mintek also offers contract research services. These often take the form of consortium-based research activities where Mintek's expertise and facilities are identified as key enablers of the research outcomes. d) Consulting, training and advisory services

As a result of Mintek's knowledge base and expertise, it is often approached to provide consultancy services to assist in addressing industry challenges. In addition, Mintek leverages its expertise to provide training and advisory services to develop human capital and address broader technical challenges.

3.2 Client base

Mintek's client base consists of the three spheres of government, state enterprises, communities, large multi-national mining companies, emerging resource companies, engineering contractors and small, medium and micro enterprises (SMMEs), both locally and internationally.

Mintek's clients span a wide cross-section of mine operators and mineworkers, project developers, engineering contractors, metal end-users and equipment vendors, and the governmental agencies that support and regulate the industry – both locally and internationally. In short, all the players in the minerals industry.

3.3 Competitors

As Mintek operates in the global arena and services a multinational industry, clients have the option to source similar services from comparable facilities in Australia, Brazil, Canada, Chile, China, Europe, Russia and the USA. The client's selection of its preferred institution is often based on the reputation of the technical experts, along with the quality of the facilities. In this regard, Mintek has very strong competitive advantages with respect to its excellent, large-scale facilities, an excellent reputation as a "one-stop shop" and – more especially – an enormous information database developed since 1934, the year Mintek was established.

3.4 Business environment

The global mining industry has experienced an almost unprecedented period of difficulty for more than a decade, in which mineral and metal demand has tumbled, metal prices have reached exceptional lows, grades have been declining in the remaining reserves and ore bodies. Coupled with rapidly rising costs, this means that stakeholder expectations are at odds with the industry reality. China, the global mineral commodity growth engine and major producer of some 29 minerals and metals, has also reduced its demand in line with its shift from infrastructural investment to consumer-led growth. In the long term, the growing demand for electric vehicles globally, coupled with the growing recycling sector, will have major implications for the future demand of minerals, mainly on PGM and technology metals, which will consequently impact on the South African economy.



The mining industry's project development pipeline, a key indicator of the demand for Mintek's commercial services, has been slow in recent years, but the geological exploration programmes and project investments appear to be entering a growth phase. Industry spend on capital development decreased to almost half in the four years up to 2017. Although signs of an upward trend in geological exploration expenditure are observable in 2018, the decline continued in 2019, and due to the effects of the global Covid-19 pandemic there was a significant decline during 2020. Again in the final quarter of 2020 there are indications that there is an increase in funding. It is unclear if this is due to the pent-up demand due to the Covid 19 restrictions being eased or if the industry fundamentals are changing. The first six months or 2021 are likely to provide more clarity on the appetite of industry and funders to pursue new capital projects.

Industry consensus was that 2017 was expected to be the start of the recovery of the industry from its current depressed state. This was seen to be the case with most commodity prices improving significantly from 2015, although some volatility within the markets exists. One notable event was the price of palladium exceeding that of platinum. It is interesting to note that at the end of 2020, many commodity prices were at near record levels. This includes gold and many of the bulk commodities including coal and iron ore. This is driven by fears of supply as a consequence of nearly a decade of underinvestment in new production capacity. For many of the commodities there is predicted to be shortfalls in supply in the next five to ten years (in many cases it takes five to ten years to develop new mines and the response by industry has been curtailed by the global Covid -19 pandemic). However, notwithstanding the fundamental demand drivers being in favour of increased investment in the sector going forward, it should be borne in mind that demand for Mintek's services may not be seen immediately since potential clients will need to focus on debt reduction, and resume deferred construction and/or expansion and brownfields projects.

Thereafter, consideration may be given to new greenfield projects and exploration programmes that will require the services of Mintek. It is therefore expected that this will create a lag of between one and two years from recovery to clients using Mintek's services. However these normal responses have been severely impacted during 2020 by the global Covid-19 pandemic. The 'green shoot' of growth in the mining sector are certainly apparent and the commodity prices of most minerals have increased, however international lockdowns, travel restrictions and working from home arrangements have severely impacted the ability of companies to expand or develop new deposits. However in the final months of the 2020 calendar year data shows a slight increase in global drilling activity, indicating that there is a small increase in project development activities.

In short, the weakened demand for Mintek's commercial services, which has been evident over the past few years, is expected to continue into 2021 and beyond. Although the fundamental



drivers for commodities are strong, the global economy has been weak and is severely impacted by the Covid-19 pandemic. It is likely that the impact of this will be felt for a number of years to come. The continued changing global and local economic landscapes require Mintek to reposition itself so that the business remains sustainable beyond the next decade. However, statefunded research programmes are showing promise as future opportunities including supporting the revitalisation of the ferroalloys sector, stimulating the development of a rare earth metal value chain in South Africa, the development and incubation of mineral and metal based medical diagnostic devices.

3.5 Organisational environment

The organisational environment is largely affected by the external business environment. After a decade of economic weakness the economic downgrade and the COVID-19 global pandemic have exacerbated the depressed economy. The projected future demand for minerals in the medium to long term bodes very well for Mintek in future but this is not anticipated to have a positive impact in the next year or two. The policy inertia and uncertainty that have constrained investment and confidence, especially for the mining sector, had begun to lift however, the impact of the investment downgrade and the COVID -19 pandemic have resulted in a continued reluctance to invest in new capacity.

Mintek's revenue is generated mainly from three revenue streams: state grants, the sale of products and services, and contract research. The work undertaken under the products and services and the contract research streams is collectively referred to as commercial revenue, and comes mainly from the sector through the deployment of Mintek's technology and providing consulting services based on Mintek's technical expertise. Mintek aims for a balance ratio of 50:50 when comparing state funding and commercial research. This ratio is currently 70:30 in favour of state funding. Even though state funding in the form of the MTEF has increased over the years, commercial revenue has decreased sharply. Mintek's revenue, in real terms, has not grown in the previous five years. In fact, its baseline has been decreasing, while additional funding on specific projects has been increasing, making it difficult for the organisation to plan in the long term. This negative growth is exacerbated even further by the ever-increasing operational expenditure, of which employee compensation is the main contributor.

The medium to long term positive outlook of the mining sector is expected to ultimately reverse the decline of over a decade in Mintek's commercial revenue, but this is not going to show significant impact for another few years. Also the investment downgrade and the Covid -19 pandemic has resulted in a decline in state funding arising from the fiscal constraint and changing priorities of government.

It is important that Mintek's research priorities are aligned to government priorities in order to maintain or attract other government-related funding. The Mintek of the future requires





the right balance of skills to attract state funding and support efficiency and new investments in the minerals sector. With respect to organisational capacity, Mintek is currently engaging in a process of rebuilding research expertise and excellence in science and innovation. Over the last ten years, Mintek's quest to attract commercial work and funding gradually shifted from research excellence to transactional and consulting services. The shift in focus also resulted in an untenable position where the ratio of researchers to support staff was heavily skewed in favour of support staff. There was a steady decline of researchers and scientists, in both headcount and proportional terms, which contributed to the current dearth of mid- to high-level skills in critical areas of Mintek's core activities.

The state of the organisation in relation to organisational capacity became stark during the comprehensive diagnostic assessment of its current resource profile, mapped against the ideal profile that will catapult research outputs to the next level. The assessment, which was conducted during the course of 2019, identified areas that required an overhaul, having noted that the organisation appeared to have veered off course in terms of research excellence.

In recognition of the importance of human capital as an organisation's greatest asset, whose main mandate is research and technology development, an urgent need was identified to develop and retain the right skills in the right numbers. The intention is to build a mid- to senior-level research capacity. With the resignation and retirement of senior and experienced staff members over the years, a phenomenon loosely defined as the "juniorisation of research" has unfortunately been the result at Mintek, albeit to varying degrees across Mintek's core disciplines. Consequently, there is a recognisable dearth of highly skilled and experienced staff members that are well placed to formulate, lead and disseminate research for maximum impact. The impact of this trend has filtered through to the dwindling number of peer-reviewed journal publications, less focus on cutting-edge research and an increasing trend of competing with small consulting firms and laboratories that do not even boast the wealth of infrastructure that Mintek has.

To address these challenges, a science, engineering and technology (SET) human capital development programme has been rolled out, targeting master's and doctoral programme candidates in science and engineering. This programme is complemented by an active recruitment strategy that is focusing primarily on recruiting experienced researchers with master's and doctoral degrees as minimum entry requirements. The success of these interventions will be measured in the next three years, and will change Mintek's staff profile.

The greatest challenge facing Mintek is the recruitment and retention of world-class expertise to maintain the historical high reputational standards.

In addition to ensuring that Mintek has the requisite SET base to deliver on its mandate, it is clear that the ability to attract

revenue and provide technical solutions that will have an impact is important. To address this the process for investing State Grant funds in research was changed during 2019. Firstly, researchers need to provide full proposals to motivate for the investment. These proposals are then externally peer reviewed by a panel of experts, in an effort to both improve the quality and capacity to write high proposals (a skill that will become more important in future), and ensure that the funded research topics are aligned with an implementable outcome that will have impact.

A further issue that was identified was that much of the research funding was addressing early stage research activities with insufficient focus on later stage development and innovation. This is being addressed by the adoption of strategic RDI programmes.

4. STRATEGIC RDI PROGRAMMES

Following a six-year period of under 2% annual growth in the gross domestic product (GDP) and uncertainty in the local economy (and particularly the mining sector), it is important that Mintek aligns its activities to delivering direct economic impact. In serving the national interest through research, development and innovation, and fostering the establishment and expansion of the minerals industry, Mintek has identified a number of high-impact programmes that can deliver socio-economic benefits in the short to medium term. These priority programmes will constitute the strategic focus for the 2021/22 financial year and are described below.

4.1 Establishing a Rare Earth Industry in South Africa

Many nations the world over have been embracing rare earth elements (REEs) due to their increasing importance in a wide range of cutting edge technologies. The importance of these elements is largely driven by two global megatrends of cleaner energy and electromobility. These two trends have essentially become inexorable and will drive demand for REE for the next decades. It is projected that the demand for energy generation only will reach 50 000t rare earth oxide (REO) by 2030.

This has caused a global shockwave of concern since the REE production is currently mainly concentrated in China and Australia; they respectively contributed 85% and 10% in 2016. The US, EU, and Japan have all publically expressed concern over China's dominance of the strategic REE industry and has actively pursued alternative sources of REE. Based on current projections by industry analysts, there appears to be a 10-year window where the race will be on to be the next global producer of REE outside of China.

Although South Africa is endowed with huge mineral wealth, no world-class REE deposits had been found to date. Most of



the deposits are of modest size ranging from 100kt to 200kt TREO. If these deposits are developed to a stage where limited beneficiation is done, then a return of <20% of the basket value of the REE is unlikely to make much economic sense to the miner. South African deposits may therefore effectively be sterilized without a path to maximum value creation through refining. Unfortunately none of the South African REE deposits have either the size or grade to support a competitive world class REE production facility that will unlock the potential for a global supply and downstream REE industry.

Although South Africa does not have a single REE deposit that will be able to support a capital-intensive REE separation facility, the combined REE content of the various South African deposits certainly appears to satisfy this criterion. The key to unlocking the full potential of South African REE resources is therefore to provide a centralised, globally competitive REE processing facility (SACREF) which will allow each deposit to be exploited by providing a path to realising 100% of the basket value of REE in the deposit. A global REE producer will not only generate huge revenues for South Africa, but will also provide political leverage and the potential to develop a downstream REE industry through supply security. The roadmap for the establishment of a rare earth industry in South Africa starts at the establishment of a REE production facility in South Africa. Mintek proposes to facilitate the establishment of a globally competitive REE production facility by compiling a compelling business case through a bankable feasibility study on the construction and operation of a centralised REE processing plant.

Key Activities

With a credible business case for the establishment of a globally competitive REE production facility being the ultimate aim of this program, the following are key activities:

- a) Develop robust and versatile REE processing technologies
- b) Develop compliant radioactive waste treatment and management processes
- c) Simulate the selected process flowsheet
- d) Carry out front-end engineering design
- e) Carry out site suitability studies
- f) Carry out a pre-feasibility study
- g) Secure funding for a bankable feasibility study
- h) EPCM of a demonstration plant
- i) Extended operation of the demonstration plant



- j) Detailed design of full-scale REE plant
- k) Carry out a bankable feasibility study
- Compile a business plan for the establishment of SACREF

The first 6 activities had already been completed by Mintek using a combination of State Grant and MTEF funding, while the last 6 are still outstanding and is estimated to require an order of magnitude more funding to complete. A credible Business Plan is considered crucial to the attraction of investment for building SACREF as the basis of a REE industry in South Africa.

Deliverables

The following are the main deliverables of the program to establish a REE industry in South Africa:

- a) Front-end engineering design of the REE processing flowsheet - complete
- b) CAPEX and OPEX estimates complete
- c) Guidelines for radioactive waste processing and storage in progress
- d) Site selection report complete
- e) MTEF funding proposal complete
- f) REE processing demonstration plant not started
- g) Detailed design for centralised REE processing plant not started
- h) Bankable feasibility study not started
- i) Business Case for SACREF not started

4.2 Medical Diagnostics Manufacturing Programme

The intent of the Medical Diagnostics manufacturing programme is to foster the establishment and expansion of a Diagnostic Industry in South Africa through the manufacture of high-value rapid diagnostic products through the beneficiation of gold and key raw materials thereof. The main aim of the programme is to establish a robust Rapid Diagnostic Test (RDT) manufacturing capability at Mintek for commercial exploitation. In addition to the RDT product manufacture, a further opportunity exists for Mintek to localize the production of antigens and antibodies, which are the key ingredients in the research, development and manufacture of rapid diagnostic kits, as well as the manufacturing





of other health-related products, such as sanitizers. The intention is to incubate the manufacturing of all these health-related products under a dedicated commercial complex, under "Ketlaphela Diagnostics".

The current status of the Programme entails the acceleration towards commercialization of four rapid diagnostic test (RDT) kits (COVID-19 antigen and antibody rapid tests, HIV, Malaria and TB rapid tests) in the next 6-12 months. As a result of COVID-19, the COVID-19 Antibody and COVID-19 Antigen RDT kits are currently undergoing external validation in partnership with the University of Cape Town (UCT) and under the stewardship of a COVID-19 consortium convened and led by the South African Medical Research Council (SAMRC). The objective is to commercialize the COVID-19 RDT products early next year with assistance from the Technology Innovation Agency (TIA) and the Industrial Development Corporation (IDC). The next in line are the HIV and Malaria RDT products that are being readied for performance approval through the National Institute for Communicable Diseases (NICD). The SAHPRA-licensed Rapid Diagnostic Test Manufacturing facility received the ISO 13485:2026 certification in August 2020 which ascertains that the Ketlaphela Diagnostics processes are safe and effective for manufacturing medical devices. In addition to these first four products, there is the TB and a suite of animal RDTs that will follow soon thereafter. A dedicated sanitizer manufacturing and bottling facility outside Mintek campus has been commercialized in November 2020, with a current production capacity of 1050 L per day.

The envisaged benefits for the country include the establishment of a health diagnostics/medical device industry that will contribute to the broad-based goal of the South African government to establish a State Pharmaceutical Company. The health diagnostics leg of the envisioned State-owned Pharmaceutical entity will position South Africa towards the localization of the RDT kits products, thereby ensuring the security of supply in South Africa and the broader SADC region. In this way, there will be the attendant benefit of import substitution by reducing the reliance on imports, thereby directly contributing to South Africa's Gross Domestic Product (GDP). From a South African policy perspective, the localization of this industry will further support the Department of Trade, Industry and Competition's (the dtic) Industrial Policy Action Plan (IPAP). The Diagnostic Programme will further unlock and leverage local manufacturing capabilities to further serve the Rest of Africa (RoA) growing market and boost intra-Africa trade.

The local investment that that has gone in and envisaged for the future in support of this Programme are three-fold: the DMRE, the DSI, TIA, NRF/Thuthuka and the SAMRC-SHIP funding instruments have immensely enabled the research, development and innovation (RDI) phase for the past 10 years. During the manufacturing phase, the DMRE, the DSI, TIA, Treasury, IDC and B4SA funding instruments will play an enabling role. On the commercialization side, TIA, IDC and the DMRE have already

pledged support. Other entities that are also being approached for further assistance are the Department of Trade and Industry (the dtic), the Public Investment Corporation (PIC) and the Bill and Melinda Gates Foundation, among others.

4.3 Revival of the ferroalloys industry in South Africa

Various elements including Manganese (Mn), Silicon (Si), Chromium (Cr), and Nickel (Ni) are added to steel and other alloys to improve their properties. Often being most cost effective, the required elements are added as an alloy with Iron (Fe) in the form of the eponymous ferroalloys. Ferroalloys can be classified as major or bulk ferroalloys which are produced in large quantities, and minor ferroalloys produced in smaller quantities but of high importance. The major ferroalloys are Ferromanganese (FeMn), Silicomanganese (SiMn), Ferrochromium (FeCr), Ferrosilicon (FeSi), and Ferronickel (FeNi). The minor ferroalloys are not important for this discussion and will be excluded for now. Major ferroalloys are produced by endothermic, carbothermic reduction processes and only used in steelmaking and in steel or iron foundries, the exception being FeNi. Steelmaking consumes around 85% to 90% of all ferroalloys.

According to data provided by the United States Geological Society (USGS), South Africa has in 2020 74% of the World's identified, land-based manganese ore resource and, together with Zimbabwe, 95% of the chromite ore resource. South Africa also has significant resources of quartz and carbonaceous reductants (bituminous coal, and anthracite and coke to a lesser extent), required in the production of bulk ferroalloys. Because of the local availability of raw materials at low costs, and historically low prices and stable supply of electricity, South Africa has significant installed capacity and the skills necessary to produce all major bulk ferroalloys except FeNi. Given the availability of ores and the favourable international market for steel, one would not expect that less than 50% of the capacity is in production.

According to the Ferroalloy Producers Association (FAPA) of South Africa, the local ferroalloys industry has been ailing due to significant increases in the pricing of ore - where China created a significant demand for both manganese and chromite ores from South Africa with resulting increases in local prices of ores and significant increases and volatility in the pricing of electricity where electricity now contributes to 30-50% of operational expenses compared to 20% a mere 10 years ago. Secondary to these two aspects is the fact that ferroalloy production in South Africa is a significant producer of CO2, both due to the carbothermic reduction processes applied and the fact that the electricity applied to meet the extensive energy needs of these processes, is mainly produced by coal fired power stations. Carbon taxes will therefore have a significantly negative effect on this ailing industry. Lastly, is the production of manganese and chromium ferroalloys are significant producers of waste in



the form of slag which is discarded at land-fill sites. These landfill sites will become a burden on the South African tax payer, similar to the ownerless and derelict mines, should the industry disappear from the South Africa landscape in totality.

As a result of unprecedented changes in the global and local environment the ferroalloy production industry in South Africa is no longer profitable due to extensive and uncontrolled increases in input costs and taxes, and significant competition from China which is a major importer of South African manganese and chromite ores.

The South African ferroalloy production industry has significant production capacity as well as established businesses with decades of experience in the production and sales of these alloys. These alloys are value-added products beneficiating local raw materials, with associated impact on GDP, and employment of human resources. According to FAPA, its members are significant contributors to the South African economy contributing R40 billion in 2019 at about 50% utilization of the installed capacity, and in particular to the sustainability of ESKOM, as key baseload customers.

The Mintek program aims at maintaining existing production capacity via dedicated industry interventions and revival of idle capacity in the short-term. In the long term, the aim is to implement and develop technology which will ensure sustainability and potentially also expansion of the installed capacity ensuring local beneficiation of ores.

- a) Interventions focussed on maintaining the current capacity include export taxes, special electricity tariff concessions for producers, and supporting policies and interventions for energy efficiency technologies, and renewable energy integration.
- b) Interventions will also focus on restarting mothballed or defunct capacities, to fast track the revival of shut furnaces. Currently more than 50% of smelters have been closed, mothballed or are in business rescue. Mintek will be conducting feasibility studies to establish potential refurbishments and modifications to closed smelters.
- New capacity to be established using the best available energy efficient flowsheets, building on a stable base, via the short term interventions.

Medium- and long-term interventions include the development of technologies aimed at reducing the dependency on electricity produced in coal-fired power stations and the valorisation of slag produced in manganese and chrome ferroalloy production. It is therefore proposed that the "Revival of the Ferroalloys Industry in South Africa" strategic research program include the following sub-programs:



- Application of renewable energy (solar thermal heat specifically) in the production of manganese, chromium, and silicon ferroalloys aiding in reducing the production of CO2 associated with the production of electricity.
- b) Development of flowsheets and bankable feasibility studies to beneficiate low grade, manganese and chromite ores which will increase the size of the reserves.
- c) Utilisation of alternative reductants i.e. bio-carbons, hydrogen, and methane in the production of manganese, chromium, and silicon ferroalloys aiding in reducing the production of CO2 associated with the alloy production processes.
- Implementation of pre-reduction or pre-heating processes which will reduce the dependency on electricity – Mintek's new pilot furnace facility will include preheating capacity to demonstrate smelting linked to preheating.
- e) Valorisation of waste products produced during production of manganese and chromium ferroalloys which will increase the revenue streams of current producers and reduce the environmental liability on the country.

Deliverables

The following are the main deliverables of the program to revive the ferroalloy industry:

- a) Supporting the DMRE in implementation of Cabinet approved chrome interventions on going
- b) Engineering and processing flowsheets for idle and decommissioned furnace capacity in progress
- c) Identification of CAPEX and OPEX estimates for opportunities
- MTEF funding proposal to demonstrate renewables in manganese preheating – not started
- e) Creation of a ferroalloy research hub with industry partnerships to address severe skills shortage in industry (Ferroalloy Research Association of South Africa – FARASA) – in progress
- f) Technology transfer of low grade chromite technology for UG2 and other low grade deposits
- g) Conversion and implementation of renewable energy in ferroalloy production (PreMa EU funded R37M commenced for preheating)





4.4 Incubating Fuel Cell Manufacturing at Mintek

Over a 10-year time period, Mintek, as a co-host of the HySA/ Catalysis Centre of Competence (CoC), has managed to produce intellectual property (IP) in platinum-based fuel cell (FC) catalysts and their scale-up. Our platinum-based fuel cell catalysts are now both competitive in performance and cost against well-established global manufacturers. Mintek plans to establish a robust commercialisation path for its IP by addressing manufacturing across the entire fuel cell value chain of catalyst, membrane electrode assemblies (MEA), stacks and fuel cell systems thus carrying our already commercially developed fuel cell catalysts up the chain to full systems deployment to unlock a greater commercialisation opportunity. In broad outline the programme expects to deliver the following milestones:

- a) 2020 Current capability FC catalyst @ 1kg/batch
- b) 2023 Commercial FC catalyst manufacture @ 10 kg/ batch
- c) 2025 MEA fabrication technology demonstrated
- d) 2028 Commercial MEA manufacture
- e) 2030 Commercial FC systems manufacture

Mintek will focus in the 2020/25 period on building the in-house capacity to commercially supply FC catalyst and MEA through two developments. Firstly enhance our current FC catalyst manufacturing infrastructure by addition of suitably sized unit operations like a high temperature furnace, catalyst filtration, and inert-atmosphere powder-mill to the plant. Secondly a high volume roll-to-roll MEA manufacturing capacity will be built, initial through an R&D programme at lab scale continuous membrane coating, followed by a suitable pilot scale coating facility. Mintek must undertake an R&D programme to build an IP portfolio in MEA manufacturing and will target a demonstration of the technology by 2025. The MEA products at that time will allow engagement of the fuel cell market and could lead to commercial manufacturing by 2028. In parallel with these developments Mintek will seek partnerships (and customers) with local and international FC manufacturers to address stack and FC systems manufacturing that would incorporate our MEA. An initial approach could be backward integrating our catalyst/ MEA into partner/customer existing stacks and systems that would increase local content for locally deployed systems. With sufficient local investment (estimated to be approximately \$325M over 2020/30) local manufacturing could be achieved across the full value chain of catalyst, MEA, stacks and system reaching approximately 5% of the estimated global FC market in 2030. The local market is poised to grow in the hydrogen and fuel cell space as seen by the increased numbers of entrants (e.g. HyPlat, Mitochondria, Bambili Energy, Cape Stack, HYENA, Isondo, Hydrogen Technologies, Impala, Anglo Platinum) and Mintek could be well placed to leverage our FC IP to service this

market. Another important market enabler is the development of the DSI Hydrogen Society Roadmap for South Africa that seeks to integrate goals for the development, commercialisation and deployment of hydrogen and fuel cell across HySA and the local industry. Coupled to this is the envisioned DSI Hydrogen Valley that will link King Shaka and OR Tambo airports and go on to the Limpopo province. The idea of the corridor is to promote long distance transport and build out hydrogen and support infrastructure along it. A strong pull for local developed and manufactured technology is expected and Mintek can contribute to that.

In addition to the infrastructure capacity building, Mintek will in the 2020/22 period start building a skilled human capital base by hiring in Technical Specialist in FC manufacturing. The technical team will refine and align the technical scope through close collaboration with Mintek business development functions and the TTO that will engage potential industry partners to foster a local fuel cell manufacturing industry.

4.5 Energy storage as an enabler of a just energy transition

Energy storage is a crucial element in a global move towards sustainable energy usage, and considerable strides are currently being made in the development of energy storage systems for electro-mobility as well as grid-scale electricity storage systems.

The sheer scale of these initiatives has led to an immense demand for technology metals. South Africa is well placed to become a significant player in the global supply of precursor battery materials as well as the development of energy storage technologies. Downstream development of sophisticated industries is likely to be dependent on competitive access to these metals or materials.

The purpose of this strategic programme is to drive the development of new industries in South Africa by developing technology for the production of high-specification precursor battery materials. These precursors will be based on South Africa's vast mineral resources and include metals such as nickel, vanadium and manganese, as well as rare earth elements, such as cerium or alkali metals such as lithium. The beneficiation of the country's mineral resources and development of technologies for the production of precursor battery materials will secure the supply of these critical materials, not only locally, but also for revenue generation from the international market, and will likely bring both economic and strategic benefits to the country.

The drive towards battery systems is a global megatrend and has led to a huge demand for precursor battery materials worldwide. Concerns over security of supply have elevated access to these materials to strategic levels in many industrialized countries. Although South Africa has vast mineral resources, as well as the technical expertise to play a strategic role as a reliable supplier



of these precursors to the global market, there is no established industry in South Africa to seize this opportunity. The absence of a precursor battery materials production capability in South Africa may also be detrimental to the incubation and growth of a local downstream electrode or battery systems manufacturing industry since such a fledgling industry will be exposed to the global supply forces.

For South Africa to become a producer of precursor battery materials and not merely an importer of such materials, Mintek will facilitate critical activities to drive a collective effort, involving all relevant role players, to develop technologies for the production of precursor battery materials. Mintek, having developed technologies for the production of high-purity nickel-sulphate, high-purity cobalt-sulphate, along with a new flowsheet for the production of high-purity manganese-sulphate mono-hydrate, as well as holding international patents for the direct electrowinning of cobalt metal and nickel metal, amongst other crucial technical expertise, is in a strong position to take a leading role related to the development of technologies for battery precursors. Collaboration and partnerships will be a critical component of the success of this programme. Piloting and demonstration of the technologies for the production of the respective precursors will be performed as part of the technology development efforts. Mintek has already established partnerships with key players, such as the Thakadu Group, Outotec, Anglo American, Eskom and SANEDI, and will expand these partnerships with other stakeholders, for the successful implementation of this national-impact programme.

Key Activities

To create a credible business case for gaining investor interest in the production of precursor battery materials, thorough process research, technology development, pilot plants, pre-feasibility studies, demonstration plants, bankable feasibility studies, and economic studies will be conducted. Mintek will drive these activities and involve all relevant role-players to ensure relevance, accuracy and achievement of the programme objectives.

a)	Develop robust and versatile precursor production technologies
b)	Simulate the selected process flowsheets
c)	Carry out front-end engineering designs
d)	Carry out a pre-feasibility studies
e)	EPCM of demonstration plants



- f) Extended operation of the demonstration plants
- g) Detailed design of full-scale precursor production plants
- h) Carry out bankable feasibility studies
- i) Develop business plans

Deliverables

In the future (next 5 years)

Year 1:

- a) Market analysis
- b) An assessment of the implementation readiness of current technologies
- c) Selection of preferred technologies
- d) Simulation of preferred technologies

Year 2:

- a) Process research
- b) Piloting
- c) Defining process design specifications

Year 3:

- a) Piloting concluded
- b) Process design specifications finalized
- c) Techno-economic analysis

Year 4:

a) PFS

Year 5:

- a) Complete PFS
- b) Commence BFS
- c) Business plan for full-scale implementation





4.6 Coal Gasification

Coal supplies over one-third of global electricity generation and plays a crucial role in major industries. South Africa derives in excess of 70% of its energy requirements (electricity and liquid fuels) from coal. A fair share of the country's coal is mined in a small region, characterised by a concentration of coalfired power stations. Consequently, this region is exposed to intensified environmental impacts. Acid mine drainage, air and ground pollution are frequently listed as major challenges for the region of interest, namely, the Mpumalanga region.

Even though the developed world seems to be moving away from coal as the main energy source, it remains important in the developing world and South Africa is no exception. The process for mining and beneficiation of coal in South Africa produces just under 300 million tonnes of coal, and discards about 60 million tonnes per annum. Eskom currently consumes approximately 124 million tonnes of coal for the generation of about 40,000 MW of electricity. Eskom's coal needs are expected to double between 2020 and 2030, which would result in increased amounts of discard. The discard coal materials have marginal value and a calorific value below 16 - 19 MJ/kg, but still contain a significant amount of carbon that could be profitably used as a feedstock for the production of syngas by gasification with steam.

The country is faced with energy challenges while millions of tonnes of accessible but difficult to process discard coal and coal fines are produced in the South African coal mining and beneficiation. These waste streams also constitute an environmental issue for CO2 emissions to the atmosphere and leaching of acid and metals to the waterways. The aforementioned resources are not suitable for conventional use in metallurgical, power generation and chemical industries. The ineffective use of coal poses a significant environmental and health risk and could render coal beneficiation in South Africa unsustainable. To sustain the coal industry in South Africa, in view of green economy and resource efficiency, a new generation coal gasification technology is proposed. Currently, large-scale coal gasification plants are mainly used for the production of electricity, chemical feedstock and production of synthetic natural gas. Scale of operation and availability are the major limitations for some of the gasification technologies while lower thermal efficiencies are limitations for others.

Direct current (DC) arc gasification of discard coal and coal fines technology is being developed based on Mintek's experience in DC arc furnace technology for the metallurgical industry. Potential benefits include scalability, high thermal efficiency, robustness to process almost all grades of coal and could potentially recover valuable trace metals in the coal deposits. The co-generation of energy is the current objective with a focus on the production and storage of syngas. Furthermore, the technology allows for a wide range of adaptations and is highly flexible. The DC arc gasifiers would be able to generate electricity surplus of about 1 MW/ tonne coal. Feasibility studies show that discard coal combustion could fuel power stations economically (up to a scale of 18GW electrical power) using fluidised bed gasification technology; a DC arc gasifier characterised by high efficiencies could achieve the same order of magnitude of electricity generation, at relatively lower costs, which presents a huge potential for electricity generation in South Africa.

Operation of DC arc gasifiers at large scale, 60 to 120 MW, would be expected to be able to generate about 20 to 50 MW of electricity surplus per unit. As smelting furnace plants consume such a large proportion of South Africa's electricity supply (approximately 10%), and the electricity usage per plant is in a comparable range (20 – 60 MW), coal gasification facilities would potentially enable the electric smelting industry in the country to become independent of the national grid, or at least offset a large fraction of its power use. This would contribute significantly to stabilising the national grid, as well as promoting cleaner electricity generation processes, especially for DC arc gasifiers powered by renewable energy. The technology can be exported to major economies of the world such as India and China which could provide valuable strategic leverage to South Africa.

Key activities

The operability of the DC arc gasifier concept has been successfully tested at Mintek, through a combination of experimental work and modelling of the arc fundamentals (main critical elements). This work included (1) arc behaviour, (2) short burst gasification, as well as (3) modelling of the temperature distribution within the reactor. The 3.2 MVA pilot DC arc facility in Bay 1 at Mintek was used for the evaluation of the behaviour and stability of the arc in the presence of dry steam. The results obtained to date were sufficient to support and complete a South African provisional patent application. A techno-economic study based on the theoretical mass and energy balance to determine the cost of energy (with and without IPP option) is currently undertaken for the proposed coal gasification technology in collaboration with the CSIR. A small pilot scale testwork as a comprehensive proof of concept for coal gasification is planned. Feed material will be supplied by ESKOM and SASOL.

Subsequent to proof of concept for coal gasification, a largescale piloting of the DC arc gasification process will be necessary to demonstrate the process, and for derisking as this is a prototype development. The design of auxiliary equipment and large scale piloting of coal gasification is planned for the next two to three years. The demonstration facility will consist of a sealed DC arc furnace, a sealed feeding system, process control infrastructure, an accurate gas analyser, a gasification column, sealed electrode ports, a scrubber and gas cleaning system, and a gas storage and compressing system. Furthermore, Mintek would develop a suite of Industry 4.0 tools to support the design, de-risking, and optimisation of DC arc gasifier plants. These will



leverage virtual prototypes based on computational models, and reduced-order models suitable for digital twinning and other real-time applications. Syngas production and potential for electricity generation from gasification of discard coal and fine coal would be demonstrated, thereby achieving major derisking of the technology. A life cycle assessment (LCA) and material flow analysis (MFA) would be undertaken at this point. Design data for an industrial scale DC arc gasification facility would be extracted from the demonstration scale testwork. This will aid in creating a credible business case for the consideration by the potential investors, and will play a vital role in the undertaking of a full bankable feasibility study (BFS) for the establishment of an industrial scale DC arc gasifier for discard coal and fine coal gasification. Such a programme will require substantial funding and partners, and is likely to be funded by the Government, or a strategic funder such as the IDC, the World Bank or BRICS multilateral funding. Engineering design partners and key stakeholders such as ESKOM and SASOL will be key for the integration of the technology into a real world environment.

Deliverables

The following are the main deliverables of the program to establish coal gasification of discard coal and coal fines in South Africa:

- a) Patent for coal gasification *complete*
- b) Operability DC arc gasifier concept *complete*
- c) CAPEX and OPEX estimates In progress
- d) Techno-economic study In progress
- e) HAZOP study In progress
- f) Business case for coal gasification In progress
- g) Bilateral/multilateral and other external funding proposals not started
- h) Coal gasification demonstration facility not started
- i) Detailed design for DC arc coal gasification processing plant – not started
- j) LCA and MFA analysis for coal gasification not started
- Bankable feasibility study for coal gasification not started



4.7 Revitalising South Africa's iron ore industry

The primary objective of this programme is to facilitate growth, sustainability and effective transformation within the Fe ore industries in South Africa by unlocking value from sterile resources. Fe ore is recognised as a critical strategic commodity for South Africa with SA ranked as the sixth largest producer and third largest exporter. Iron ore sales alone accounts for 12% of the total mineral sales within the country. The South African iron ore mining sector is facing a confluence of challenges some of which entail depletion of high grade reserves, high operational costs, market competition, lack of innovation and skills shortage, with instability and volatile commodity prices exacerbating the crisis within the industry. Mintek's strategic programme aims to reinvigorate this industry by exploiting novel, cost-effective solutions to unlock sterile resources (fines and reject stockpiles, low-grade material below cut-off and banded iron formations (BIF)) which has the ability to extend life of mine for another two decades and improve the competitiveness of the sector. Thus the future of Fe ore processing in South Africa considering the imminent depletion of high grade lumpy material will be low grade material and BIF which exists in abundant supply (~1.6 billion tonnes of existing material).

Research upstream of the value chain focusing on beneficiation is fragmented in South Africa. A need exists to create a platform for a local research institute. Incentives to rejuvenate the "Iron and Steelmaking" beneficiation value chain have been discussed in depth through numerous stakeholder meetings; it is through these discussions that the formulation of a South African based expertise network involving key stakeholders (state and private entities) to consolidate and develop comprehensive strategic programmes continuously addressing challenges along the value chain is deemed necessary.

Mintek has developed a renowned competency in the beneficiation of Fe ore assisting with process development and technological solutions for growth and expansion of existing industries locally and globally. Ground-breaking work has commenced in developing an optimised process to treat fine low-grade and reject stockpiles through a novel approach being the Ultra High Density DMS (UHDDMS), tested and validated at Mintek. South African primary iron ore producers have since adopted this technique for the processing of historical fine stockpiles and discard material. Work is underway regarding the upgrade potential of low grade material which will proceed into financial year 2021/22. Non-disclosure agreements (commercial and collaborative research) have been signed with ASSMANG as a primary industry partner with geological mapping being undertaken to acquire BIF material for process optimisation and validation.





The strategic outcomes and hence envisaged impact is summarised below:

- a) Stimulating mining and exploration of iron ore resources in South Africa.
- b) Addressing the diminished supply of high-grade lump material and shift towards market preference of fines by unlocking sterile resources through the evaluation of low grade fine stockpiles and Banded Iron Formation (BIF).
- c) Extension of life of mine (LOM) thereby resulting in direct and indirect job preservation and creation as well as industrial growth and development across the iron and steel value chain.
- d) Creation of a South African based expertise network involving key stakeholders (state and private entities) to consolidate and develop comprehensive research programmes addressing challenges along the value chain. While it is proposed that Mintek plan and monitor execution of sub-programmes as well as carry out essential RDI, there is a need for private partnerships to direct technological innovation that will drive industrialisation and sustainability off sectors across the value chain.

To fulfil the value proposition above, the programme must be able to translate or convert research into practical and relevant solutions that is valued by the domestic and global market and results in the sustainability of the sector. The success of this programme is dependent on commitment from various key stakeholders. Mintek together with various government entities are well equipped to co-ordinate and drive the programme. The sub-programme objectives are being driven by industry needs as the primary benefactors.

4.8 Unlocking the Bushveld Complex's

titaniferous magnetite

The Bushveld Complex hosts the largest known vanadiferous titanomagnetite deposit in the world and the primary outcome of the "Unlocking the Bushveld Complex" programme is the creation of an integrated, one-of-a-kind, state-of-the-art commercial smelting complex to comprehensively extract iron, vanadium and titanium from titanomagnetite.

Technological risk will be minimized primarily by leveraging South Africa's beneficiation knowhow and mature DC arc smelting technology, integrated with global state-of-the-art proven iron ore pre-reduction technology to minimise the cost of smelting and extract maximum value for the country. The incorporation of renewable energy resources and electricity co-generation are additional viable process options and the mountains of worthless diluted titania slag waste previous generated by the industry, will remain a thing of the past. The resultant process will thus not only be economical but energy efficient and environmentally sustainable to contribute towards the industrialisation of the South African economy.

Although Mintek's technologies for titaniferous magnetite processing have been shown to be superior in many respects if compared to current practises, currently there is no demonstrated and proven economic process for the co-extraction of vanadium, titanium and iron as saleable products. Moreover, despite numerous successful pilot plant tests, technology transfer has been hampered by the perceived complexities associated with an integrated system.

The aimed output is to boost investor confidence via technology demonstration and also through government support and incentification. This will in part be achieved by engagement with potential commercial investors to identify real and perceived technological risks that can be addressed by Mintek's suite of technological interventions. A prime example of an important programme tool that would effectively provide the necessary support required by a bankable feasibility study, would be the current MTEF funded establishment of a strategic national facility with the ability to test and demonstrate the pre-heating or pre-reduction of various titaniferous magnetite ores and which will also be directly coupled to Mintek's existing 3MW DC arc smelting facility. Additionally relevant government bodies and institutions such as the DMRE and IDC and/or PIC will be engaged to identify investment incentives such as capital funding, electricity tariffs (long term/commodity linked), power generation buy-backs, ore export regulations and product logistics.

It is anticipated that the impact of a titanomagnetite smelting complex would exceed that of the ilmenite smelting complex in the Western Cape i.e. R2billion investment, generating 1000 direct jobs, 3000 indirect jobs and R2billion in revenue.

Mintek commenced work in this programme in 2016, initially to identify, evaluate and shortlist potential suppliers with appropriate commercially proven iron ore pre-treatment technology. This study was completed in 2017 and moved forward with the MTEF funded demonstration facility (R35m capital investment) which is currently under construction and due to be commissioned in 2021. Thereafter a comprehensive pilot testing programme is planned for the following 2 years, the results of which will be used to develop a feasibility study to support investment. A collaborative support agreement with a potential industrial implementation partner has additionally been entered into.





5. TECHNICAL OPERATIONS AND CORE CAPABILITIES

Mintek operates across the nexus of the RDI and mineral beneficiation value chains. This means that Mintek's operations and core capabilities have to cover all aspects of research, development and innovation across the full beneficiation value chain, from exploration, through extraction and processing, to refining and the production of metal-based products and processes. In line with Mintek's core mandate to foster the establishment and expansion of the mining industry, it is also critical that Mintek is adequately capacitated to implement its research and development outcomes to drive economic growth.

Consequently, Mintek is capacitated with the core capabilities, both in terms of human capital, and facilities and equipment, that cover the full spectrum of both of these value chains.

5.1 Analytical testing services

The Analytical Service Division is one of the technical divisions integrated in Mintek's value chain to perform mineral composition (elemental analysis) of geological and metallurgical ores using advanced analytical techniques. The division has been operating continuously under ISO 17025 accreditation for more than 25 years. The division is in the fore front in advance analysis of precious and base metals using robust advanced methods such as fire assay, fusion, wet chemistry and acid digestion for sample preparation followed by analysis using advanced techniques such as inductive coupled plasma optical emission spectroscopy (ICP-OES), inductive coupled plasma mass spectroscopy (ICP-MS), X-ray fluorescence and atomic absorption (AA). Other advance methods includes determination of sulphur, carbon and phosphorus by combustion methods.

The division also manufactures and sells certified reference materials (well-known as South African Reference materials (SARM) which play an important role to the minerals industry at large as they are used for quality assurance and quality control, adding value to mining value chains. SARM are distributed globally for routine analysis and research purposes, many of the publications experimental work references material to SARM, making the division to be one of the global competitive within the space of producing certified reference materials.

The division contributes to overall quality control of other industry products by participating in the proficiency testing schemes of mineral composition of various ores which are used as reference materials. Proficiency testing schemes are critical requirement for obtaining and maintaining ISO 17025 accreditation. The division uses this opportunity to of participating in proficiency testing scheme in order to confirm competence, and underpin measurement capabilities in the analytical services offerings. It provides clients with confidence that ASD results are good quality, there-by giving competitive edge in the market.

The division new strategy is to implement key research, development and innovation in the analytical services field, to unearth young talent, to improve skills set contribute output of high calibre through publications and to promote knowledge transfer through training. The approach of research is in many folds, to add value to existing mineral processed to the organisation, to collaborate with key stakeholders outside of Mintek to support emerging markets in minerology related products.

5.2 Mineralogy

At every stage during the life cycle of a mineral deposit, from exploration to resource evaluation, mine planning, plant design and operation, product quality control, and through to closure and site rehabilitation, the information from mineralogical investigations should form an integral part of the knowledge base related to the resource. Mineralogy during exploration provides an early indication of likely later extraction processes required. It can also be used to constrain end-member variability for geometallurgical mapping and for process control modelling.

The Mineralogy Division (MNL) provides a range of specialised mineralogical solutions to mining processes, industrial plants and environmental challenges. The Division applies the principles of mineral characterization to understand processing behaviour of minerals, thus empowering metallurgists and engineers to obtain optimum recovery and grade in mineral beneficiation.

The Division provides mineralogical services across the life cycle of a mineral deposit, from exploration to mine closure. The key role of the Division is to identify minerals and interpret the data with respect to evaluating a mineral deposit, beneficiating the ore, providing vital information for process design as well as on-going support with mineral industry troubleshooting, analysing metallurgical projects and dealing with environmental

Mineralogy division research objectives is to apply mineralogical characterisation and associated data, using appropriate tools and approaches:

- a) For efficient processing and extraction of value from ore bodies; and
- b) To mitigate environmental impact, and at the same time, realise value from waste of different types; and

The impact to be made by the outcomes of the research that is conducted are the following:

 a) Optimal exploitation of South African ore deposits. This in turn reduces technical and economic risk of mining and ore processing operations, and unlocks resources. Without mineralogical input, this cannot be realised.

issues.





 Improved approaches to processing informed by mineralogical inputs using cutting edge techniques.
 Process optimisation can yield benefits to grade and recovery through a thorough understanding of mineral behaviour that results in minerals reporting to different streams.

5.3 Mineral processing

Minerals processing improves the South African mining sector through research, development and innovation in physical mineral upgrading processes and technology. Minerals processing capabilities are at the entry point of the metallurgical value chain, and focus on exploiting the physical properties of minerals for upgrade or concentration purposes. In this regard, Mintek plays a pivotal role within the mining value chain as its spectrum of service offerings is diverse and includes metallurgical optimisation solutions, assessing technology innovation, close interaction with mining sectors and technology suppliers, as well as preparing and pre-concentrating material for downstream operations. Mintek is at the forefront of mining challenges, thereby offering relevant solutions that support exploration, growth and sustainability.

The goal in mineral processing is to produce maximum value from a given raw material and to derive value from unexplored and sterile resources.

In this space, Mintek provides metallurgical solutions for the recovery of minerals from a large variety of ores. This is achieved by means of desktop, laboratory and pilot plant studies to develop the most suitable plant configuration for existing operations and new projects or ore types.

With respect to mineral processing, Mintek provides solutions on pre-concentration of commodities that are of greatest economic and strategic importance to the country, most notably PGMs, gold, ferrous, chrome, uranium, titanium, magnesium, industrial, base metals, energy, and REEs. Although the particular research questions that Mintek works on vary across the different commodities, the overarching and cross-cutting research themes have been those of accessing and processing low-grade and complex ore bodies, developing water-efficient and waterless processing technologies, developing energyefficient technologies. Therefore, Mintek is vital in ensuring the sustainability of the SA mining industry through leading technology innovation in mineral liberation and separation that enables optimal solutions for the beneficiation of strategic and complex minerals.

5.4 Pyrometallurgy

Pyrometallurgy is a branch of extractive metallurgy that involves the practice of removing valuable metals from an ore and refining the extracted raw metals into a purer form. Pyrometallurgy involves high-temperature processes where chemical reactions take place to extract or concentrate metals. It is, therefore, the science and technology concerned with the use of high temperatures to extract and purify metals. It consists of the thermal treatment of minerals and metallurgical ores, and concentrates on bringing about physical and chemical transformations in the materials to enable the recovery of valuable metals, which often requires a liquid or near-liquid state. The nature of the material determines whether a pyrometallurgical process step is required. Process temperature can range from 900 to 2 000 °C. The major types of operations are roasting, smelting and refining. Pyrometallurgical processes are often complicated, high-risk and generally energy-intensive as the operating temperatures are frequently above 1 500 °C. The containment of liquid slags and metals at these elevated temperatures requires specialised know-how and equipment, as well as access to energy, often electrical energy.

The complex nature of pyrometallurgical processes means that demonstration on a large pilot scale is frequently required. Mintek's pyrometallurgical pilot facilities are unique. No other entity in the world has both the scale and variety of facilities hosted by Mintek. Scale-up variations and operability challenges cannot yet be accurately predicted via modelling, simulation or even rigorous laboratory experimental investigation, albeit an essential part of optimising and designing high-temperature processes. Extrapolating the observations from a series of laboratory tests needs to be validated on a larger scale.

Mintek curates a number of pilot facilities, the majority of which contain smelting equipment, which enables technology development from laboratory to the pilot. Smelting processes frequently require process heat generated from electrical power. In the constrained energy environment, energy-intensive industries continuously strive to reduce electrical energy consumption. Energy efficiency and energy optimisation are primary areas of research for Mintek. Alternative energy sources, such as solar thermal heat and gas-fired energy, are applied to existing processes to facilitate improved energy and environmental efficiency. Mintek excelled at developing highimpact smelting technologies, primarily via the DC smelting technology, with numerous commercial installations around the world based on the technology developed internally. The DC smelting technology has had a significant impact on the industry, with successful technology transfer for chromite, ilmenite, battery recycling, cobalt slag cleaning and - recently -nickel laterite-smelting processes

5.5 Hydrometallurgy

Hydrometallurgy is a collection of techniques for obtaining metals from their ores. It falls within the field of extractive metallurgy involving the use of aqueous chemistry for the recovery of metals from ores, concentrates, and recycled or residual materials. In the simplest terms, Hydrometallurgy can be seen as a discipline that strives to dissolve metals from their ores and then purifies the dissolved metals. Since hydrometallurgy goes





beyond manipulating minerals and works at atomic level, it is the only extractive metallurgy discipline that can purify metals to the maximum extent. Hydrometallurgy can do this by manipulating interrelated aqueous and multiphase chemical equilibria by controlling the chemical potential governing these equilibria. This means that hydrometallurgical processes are very complex, requiring a thorough understanding of the chemistry of each element in the process in order to achieve optimum solubilisation and purification.

The value proposition of the Hydrometallurgy Division is to bring research knowledge to responsible exploitation of mineral wealth. The Division therefore aims to provide the best technical solutions in support of the minerals industry in South Africa in particular, but also related industries.

Besides extensive chemistry and process engineering expertise, the Hydrometallurgy Division at Mintek has particular expertise in pressure leaching, precipitative purification, electrowinning, solvent extraction, ion exchange and process modelling. This forms an excellent base for the Division to develop innovative solutions for complex hydrometallurgical and refining problems in support of the mandate of Mintek. Since hydrometallurgical processing is often complicated by other factors such as cost, market dynamics, process equipment and environmental impact, the "best" process solutions are not necessarily determined by the chemistry of the process only. This is where the Hydrometallurgy Division at Mintek has traditionally excelled in bringing the basic chemistry understanding of a system together with these external factors to develop the optimal solution for the processing of a specific ore or concentrate. Extensive process and industry knowledge is incorporated into state of the art digital process twins to carry out techno-economic evaluations of the various process options so that the optimal process or product can be selected for potential application. This approach in the Hydrometallurgy Division has led to the development of numerous innovative products and processes in support of the mining and minerals industry in South Africa.

5.6 Biotechnology

Biohydrometallurgy is a branch of extractive metallurgy that describes biotechnological processes that involve interactions between microorganisms and metal-bearing minerals. Bioleaching and bioremediation are two of the most studied branches in this field and are employed worldwide at commercial scale. Bioleaching involves the use of naturally occurring microorganisms to recover gold, base metals and uranium from mineral ores, concentrates and a range of waste materials. Mintek has established an internationally recognised position for the treatment of sulphide ores and concentrates bearing gold and base metals. The tank bioleaching technologies developed by Mintek typically find application in niche areas for the treatment of refractory gold concentrates, as well as complex polymetallic concentrates that contain impurities that attract smelting penalties. The organisation has the ability to take processes from amenability test work through to piloting, flowsheet design, techno-economic studies and commercial implementation.

With the depletion of higher-grade resources, Mintek's biotechnology processes have shifted focus to include heap leach applications where metals are extracted into solutions from minerals contained in dumps or stacked heaps of lowgrade ores. The learnings from biological heap leaching have been expanded to include acid, alkaline and chloride heap leaching in the division's portfolio. In addition, Mintek has the unique ability to combine percolation leach test work with the geomechanical (hydraulic/hydrodynamic) testing of such ores and their leach residues. This allows Mintek to offer clients a combination of metallurgical performance results and geomechanical/hydrodynamic information from which engineering can be done based on the quantified specifications provided. Mintek's activities in this area range from a suite of various bench-scale tests to integrated pilot and demonstration tests at pre-feasibility study or process selection phase level, enabling commercial clients to determine ideal flowsheet design and operating conditions to optimise value.

There is a global trend to move the mining industry towards participating in a circular economy by promoting and investing in sustainable solutions and green technologies. Mintek is uniquely positioned to contribute to this drive through its multidisciplinary capabilities, which include bioprocessing, chemical and environmental engineering, and biological sciences expertise. The focus is on the economic, environmental and social benefits of waste treatment. Current flagship projects include the passive biological treatment of mine water, integrated with irrigated agriculture, the production of value products from mine effluents and the recycling of electronic waste and tailings

5.7 Measurement and control

Mintek's capabilities in measurement and control are for developing and supplying world-class process control solutions and measurement instruments that deliver tangible and significant improvements in recovery, and reductions in reagent and energy usage to minerals processing plants and smelters all over the world.

The differentiating factor in Mintek's measurement and control capabilities is that it is able to combine in-depth process understanding with sophisticated process control skills on a flexible control platform, which has been purpose-built, to deliver solutions that are tailored to extract every last ounce of performance from each mineral's processing control challenge to which it is applied

The advanced process control builds in layers, beginning first by ensuring that the base processes are stable, and then optimising





the performance further to ensure maximal recovery, with minimal input cost. Niche process measurement instruments are developed to enable further optimisation in cases where the standard plant infrastructure is inadequate.

The approach to technology development is very much "technology pull". Close contact is maintained with industry so that market need is clearly understood and fed into the technology development pipeline. This focus means that the products Mintek delivers appeal to a wide range of operations, which protects revenue generation prospects from the cyclical nature of the mining industry. Revenues generated through the sale of measurement and control products are spread well across regions, commodities, project stages and product types (service, software and equipment). The primary focus is the African continent, with a growing network of sales agents and distributors providing support in other markets around the world. Mintek has more than 400 active process control and instrument implementations spread across 40 countries.

5.8 Advanced materials

At the heart of materials in general is the chemistry that informs the structure of the material in order to eventually arrive at a useful application. However, in order to attain a desired structure with the properties required for a particular useful application, processes are required. Embedded in this process of materials design is an understanding of the theory, materials synthesis and characterisation of the materials.

Advanced materials, therefore, entail advances over old and conventional materials that have hitherto been in application. The discovery and manufacture of advanced materials, therefore, require advanced theories for their discovery, which currently entails the use of computational approaches to understand and predict their performance in various applications. These new and novel approaches to materials allow for a deeper understanding of their structure, dynamics and functionality. The research and development of advanced materials normally exhibit novel properties that are superior to their conventional counterparts. This inherent novelty, in most cases, is associated with the generation of new knowledge and IP that can be exploited in the form of new processes, products and technologies. The knowledge and IP hereby developed can now be exploited through the formation of new industries, and their use in enhancing and revitalising the existing industry for job creation and job retention.

In this regard, Mintek follows the abovementioned approaches towards specific research, development and innovation into the end-use of materials in the mining, fabrication and manufacturing industries. Through the use of advanced process technologies, Mintek aims to produce high value-added products by deploying cross-cutting skills from various disciplines, ranging from chemical sciences to physics, materials science and engineering, biochemistry and chemical engineering.

The focus areas through which these are attained are in physical metallurgy, catalysis, and nanotechnology. In physical metallurgy, the sectors of interest are the broader metalsrelated industries that require novel materials for application in conventional and extreme environments. Catalysis, on the other hand, finds special application in the hydrogen economy sector through the manufacture of fuel cells for various applications. Through the Catalysis Group, Mintek has taken a strategic position to seek to increase the opportunities to commercialise its fuel cell intellectual property (IP) by building capacity for fuel cell manufacturing along the entire value chain of catalysts, membrane electrode assemblies (MEAs), fuel cell stacks and fuel cell systems. Legacy programmes in general catalysis include the production gold catalysts for use in carbon monoxide remediation and general air purification applications. Nanotechnology has a special focus for application in health, and in water and wastewater technologies. The Biolabels Unit of the Nanotechnology Group has now given birth to the Mintek Health Platform which is underpinned on R&D in nanotechnologyinspired high value colloidal gold products from which "smart"/ functionalized gold nanoparticles can be produced. Through these functionalized gold nanoparticles, nanotechnologyinspired health solutions through the development of point-ofcare (PoC) diagnostic kits for the detection of both human and animal diseases is possible.

From R&D based on metals/materials-in-medicine towards the design of health-related solutions for a range of burden of disease such as HIV, malaria, etc., Mintek has built a knowledge base that can be tailored towards a range of health-related solutions. One of such solutions is the design and production of biomarkers that are key enablers towards diagnostics and therapeutics products R&D and manufacture. Through this integrated knowledge-base at Mintek, a complete and integrated suite of health-focused solutions ranging from nanoparticle production, biomarker production, nanoparticle functionalization, design and manufacture of diagnostic and therapeutic solutions for human and animal diseases, is possible.

Through these capabilities, the Health Platform is well-positioned to Foster the Establishment and Expansion of a Diagnostics Industry through the manufacture of high-value diagnostic products (human and animal) and to supply the products on a commercial scale. In addition, a further opportunity exists to establish a Biomarker Production Industry to support the diagnostic industry and other health-related research, development and innovation initiatives in South Africa.





5.9 Small-scale mining

Mintek provides support to the small-scale mining sector by empowering them through skills development and transfer for minerals processing and beneficiation. Mintek further supports this sector through research and development of new processes and processing technologies and environmental management. Success is often achieved through the deployment of Mintek's laboratories and expertise at various stages of the minerals processing value chain for the benefit of community-based minerals processing and beneficiation operations. Part of the outputs towards the fulfilment of Mintek's mission include feasibility reports, technologies developed or adapted, and the number of people trained.

5.10 Mineral economics

Mintek has in-house mineral economics capabilities to develop market insights and techno-economic analysis related to the extraction, processing, use, recycling and disposal of mineral commodities.

This capability enables Mintek to undertake market and sectoral analyses for external clients in the public and private sectors.

Furthermore, it enables Mintek to participate in policy and thought leadership engagements with government and research entities on issues pertaining to mineral beneficiation, resource management, renewable energy and electronic waste recycling. As Mintek's undertakes its organisational transformation journey, it will be strengthening capabilities in two competency areas: mineral economics and techno-economic analysis.

The key activity of this function is as follows:

- Conducting mineral economic research and technoeconomic feasibility studies through: promotion of value addition in the minerals industry,
- Assessment of growth potential and identification of strategic options for the development of the countries' mineral endowments, both in South Africa and elsewhere in Africa.

These market studies highlight resource potential, infrastructure requirements, and advantages of ordered development and clustering of projects, thereby assisting variety of clients in attracting investment for economic growth and development.





6. SUPPORT FUNCTIONS

In the last financial year, Mintek started a transformation journey that sought to return the main thrust of its business to its core of being a research institution. A critical aspect of that journey pertained to the transformation of the support services functions that is moving away from a transactional focus to strategic support in order to create an enabling environment for the RDI programmes to flourish. To that end, the business development function is going through a change that will prioritise the commercialisation of Mintek's expansive IP portfolio, which has been amassed over decades of cutting-edge research. Similarly, Information and Communication Technology (ICT) and Engineering Management Services are geared towards creating a network of infrastructure, plant and equipment that will effectively enable Mintek's researchers to excel in their programmes. This section of the Shareholder's Compact summarises the critical focus areas for each support function.

6.1 Business Development and

Commercialisation

Mintek's intended impact is primarily to foster the establishment and expansion of the minerals industry. To achieve this, it is critical that the outputs of Mintek's activities are transferred to industry and commercialised. This is driven by the organisation's business development and commercialisation functions. These activities are therefore the main drivers of Mintek achieving its strategic impact.

The business development function encompasses a number of activities that are collectively aimed at coordinating and driving technology transfer and commercialisation.

The key activities of this function are as follows:

- a) Developing and coordinating Mintek's marketing plan. This includes attending international events and exhibitions.
- b) Managing the commercialisation and technology transfer functions, including the building of organisational capacity to maximise Mintek's impact.
- c) Developing and managing key account managers for Mintek's key partners.
- d) Developing and managing RDI networks on behalf of Mintek.
- e) Managing Mintek's industry-focused brand, including its reputation management.
- 6.1.1 Mintek Office of Technology Transfer

Mintek established the Mintek Office of Technology Transfer (MOTT) in 2011 following the promulgation of the Intellectual Property Rights from Publicly Financed Research and Development Act (IPR Act). The Office was established to ensure the efficient management and administration of Mintek's IP portfolio. The Office was not capacitated to lead the commercialisation of Mintek's IP. This function was decentralised and delegated to the various business units. In the period since the establishment of the MOTT, Mintek has been partially successful in commercialising its IP, with annual revenue in the range of R30 million to R40 million. A recent review of Mintek's technology commercialisation and industrial impact revealed that greater emphasis is needed on technology commercialisation and transfer so that the impact of Mintek's RDI can be maximised. As a result of this change in emphasis, Mintek needs more capacity in the area of technology transfer and commercialisation. Consequently, Mintek successfully applied to the National Intellectual Property Management Office (NIPMO), under the Office of Technology Transfer Support Fund, to capacitate the MOTT with commercialisation and technology transfer skills.

Specialists in the following specific skills are being targeted:

- a) Technology transfer and commercialisation at Head/ Director level
- b) IP-related legal skills at Manager level
- c) Technology transfer and commercialisation skills and project management and coordination skills at Coordinator level

This capacitation of this enhanced MOTT began during 2020/21 and will continue during 2021/22 and will formally drive the transfer of technology and commercialisation of Mintek's outputs in line with Mintek's revised Business and Operating Models. Additional capacity will also be recruited and developed within the business units to ensure that the impact of Mintek's research and development activities is maximised.

6.2 Information and Communication Technology

ICT is driving business enablement through technology initiatives that seek to advance the Mintek agenda, enable greater effectiveness, efficiencies, and enable innovation. These initiatives take into consideration the interconnectedness of people, processes, information, and technology capability. Part of the ICT roles is to facilitate and empower Mintek divisions' to adapt and modify processes that are aligned to Mintek strategic goals.

The business enablement will consist of multiple projects, such as the implementation of technology, integration of systems, policy development, process changes, digital migration,





innovation with purpose, and other activities that are intended to support and enable Mintek. The evolving business expectations and ever-changing digital world will be kept in mind in the execution.

6.3 Planning, Monitoring, Evaluation and

Reporting

The Planning, Monitoring, Evaluation and Reporting Division (PMER) is a new portfolio aimed at harnessing the capabilities of each Division by promoting integration and accountability. The PMER will assume overall responsibility for strategic, operational and business planning across the organization, as well as monitoring and reporting against targets, objectives and goals in support of the Mintek's mandate. Key developments will include building core competencies for the PMER, implementation of the planning and monitoring framework and the development of a reporting tool/system to enable standardization and integration of processes to support insights and in-depth analysis of the organizational performance against the delivery of the Mintek strategy.

6.4 Engineering and Maintenance Services

Engineering and Maintenance Services is responsible for the management and maintenance of Mintek's infrastructure and facilities, plant and equipment. The services offered include basic maintenance service, electrical and instrumentation services, building maintenance (including laboratories) and mechanical maintenance (heating, ventilation and air conditioning (HVAC), drainage, effluent bays, mobile equipment and mechanical equipment). Engineering and Maintenance Services is also responsible for the management of site support services, such as security, garden maintenance, hygiene and transport services.

The optimisation of maintenance processes, energy management and safety, health, environment and quality (SHEQ) compliance remains the main driver of ensuring optimal infrastructure availability and utilisation. EMS will no longer offer R&D related engineering support activities in line with the new organisational strategic direction. The division will focus on reorganising its resources to align with the revised mandate. This is expected to take at least up to the end of the 2021FY.

In the quest to enable Mintek to remain competitive, infrastructure capitalisation is inevitable. EMS will continue to lead infrastructural asset modernisation programme through various projects that will be selected and prioritised on the basis of their impact to sustainability of Mintek.

6.5 Human Resources

Human Resources is responsible to support the implementation of Mintek's strategy by building leadership capability, employee competence and ensuring high levels of employee engagement. HR will continue to provide support to help business cascade and communicate goal clarity for employees to know what they're working towards. As part of this process, HR is gearing itself through collaboration with stakeholders, providing change management capability and agreed set of tangible and intangible people metrics against which success will be measured.

The division will continue with efforts to build practitioners who are skilled, equipped and properly supported to perform the full range of functions.

The key activities of this division are as follows:

- a) The creation of a positive working environment characterised by empowerment, involvement and heightened engagement so that people can give their best and deliver beyond expectations
- b) Ensuring that we have the right people in the right positions to protect Mintek's core and sustain growth
- c) Instil a high performance culture where employees are driven to exceed expectations
- d) Build leadership and staff capability so that we are competitive
- e) Develop performance management system aligned to business strategy, talent management and Mintek's compensation philosophy
- f) Leverage technology and systems to drive data focused decisions

6.6 Finance

Financial management is one of the most important aspects of any business to ensure that the entity delivers on its mandate. Finance is the lifeblood of business. Without it, things would not run smoothly. It is the key to ensuring that any organisation functions in a healthy and financially sustainable manner. The focus of Finance is to optimise Mintek's financial resources to increase surpluses while meeting business objectives. The division is very compliance driven and transactions are underpinned by solid internal controls. Mintek's financial management includes the provision of transactional, administrative, financial support, management reporting and value-added decision support. It provides a support service and creates an enabling environment for all divisions within Mintek.





The main activities of financial management include budget control, internal control, revenue and expenditure management, supply chain management and accounting system management. During the planning cycle, the function will focus on the following aspects:

- a) Improved internal control and management reporting.
- b) Identification of opportunities within the new ERP to eliminate unnecessary processes. Investigation of the possibility of using 'bots' for routine transactions.
- c) Improved agility in the ever changing business environment to provide the right information at the right time and placing the correct systems in place to support the requirements of business.
- d) Development of enterprise incubation programme to support small businesses such as garden service.
- e) Development of a Mintek BEE strategy formulation to ultimately increase our BEE rating but also contribute as a good corporate citizen by upskilling the South African workforce and assisting small enterprises to grow into sustainable businesses who would stimulate the national economic.
- f) Implementation of online tendering tool that will improve efficiencies, strengthen internal controls over tender submissions, etc.

6.7 Project Management Office

Mintek is undertaking the project management and implementation of the Abandoned Mines Rehabilitation programme or Derelict and Ownerless Mines (D&O) programme on behalf of and funded by DMRE. The programme has been funded on a three-year MTEF funding cycle since 2009. Mintek has increased its internal capacity to execute the D&O programme by opening a new Project Management Office that will focus solely on the programme. It will also keep the repository of institutional knowledge and data gained by Mintek over decades in this programme in order to improve its efficiency on the number of rehabilitated project sites delivered to DMRE.

6.8 Internal Audit

Internal Audit is an independent, objective assurance and consulting activity designed to add value and improve an organisation's operations. It helps an organisation accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of risk management, control and governance processes.

Mintek has an in-house internal audit function. The Internal Audit function's purpose, authority, and responsibility is defined in the Internal Audit Charter, which is approved by the Audit and Risk Committee.

Internal Audit prepares a risk-based audit plan each year, which is approved by the Audit and Risk Committee. The Risk-based Audit Plan details all the projects to be reviewed by Internal Audit. The results of the internal audit activities are reported to Management and the Audit and Risk Committee quarterly.





7. SAFETY, HEALTH, ENVIRONMENT, QUALITY AND RADIATION PROTECTION (SHEQ-RP)

The safety, health, environment and quality (SHEQ) function is responsible for ensuring legal compliance with health and safety regulations, environmental regulations, radiation protection regulations and quality control requirements.

By applying several disciplines for continuous improvement, the function supervises and coordinates ISO systems for quality management (ISO 9001), for environmental management (ISO 14001) and for health and safety management (ISO 45001) to ensure that the organization meets the highest quality standards and that the working conditions are favourable and safe.

With a SHEQ system in place, Mintek benefits from an improvement in product and service quality, lower impact on the environment, lower levels of waste, improved customer satisfaction, higher employee morale, reduction in consultancy fees, fewer accidents (and lower costs associated with these), and ongoing legal compliance with statutory requirements.

The function also ensures that Mintek follows a risk based approach to effectively manage all prioritised SHEQ risks, including the mitigation and/or elimination of potential high severity incidents and coordinates the ongoing awareness and training to enhance a fully embedded risk management culture within the organisation.

7.1 Safety and health

Health and safety is a core value at Mintek and the organisation is committed to continued advancement of an institutional health and safety culture with strong programs of personal safety, incident and injury prevention and wellness promotion. Health and safety culture programs that focus on providing a completely healthy and safe environment for workers, contractors, and visitors on a daily basis have been developed and implemented to guide Mintek's operations to deliver on its H & S commitment throughout the organisation.

Zero fatalities and a Lost Time Incident Frequency Rate (LTIFR) target of \leq 1 has been set and is continuously monitored.

7.2 Environment

Mintek's goal is to conduct all its business activities with the lowest environmental footprint by proactively searching for technologies to steadily increase the level of efficiency in the use of resources such as energy, water and raw materials and taking steps to prevent pollution from the different processes in our operations.

An Environmental Incident (EI) target of \leq 1 has been set and is continuously monitored.

7.3 Quality

Mintek endeavours to provide quality products and services that meet and exceed its client's expectations. Its goal is to achieve operational excellence in all aspects of its operations. A systematic approach is followed to analyse process performance and efforts to improve such performance.

The process of quality management involves setting and measuring of quality targets, identifying any issues that arise, initiating improvements and reporting the overall level of the quality achieved.

A Client Satisfaction Frequency Rate (CSFR) target of \ge 90% has been set and is being monitored.





8. FINANCIAL PLANNING

8.1 Consolidated budget - 2021/22 to 2023/24

The consolidated budget for the 2021/2022 financial year is presented in Table 1. The total expected income is R568 million, with the state grant contributing 62% of the total budget. Baseline funding remains the biggest contributor to the revenue budget of the organisation. A fundamental shift in the state grant is the absorption of MTEF funding previously earmarked for the Titaniferous Magnetite. Project revenue will in future be reported under state grant. The summarised budget projects a breakeven position throughout the MTEF period. This is dependent on the successful generation of revenue through commercial activities and will therefore only be attainable if the current economic conditions improve. The tables on the ensuing pages (Table 2 and Table 3) should be read together with the state grant reconciliation in Table 5, which reconciles the figures in accordance with the Adjusted Estimates of National Expenditure (AENE). This includes all MTEF allocations and spending in the same period.

Mintek undertakes its budgeting process in November of each year on a strategic business unit level, considering current market conditions and inflation. A realistic budget is then compiled, which reflects the business plan for the next financial year. The outer years of the MTEF period (2022/23 and 2023/24) are based on the following assumptions:

- a) State grant allocation as confirmed by DMRE
- b) Contract work This relates to revenue generated where Mintek is project managing projects for DMRE and DSI such as Derelict and Ownerless Mine Rehabilitation (D&O) and Centres of Excellence (CoE). The funds are received from the departments and paid to service providers/universities. Budget is as per allocation from DMRE for D&O and as per contract for DSI.
- c) Commercial income (contract research and sale of products and services) – average of 5% increase per year on research and 9% in 2022/23 and no growth in 2023/24 as a result of capacity constraints to execute the necessary work at that point.
- d) Sundry and investment income average of 2% increase per year
- e) Staff costs increased by 2%
- f) Bursaries increased by 2%
- g) Contract Expenditure this is in direct relation to contract work revenue and will fluctuate in a similar trend.
- h) Operating expenses increase of 5% and 2% per year respectively in relation to increases in products and services in the same years.
- i) Depreciation increased by 2% per year.

Income ['000 Rand]	2020/2021 Forecast	2021/2022	2022/2023	2023/2024
State grant	244,915	282,598	292,697	297,679
Contract Work	134,273	138,088	138,755	129,526
Research	9,706	14,676	15,480	16,254
Products and services	97,363	108,777	118,229	118,398
Investment income	15,172	20,257	20,663	20,869
Sundry Income	7,611	4,256	4,341	4,384
Total Income	509,039	568,653	590,165	587,110

Table 1: Income and expenditure budget





Table 1: Income and expenditure budget (continued)

Expenditure ['000 Rand]	2020/2021 Forecast	2021/2022	2022/2023	2023/2024
Staff Costs	291,664	291,320	297,146	303,089
Bursaries	8,720	13,966	14,246	14,532
Contract Expenditure	88,612	99,930	100,023	91,111
Operating costs	101,842	117,493	123,091	126,108
Depreciation	38,508	45,317	46,222	47,147
Total Expenditure	529,346	568,026	580,728	581,987
Net result	-20,306	627	9,437	5,123

Table 2: Statement of financial position budget

	2020/2021 Forecast	2021/2022	2022/2023	2023/2024
Non-current assets	415,968	422,879	429,533	435,263
Property, plant and equipment	412,393	419,304	425,958	431,688
Intangible Assets	3,575	3,575	3,575	3,575
Current assets	499,136	492,852	495,633	495,028
Inventory	8,632	8,632	8,632	8,632
Trade receivables	34,023	34,023	34,023	34,023
Short term investments				
Cash and cash equivalents	456,481	450,197	452,978	452,373
Total assets	915,104	915,731	925,166	930,291





Table 2: Statement of financial position budget (continued)

	2020/2021 Forecast	2021/2022	2022/2023	2023/2024	
Equity	613,239	613,865	623,300	628,426	
Revaluation surplus	142,184	140,653	139,121	137,590	
Retained Income	471,055	473,212	484,179	490,836	
Long term liabilities	9,254	9,254	9,254	9,254	
PRMA liability	9,254	9,254	9,254	9,254	
Current liabilities	292,612	292,612	292,612	292,612	
Trade and other payables	72,111	72,111	72,111	72,111	
Loans and advances from subsidiary					
Deferred Income	220,500	220,500	220,500	220,500	
Total funds and liabilities	915,104	915,731	925,166	930,291	





Table 3: Cash flow budget

	2020/21 Forecast	2021/22	2022/23	2023/24
	R '000	R '000	R '000	R '000
Cash (utilised in)/generated from operations	9,903	25,687	34,996	31,401
Interest received	15,172	20,257	20,663	20,869
Net cash from operating activities	25,076	45,944	55,659	52,270
Additions to property plant and equipment	-50,331	-52,228	-52,877	-52,876
Increase in investment deposits				
Net cash from investing activities	-50,331	-52,228	-52,877	-52,876
Net (decrease)/increase in cash	-25,255	-6,284	2,781	-606
Cash at beginning of the year	449,731	424,476	418,192	420,973
Cash at end of the year	424,476	418,192	420,973	420,367
Cash generated from operations - calculation				
(Deficit)/surplus from operations	-20,306	627	9,437	5,123
Investment income	-15,172	-20,257	-20,663	-20,869
Depreciation	38,508	45,317	46,222	47,147
Working capital changes	6,874	0	0	0
Increase in inventories	958	0	0	0
(Increase)/decrease in receivables	2,724	0	0	0
Increase in provisions	-1,139	0	0	0
Decrease in payables	15,522	0	0	0
Increase in deferred income	-11,192	0	0	0
Cash generated from operations	9,903	25,687	34,996	31,401





8.2 Capital Investment Plan

The capital expenditure (Capex) budget for the MTEF period from the anticipated funding sources is presented in Table 4. Mintek will continue the investment on capital expenditure, which

 Table 4: Capital expenditure budget

averages R50 million annually, and 42.3% of the total Capex will be from the state grant allocation, while the balance will come from reserves and MTEF funding. Funding from reserves will increase as MTEF funding decreases over the coming three years.

Capital expenditure budget ['000 Rand]	2020/2021 Forecast	2021/2022	2022/2023	2023/2024
State grant - capital allocation	22,265	25,691	26,609	27,062
MTEF funding - capital allocation	10,423	0	0	0
Capex funded from reserves	17,643	26,537	26,268	25,815
Total Expenditure	50,331	52,228	52,877	52,877

8.3 State grant allocation

Mintek has two main sources of funding for its long-term research programme: the baseline state grant (the Science Vote) and MTEF allocations. Wherever possible, additional funding is leveraged from private companies and international agencies. Mintek funds its early-stage research from the baseline Science Vote and largely utilises the MTEF funding for specific later-stage development.

Mintek's R&D programme is structured into various platforms or themes. These themes are determined according to government priorities, and industry needs and opportunities. Over the past decade, Mintek's RDI portfolio has been managed via the Science Vote Cluster system. For the 2020 financial year, starting in April 2019, funding was awarded on the basis of an "open call" for funding proposals. This "open call" is a bottomup process and replaced the previous Science Vote Cluster system. The new "open call" process is aimed at tapping into innovative ideas throughout the organisation and any new ideas that are broadly aligned with Mintek's mandate, objectives and market segment. Mintek strives to invest in a robust and diverse portfolio of projects that creates new knowledge and enables breakthroughs across all areas of SET research. Together with the open call, eight strategic programmes were identified that would be funded from the state grant.

Mintek supports the mineral strategies and initiatives of the DMRE. The Department has identified ten commodities and five value chain priorities as a basis for deciding on technical programmes. Mintek's R&D plans and activities are thus fully aligned with DMRE's priorities.

The starting cost-basis budget for state grant allocation (the Science Vote) distribution for the current financial year is R257 million. A provision of R20 million is made for support functions and R26 million for capital expenditure. This results in R211 million being available for research in the 2020/21 financial year. The gross MTEF funding allocation decreased from R146 million in 2019/2020 to only R114 million in 2021/2022. This is partly due to the reallocation of the Titaniferous funding to the baseline amounting to R24 million. A reduction of R8 million was made in the D&O programme. This includes the D&O programme, but excludes roll-overs.

The MTEF investment is motivated to National Treasury for specific project activities. These project proposals are based on successful early-stage research funded from the state grant and where there is close alignment with government priorities. Once National Treasury has accepted a project, the operational management and oversight of the project are undertaken by the same team that manages the allocation and oversight of the state grant research funds.

8.4 Cost-containment plan

The definition of cost containment is "the process of controlling the expenses required to operate an organisation or perform a project within pre-planned budgetary constraints." The costcontainment process is an important management function that helps keep costs down to only necessary and intended expenses to satisfy financial targets.

Budget monitoring is performed on a regular basis to ensure that there is no excessive spend. The focus for Mintek is to improve efficiencies through a better utilisation of resources.





The Cost-containment Plan, as set in National Treasury's Instruction/Circular No. 2 of 2016/17, issued on 30 September 2016, gives an account of some of the measures that Mintek will continue to implement over the planning period. Mintek's Cost-containment Plan is included in Appendix III.

8.5 Allocation of other government grants

8.5.1 Rehabilitation project

Mintek has been managing the programme to rehabilitate asbestos mines on behalf of DMRE since 2013. The initial contract, to the value of R165 million, was for a duration of three years. It was concluded at the end of March 2016. The contract was extended to a second phase to the value of R155 million over a three-year period from 2016 to 2019. In 2019, the contract was further extended with a total value of R450 million over the three-year period from 2019 to 2022. The current contract scope includes managing the rehabilitation of certain derelict and ownerless (abandoned) mine sites identified by DMRE, with a specific focus on asbestos mines, as well as closing and sealing derelict shafts (holings).

To date, 38 sites have been rehabilitated with great success. The extensive Streatham Project in Limpopo, which was divided into four smaller projects due to the project's size, reached practical

completion in 2020. The project completion was delayed due to community-related challenges.

Over and above the Streatham Project, the Msauli and Steelpoort projects also reached practical completion in 2020. The three projects awarded in 2019; Uitkyk, Penge Village and Lagerdraai, are in the construction phase and scheduled for completion in 2020/21. Tenders were also awarded in 2020 for the Dublin and Uitval projects. The Dublin project is in the construction phase while the Uitval project is still to commence.

The project commencement has been delayed by more than 8 months due to community-related challenges.

Starting from 2019/20 the project was expanded to include the sealing of derelict shafts and holings. The sealing of holings programme has proceeded with great success. To date, 65 shafts/holings have been closed while 18 are in the construction phase, and a further 20 are in the design stage.

This additional work led to a change in the model of execution of rehabilitation projects. A dedicated project office was established in November 2018 and is now almost fully capacitated. All previously outsourced services, such as the design and management of projects, are now performed internally.





8.6 Reconciliation of allocations as per the Adjusted Estimates of National Expenditure

The reconciliation of all allocations as per the AENE and Mintek's budget is presented in Table 5.

Table 5: Reconciliation of allocations as per the AENE and Mintek's budget

State grant reconciliation	2020/2021 Forecast	2021/2022	2022/2023	2023/2024
CASH	427,998	439,191	450,679	444,885
Baseline Allocation	281,652	324,988	336,602	342,331
MTEF	146,346	114,203	114,077	102,554
Titaniferous Magnetite	22,282			
D&O	124,064	114,203	114,077	102,554
AVAILABLE FUNDS (excluding VAT)	372,172	381,905	391,895	386,857
Baseline Allocation	244,915	282,598	292,697	297,679
Operational	222,650	256,908	266,089	270,617
Сарех	22,265	25,691	26,609	27,062
MTEF	127,257	99,307	99,197	89,178
TiMag - Operations	8,953	0	0	0
TiMag - Capex	10,423	0	0	0
D&O	85,579	99,307	99,197	89,178
Total state grant funding	372,172	381,905	391,895	386,857
State grant research	244,915	282,598	292,697	297,679
Contract work	127,257	99,307	99,197	89,178




9. PERFORMANCE ASSESSMENT WEIGHTING

The 12 national outcomes contained in the "Guide to the Outcomes Approach" formed the starting platform for Mintek's planning process. The possible support and contribution that Mintek could make to each of the national outcomes was carefully considered. These were formulated into Mintek's strategic objectives. The weighting is presented in Table 6.

Table 6: Performance assessment weighting

Objectives	Weighting
Conduct relevant, applied research and technological innovation	35%
Foster industry establishment and expansion	30%
Developing a capable workforce	15%
Ensure financial sustainability	15%
Develop and maintain a world-class RDI infrastructure	5%

9.1 Planning process for 2020/21 to 2022/23

The planning process has been conducted in line with the National Treasury Guidelines. The Shareholder's Compact and Corporate Plan outline a set of annual corporate objectives, as well as priority research programmes that are at the core of Mintek's mandate. The set of KPIs that will be used to measure organisational performance is provided in Section 0 in an aggregated form. For the internal management control of the business, a more comprehensive set of indicators and Executive Committee priorities will apply and be used for regular internal reporting.

Management revised the corporate objectives and performance indicators for 2020/21 and discussed them during a series of engagements at all management levels of the organisation, as well as during engagements with all staff at divisional level. Various national documents and key legislation and policy instruments were taken into account during the planning process, including the following:

- a) The Mineral and Petroleum Resources Development Act - DMRE
- b) The Public Finance Management Act National Treasury
- c) The National Environment Management Act (NEMA)
 Department of Environmental Affairs, Forestry and Fisheries

- The Intellectual Property Rights from Publicly Financed Research and Development Act (IPR Act) – Department of Science and Innovation (DSI)
- e) The Occupational Health and Safety Act Department of Employment and Labour
- f) The Mine Health and Safety Act DMRE
- g) The Construction Industry Development Act Department of Public Works and Infrastructure
- h) The Ten-year Innovation Plan for South Africa DSI
- i) The Industrial Policy Action Plan (IPAP) 2016/17–2018/19 – Department of Trade and Industry

Mintek has identified five objectives supporting the 12 national outcomes.

These were cascaded into a larger number of activities with performance indicators that are based on the SMART criteria (specific, measurable, achievable, realistic and timely).

The mapping of national outcomes to activities per programme and performance indicator emerged as follows:





Table 7: Mapping of national outcomes to Mintek's objectives

National MTSF priority	Mintek's objectives	Policy alignment
Priority 2: Economic transformation and job creation	 Strategic Objective 1: Conduct relevant, applied research and technological innovation Strategic Objective 2: Foster industry establishment and expansion Both these objectives entail the mineral processing and beneficiation of South Africa's strategic minerals and metals such as the beneficiation of platinum for developing fuel-cell technologies and the beneficiation of nano gold particles to develop high-value diagnostic products for use in the pharmaceuticals industry. 	 Medium-term Strategic Framework (MTSF) NDP IPAP (2016/17–2018/19) Preferential Procurement Pol- icy Framework Act (PPPFA) Broad-based Black Economic Empowerment (B-BBEE) Act MPRDA Beneficiation Strategy
Priority 2: Economic transformation and job creation	Strategic Objective 2: Foster industry establishment and expansion This objective includes priority research programmes that are aimed at reviving sectors of the industries that have been struggling over the last few years, such as the ferro-alloy industry. Furthermore, there are numerous technologies and processes that Mintek will be commer- cialising to gold-mining companies in particular, to assist extending the life of mining operations. All of these inter- ventions will have a direct positive impact on employment.	 MTSF NDP IPAP (2016/17–2018/19) PPPFA B-BBEE Act MPRDA Beneficiation Strategy
Priority 1: Capable,ethical and developmental state	Strategic Objective 3: Develop a capable workforce This includes a robust human capital development pro- gramme, primarily targeting SET skills.	 MTSF NDP IPAP (2016/17–2018/19) DSI's Innovation Plan PPPFA B-BBEE Act MPRDA Beneficiation Strategy
Priority 2: Economic transformation and job creation	 Strategic Objective 1: Conduct relevant, applied research and technological innovation Strategic Objective 2: Foster industry establishment and expansion Both objectives entail Mintek developing technologies and originating patents, trademarks and other discoveries, which are protected in terms of the IPR Act. These technologies are transferred to industry in line with Mintek's mandate. 	 MTSF NDP IPAP (2016/17–2018/19) DSI's Innovation Plan IPR Act





The above Mintek objectives have been grouped using a balanced scorecard approach as shown below. Details of the scorecard, highlighting Mintek's strategic objectives, programmes, measures and indicators, follow in Section 10 and Appendix I.

Stakeholder perspective

- Conduct relevant, applied research and technological innovation
- Foster industry establishment and expansion
- Develop and maintain a world-class RDI infrastructure

Financial and internal business perspective

• Ensuring financial sustainability

Learning and growth perspective

• Develop a capable workforce





CORPORATE SCORECARD 10.

A comprehensive and balanced set of KPIs will be used to measure the health of the organisation, focusing on its core business of R&D, its capacity and capabilities as a research organisation, as well as its financial sustainability. The KPIs reflect outputs and outcomes of the work that will be done in the areas of RDI and technology development over a period of three years. We will be tracking and managing quarterly targets in the 2021/22 FY to ensure we establish a baseline before we elevate them in the 2022/23 Shareholder's Compact.

Table 8: Key performance indicators for 2021–2024

Strategic Outcome- Oriented Goal	Key performance indicators	Forecast ⁽¹⁾ 2020/21	Target 2021/22	Target 2022/23	Target 2023/24
	Number of journal papers	29	30	33	35
O and the st	Number of conference papers (2)	25	35	37	39
relevant,	Number of book chapters	7	5	5	6
applied research and	Number of books	1	1	1	1
technological	Number of invention disclosures	18	16	17	18
innovation	Number of new patents	5	4	4	4
	Number of new trademarks	4	6	6	7
	Number of new prototypes, processes and/or models demonstrated/ validated in a relevant environment	15	20	21	22
Foster industry establishment	Income from the sale of products and services, royalties and licences (R million)	97.4	108.78	118.23	118.4
and expansion	Number of IP licences	0	1	1	1
	Number of certified reference materials (3)	n/a	6	6	7
	Number of accredited methods (3)	n/a	19	20	21
	Total number of SET employees	202	220	225	228
	Percentage of black SET staff	79%	80%	84%	88%
Develop a	Percentage of female SET staff	50%	52%	53%	53%
workforce	Total number of SET staff with doctoral degrees	45	55	58	61
	Percentage of SET staff with doctoral degrees	22%	25%	26%	27%

1. The forecast for 2020/21 is based on what Mintek anticipates achieving by the end of the financial year

2. Because of the COVID-19 pandemic, all conferences will be online 3. New KPI





Table 8: Key performance indicators for 2021–2024 (continued)

Strategic Outcome- Oriented Goal	Key performance indicators	Forecast ⁽¹⁾ 2020/21	Target 2021/22	Target 2022/23	Target 2023/24
	Total number of SET staff with master's degrees	63	70	73	73
	Percentage of SET staff with master's degrees	31%	32%	32%	33%
	Total number of SET staff at middle and senior levels (SP, MP and SE)	111	115	119	123
	% of black SET staff at middle and senior levels (SP, MP and SE)	72%	65%	68%	74%
	Total investment in plant, property and equipment (R million)	50.3	52.2	52.9	52.9
	Total investment in human capital (R million)	8.7	14	14.2	14.5
Develop and	Lost Time Injury Frequency Rate	<1	<1	<1	<1
world-class RDI	Client Satisfaction Rate	90%	90%	90%	90%
capacity	Number of accredited facilities ⁽³⁾	n/a	5	5	5
	Safety, Health, Environment and Quality	Maintain accreditation	Maintain accreditation	Maintain accreditation	Maintain accreditation
	Total income (R million)	509	568.7	590.2	587.1
	Net result (R million)	-20.3	0.6	9.4	5.1
Ensure financial sustainability	Contract R&D income (R million)	9.7	14.7	15.5	16.3
	BEE spend as a percentage of procurement spend	80%	85%	90%	90%
	Audit opinion	Unqualified	Unqualified	Unqualified	Unqualified

The forecast for 2020/21 is based on what Mintek anticipates achieving by the end of the financial year
 Because of the COVID-19 pandemic, all conferences will be online
 New KPI





It is hereby recorded that the Corporate Scorecard, as presented in Section 10 above, has been accepted by the Shareholder.

Dated at Randburg on this the 26th day of February 2021.

AS WITNESSES: 2

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(Dr Vangward Mkosana: Chairperson of the Board of Mintek)

Dated at ______ on this the _____ day of _____ 2021.

AS WITNESSES:

(Mr Gwede Mantashe: Minister of Mineral Resources and Energy for and on behalf of the Republic of South Africa)

2.__

1._





APPENDIX I – PROGRAMME OBJECTIVES

PROGRAMME 1: ANALYTICAL SERVICES

The Analytical Service Division is one of the technical divisions integrated in Mintek's value chain to perform mineral composition (elemental analysis) of geological and metallurgical ores using advanced analytical techniques. The division has been operating uninterrupted under ISO 17025 accreditation for 25 years.

The division's new strategy to implement key research, development and innovation in the analytical services will unearth young talent, improve skills set and contribute output of high calibre through publications and promote knowledge transfer through training. The approach of research is in many folds: to add value to existing mineral processes at Mintek, to collaborate with key external stakeholders to support emerging markets in minerology related products.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective	Redesign analytical services to focus on establishing research activities to advance testing capabilities.
Objective statement	Create research and development facility to advance measurement capabilities of ASD and con- tribute to publications and scientific forums. Five programmes are proposed going forward, where research will be conducted by employees qualified with PhD and master's degrees. The aim is to increase the qualification profile of the division to seven PhDs and 10 master's degrees in the next three years, who will contribute to divisional outputs, e.g. publications (four journal papers in the next three years) in high-impact journals. One of the key focus will be to develop new and im- prove analytical methods thereby establishing collaboration with other divisions and universities to strengthen the research and development portfolio.
Baseline	This is a new focus area, which intends to increase the divisional output i.e. journal papers, patents etc. The division contributed one journal publication and there are four (4) PhDs and three (3) Masters employees.
GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective	Refine and maintain a strong focus on the core analytical sciences measurement capabilities of strategic commodities: rare earth industry, gold-mining industry, and ferrochrome and iron ore industries.
Objective statement	The division will increase its core analytical sciences measurement capabilities focusing on strate- gic commodities in order to support the establishment of rare earth industry etc. Continue to sup- port the ferrochrome and iron ore industries as part of minerals forensic programme in contributing to stop the illegal mining activities. An analysis of low gold tailings will allow for an extension of gold operations in the country. An accredited method for low gold tailings will be targeted under this programme in the next three years.
Baseline	The division has 13 accredited methods in the mining industry (PGM and gold), and will increase the scope of the rare earth analysis.
GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective 1	Grow the number of qualified SET employees in the division.
Objective statement	Establish a team that has a majority of employees with a minimum of an honours degree for both the commercial and the research units within the next three years to ensure high-quality outputs and a sustainable financial position. The key focus will be to upskill SET staff through integrated learning opportunities towards postgraduate degrees. In addition, to provide training opportunities to staff to develop their expertise in analysis field (e.g. courses such as measurement uncertainty, etc.
Baseline	There are currently 12 SET employees, of which only four have PhD degrees and four have master's degrees.





Objective 2	Establish new pipeline studentship/bursars/internship
Objective statement	Establish a new pipeline of student team that are studying towards Masters and PhD degrees in order to strengthen the research and development strategy within the next three years to ensure high-quality outputs.
Baseline	New initiative within the division
Objective 2	Establish new analytical services and products
Objective statement	Identify areas of opportunities and expand ASD services, including products that support Mintek strategy in generation of new business areas. Expanding of product range that ASD offers
Baseline	Most of the services offered by ASD, have not changed for over 15 years.
Objective 3	Improving Quality Data and Turn Around Time
Objective statement	The main aim is to improve on the division quality services thereby making sure the quality data issued by the division is excellence. To improve in the turn-around-time with the aim of retaining internal and external clients.
Baseline	Currently, the quality assurance of analytical data and turnaround time is not excellence.
GOAL 5	DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE
Objective	Actively participating in multi-disciplinary research (Cross-Cutting) to achieve world class RDI
Objective statement	Instigate a partnership with suppliers for instruments (Analytical Innovation Laboratory for mining) within the next three years to establish a new laboratory with loaned instruments at no cost for instruments and maintenance, with the continuous improvement of processes and opportunity to be the first laboratory to test its new technologies. Participate in research activities of multidisciplinary approach that involve other areas of expertise.
Baseline	Most of the key instruments and equipment are outdated, without recent efficient technologies – high repair frequency rate and downtimes – high maintenance cost and repair cost, causing delays and production losses. Currently, there is no intra- and interdisciplinary research collaboration with other Mintek's division researchers.





PROGRAMME 2: MINERALOGY

Mineralogy focuses on mineral characterisation to understand the processing behaviour of minerals, and ensure optimum recovery and grade in mineral beneficiation. The programme has identified a need for an effective approach in the minerals value chain, as ores become more complex and of low grade. New, more complex operations require the integrated and sophisticated use of current and future knowledge that will need to be developed to overcome technical, environmental or societal considerations; for example, when the excessive use of energy and water cannot be tolerated or permitted. Innovative and novel technologies, and the skills to utilise them to process lower-grade deposits can be developed. The mineralogical knowledge will be essential to the provision of minerals and metals for a sustainable world.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective 1	Mineral characterisation
Objective statement	To apply mineralogical characterisation and associated data, using appropriate tools and approaches to: -Allow efficient processing and extraction of value from ore bodies; -Mitigate environmental impact, and at the same time, realise value from waste of different types; -Build on existing characterisation capabilities through the application of characterisation tools to the construction sector, which makes use of industrial minerals.
Baseline	Currently not doing predictive work in geometallurgy programmes or environmental mitigation from commercial sources; No research yet for new markets.
Objective 2	Mineral Intelligence
Objective statement	To add value to mineralogical characterisation efforts through building of data analytics and geospatial modelling capabilities in line with the digital revolution. In this manner, the Division can move from data and information collation, towards insights derived from the information.
Baseline	Currently no data analytics capability; large datasets are being generated that require processing capability and extraction in a meaningful way.
Objective 3	Data management and analysis performance.
Objective statement	Organise mineralogical data from disparate sources into an integrated framework that allows efficient extraction of information on South African mineral resources.
Baseline	Mintek has amassed a wealth of data from different ores and ore types in any given commodity over many years. However, disparate datasets emanate from samples of different origins, and come from different sources (e.g. bulk mineralogy, as opposed to electron probe micro-analyser (EPMA) spot analyses). Furthermore, large datasets are being generated that require processing capabilities to enable storage and later extraction/interrogation in a meaningful way.
GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective	Mineral characterisation
Objective statement	The objective is to grow the existing industry by providing inputs for waste valorisation efforts and environmental impact mitigation.
Baseline	Only a few commercial projects address waste valorisation at present. AMD predictor needs demonstration in a relevant environment to promote uptake of mineralogy-based predictions on AMD kinetics.





GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective 1	Ensure that the programme has a transformed and diversified workforce.
Objective statement	Increase the number of SET employees to 14.
Baseline	There are currently 13 SET staff members in Mineralogy.
Objective 2	A skilled workforce with higher qualifications, doctoral degrees.
Objective statement	Increase the total number of SET staff members with doctoral degrees from 4 to 6.
Baseline	There are four (4) SET staff members with doctorates.
Objective 3	A skilled workforce with higher qualifications, master's degrees.
Objective statement	Increase the total number of SET staff members with master's degrees from 7 to 8.
Baseline	There are 7 staff members with master's degrees.
GOAL 4	FINANCIAL SUSTAINABILITY
Objective	Income from products and services and attract contract research revenue
Objective statement	Ensure that the division attracts and retains its clients to maintain a revenue of above R12.5 million per annum from products and services and R9 million from contract research
Decelies	The current commercial revenue for 2020/2021 is R10 million and for contract research is less the
Baseline	a million rand.
GOAL 5	a million rand. DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE
GOAL 5 Objective	a million rand. DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE To develop and grow the Division's existing infrastructure to ensure optimal use and value add to characterisation efforts
GOAL 5 Objective Objective statement	a million rand. DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE To develop and grow the Division's existing infrastructure to ensure optimal use and value add to characterisation efforts Mineralogy wishes to add value to current offerings, through: -automation of workflows, from sample preparation to sample and data management -enhanced connectivity and correlative workflows -development of interactive databasing -development of modelling capabilities for predictive work in line with 4IR principles





PROGRAMME 3: MINERAL PROCESSING

Mineral Processing contributes to the mining sector by conducting research, development and innovation in physical mineral upgrading processes and technology. It focuses on exploiting the physical properties of minerals for upgrading or concentration purposes. The overall aim in mineral processing is to maximise the value that can be derived from any raw material and any unexplored or sterile resource. This is achieved by means of laboratory and pilot plant studies to develop the most suitable plant configuration for existing operations and new projects or ore types. Mineral Processing's research goals are aimed at providing solutions for the preconcentration of commodities that are of the greatest economic and strategic importance to South Africa, notably precious, ferrous, energy, industrial and base metals, and rare earth elements.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective	Equipment improvement and development.
Objective statement	Develop and provide locally manufactured products and equipment to the mining industry to enhance the operational performance of mineral separation process plants.
Baseline	This is a new programme that will be launched in 2021. Technology is at TRL 4 (a bottom-driven cell prototype has been developed).
GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective 1	Revitalisation of the iron ore industry in South Africa.
Objective statement	The purpose is to grow and sustain the iron ore industry in South Africa through the evaluation of sterile resources (low-grade fine stockpiles and banded iron formations via unconventional process solutions) and to create a South African-based expertise network in the context of an existing fragmented value chain.
Baseline	In October 2019, Mineral Processing had discussions with ArcelorMittal South Africa to discuss areas of collaboration. It was decided that it should work with the primary ore producers and conduct research on their feed material. As a result of this arrangement, Assmang and Mintek signed a non-disclosure agreement. Assmang is mining the ore needed for research. Technology is still at TRL 3 (laboratory tests have been completed).
Objective 2	Processing of Platreef ores and developing new PGM and chromium resources.
Objective statement	Develop a unique approach with regard to flotation and downstream processing so as to maximise value extraction from new and historical PGM ore reserves, thus ensuring the sustainability of the industry. The overall aim of the proposed research programme is to enhance the quality of Platreef concentrates obtained from flotation circuits by improving the mass pull, grade and recovery relationship.
Baseline	Commercial test work has been conducted on Platreef ores where recovery and mass pulls were low. At the time, Mineral Processing did not have the required competency to process this type of ore. Fresh feed material has therefore been requested from Ivanhoe to be used as a feed in the research. Technology is at TRL 3.
GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective	Increase the level of qualification of SET staff members.
Objective statement	Accelerate the development of SET staff members to deliver applicable technologies and scientific outputs. Upskilling, training and skills transfer for SET staff within the division must be initiated. Mineral Processing must increase the total number of PhDs to four, and master's degrees to 10.
Baseline	Currently, there is one staff member with PhDs and seven with master's degrees. Two papers are currently being produced per year and one discovery is being made per year.





GOAL 4	ENSURE FINANCIAL SUSTAINABILITY
Objective	Increase the contribution of commercial projects to the overall revenue of Mineral Processing.
Objective statement	Provide high-quality research to the industry, thus contribute to making Mineral Processing finan- cially sustainable by offering process separation efficiency/optimisation services, e.g. flotation re- agent screening, locked cycle tests, spiral and shaking table tests.
Baseline	Mineral Processing's commercial revenue is currently R32 million per annum.
GOAL 5	DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE
Objective	Modelling and simulation.
Objective statement	Build and design solutions, including computational modelling, simulation and data analytics in the development of virtual prototypes and pilot-scale processes.
Baseline	The modelling and simulation of spiral circuits and Reflux classifier has been performed. Comminu- tion simulation tests are currently underway. Technology is still at TRL 3.





PROGRAMME 4: PYROMETALLURGY

The value proposition of Pyrometallurgy is to use research knowledge responsibly to maximise the value from extracted metals by providing sustainable, superior and practical technical solutions to complex pyrometallurgical challenges at a high value-to-cost ratio and transfer its technological expertise to support and grow sustainable metal production and adjacent industries in South Africa. In order to do this, RDI activities in the Pyrometallurgy programme have been consolidated into a number of objectives designed to maximise impact.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective 1	Unlock complex and low-grade ores to support the growth of the mining and metallurgical industry in South Africa.
Objective statement	Develop a sustainable, integrated process to extract iron, vanadium and titanium from South Afri- ca's Bushveld Complex and demonstrate the technology at pilot scale.
Baseline	Funding for the pilot demonstration of fluxless DC smelting via a five-year MTEF programme (R106 million), including about R35 million of capital investment. This is an integrated, modern operation with the ability to feed pre-reduced titanomagnetite. The project is completing the second year of the five-year programme.
Objective 2	Support and revive energy-intensive industries in South Africa.
Objective statement	Revive the declining manganese smelting capacity in South Africa by optimising the electrical energy consumption through the pre-heating of ores via alternative energy sources, including solar thermal heat.relationship.
Baseline	PreMa is funded by the Horizon 2020 programme of the European Union. It includes a capital investment in pilot equipment and human capital development. PreMa completed the first year of a three-year funding period with an overall amount of R37 million of funding.
Objective 3	Support and revive energy-intensive industries in South Africa.
Objective statement	Support and grow the chrome-smelting capacity in South Africa through the development of com- petitive and energy-efficient smelting technologies to address the declining smelting capacity in South Africa.
Baseline	Self-fluxing smelting technology for low-grade chrome patented and licensed.
Objective 4	Comprehensive utilisation of coal resources.
Objective statement	Developing the DC gasification technology to comprehensively use South Africa's coal resources, focusing on fine metallurgical grade coal and waste coal dumps to upgrade coal to synthetic natural gas for use as energy storage in support of the hydrogen economy.
Baseline	DC gasification patented.
Objective 5	Solar thermal applications in minerals processing (STAMP)
Objective statement	Integration of solar thermal heat in minerals processing to reduce the reliance on electrical energy to dry, heat or process materials prior to smelting and to apply solar thermal heat to the processing of low-melting metals.
Baseline	Reviewing of opportunities in low-temperature metallurgy such as zinc galvanizing Work package leader in European-Union-funded programme PreMa Organising Committee of HiTemp2 – conference on application of renewables





GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective 1	New industries: Establish a titanium metal manufacturing industry in South Africa.
Objective statement	Identify the potential opportunity in South Africa to establish a titanium metal production capacity with the view to supporting the manufacturing capacity to create a local manufacturing industry to leverage the titanium metal production capacity to produce titanium metal products from local resources.
Baseline	Review of industry and opportunities identified as a first stage to develop a value proposition and input in feasibility.
Objective 2	New industries: Establish a rare earth manufacturing industry in South Africa.
Objective statement	Commercialise the PyEarth [™] technology as a critical enabler to establish a rare earth metal pro- duction capacity in South Africa, including refining and metal production capacity.
Baseline	PyEarth [™] patented (PCT) and pre-feasibility study, journal paper and conference paper published. Funded via State Grant and part of larger programme for SACREF.
Objective 3	Valorisation of waste streams.
Objective statement	Establish a commercially viable business to process local metals arising from electronic waste through the commercialisation of the eWasteSmelt technology via a business incubation model to enable the co-processing of low-value cathode ray tubes.
Baseline	Technology tested at TRL 7 and partnership with commercial entity negotiated.
Objective 4	Foster the industry by extending the life of the South African gold mining industry.
Objective statement	Extend the life of gold producers through technologies, equipment supply and technical support to improve efficiencies and maximise the value and life-of-mine of gold industries.
Baseline	Minfurn200 has been commercialised.
GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective	Develop and maintain a world-class research team that delivers applicable science and tech- nology solutions to the mining and metals industry.
Objective statement	Develop a team of researchers that is able to deliver applicable technologies and scientific output at a SET ratio of three researchers per output by increasing the number of world-class researchers through development and recruitment over a three-year period.
Baseline	Four PhDs and six master's degrees Two journal papers per annum (base of 20 researchers) Five conference papers (from a baseline of 20 researchers) Three discoveries and one patent
GOAL 4	FINANCIAL SUSTAINABILITY
Objective 1	Offer high value-to-cost and diversified services to industry.
Objective statement	Develop new and digital services to support and grow the commercial revenue stream. Develop modelling capacity to support and grow business development for the division.
Baseline	One PhD modeller.
Objective 2	Increase revenue-earning capacity.
Objective statement	Appoint experienced senior researchers to increase revenue-earning capacity to build a SET capacity from four to ten senior researchers who are able to lead research teams.
Baseline	PhD baseline = 4





PROGRAMME 5: HYDROMETALLURGY

The Hydrometallurgy programme is a specialist set of techniques for obtaining metals from ores, using innovative solutions for complex hydrometallurgical and refining problems. The current focus areas of Hydrometallurgy are to leverage key technologies that have been developed over years of extensive research for maximum impact in the South African minerals and related industries, as well as to establish a relevant and sound technology and expertise base to be able to direct and drive developments in the industry going forward. In order to do this, RDI activities have been consolidated in a number of sub-programmes that are designed to drive maximum impact.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective 1	Revolutionise extractive metallurgy through cutting-edge design, process control and sup- port services by means of digital process twinning.
Objective statement	Stimulate sustainable project development in the mineral industry through rapid process design based on verified Digital Process Twins. This approach will also lead to the provision of better-in-formed and more rapidly completed feasibility studies, process implementation and commission-ing, as well as optimisation and support of the corresponding plants. A further benefit of the construction of Digital Twins is the generation of fundamental scientific or engineering insights that are likely to lead to further RDI outputs.
Baseline	The development of the technology framework and modelling philosophy that will form the basis for the Gemini Programme has been funded from a state grant (R1 604 000). This is the first year of the programme, which is expected to run over a 10 year period.
Objective 2	Incubate a South African high-technology industry.
Objective statement	Unlock the potential of a high-technology industry in South Africa by leveraging mineral wealth and metallurgical expertise to provide competitive access to technology-specific precursors.
Baseline	Three projects to develop and certify technology-specific precursors for the battery storage indus- try have been funded by a state grant (combined R1 871 000). All three projects are in their first year and will form the basis of targeted technology developments over the next five years.
Objective 3	Reduce the water footprint of metallurgical processes.
Objective statement	Minimise the water footprint of metallurgical processing through the integration of Digital Process Twins with in-depth knowledge of membrane separation mechanisms.
Baseline	A project to establish a membrane test facility has been funded from the divisional capital alloca- tion. A project to deepen the understanding of membrane separation mechanisms has been funded from Mintek's state grant allocation (R909 000). This is the first year of the programme, which is expected to run over a five year period, culminating in a process advisor software package.
GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective 1	New industries: Establish a rare earth production and manufacturing industry in South Africa.
Objective statement	Facilitate the establishment of a rare earth production and refining facility in South Africa by lever- aging Mintek's political influence and rare earth processing expertise.
Baseline	The current activity is funded from Mintek's state grant (R1 900 000) and comprises a facilitation initiative to bring all stakeholders together in the design and application of the Southern African Centralised Rare Earth Refinery (SACREF) concept. A project Steering Committee has been established, representing the major stakeholders such as Mintek, the Industrial Development Corporation, the National Radioactive Waste Disposal Institute, the Department of Trade and Industry, the South African Nuclear Energy Corporation and Tronox. A project charter has been drafted to govern the project. An application has been made for funding of R240 million from the MTEF for an integrated demonstration of the REE-processing technology for a centralised facility accepting ore from diverse sources. The main output of this programme is a credible business case for building a centralised REE production facility in South Africa.





Objective 2	Foster the industry by extending the life of the South African gold mining industry.
Objective statement	Extend the life of gold production through technologies, equipment supply and technical support that will reduce operating costs, improve efficiencies and maximise the value and life-of-mine of gold industries.
Baseline	Patented gold from carbon fines technology had been developed and piloted. A project to demon- strate the gold from carbon fines technology to transfer the technology had received state grant funding (R2 009 000). Industrial partners in both South Africa (GoldPlat) and Burkino Faso had been identified as vehicles to transfer this technology. Detailed process design is currently in progress. This is the first year of the technology transfer project.
Objective 3	Foster the industry by transferring cost-saving technologies to the industry.
Objective statement	Enhance the competitiveness of copper and cobalt producers through technologies, equipment supply and technical support to improve efficiencies and maximise the value of production.
Baseline	Patented magnesium oxide recycling technology has been developed and piloted. A project to demonstrate the magnesium oxide recycling technology in a relevant production environment had received state grant funding (R995 000). An industrial partner has been identified (Metorex). An agreement has been reached to test the technology at a copper cooperation in the DRC. This is the first year of the technology transfer project.
Objective 4	Foster the industry by transferring mining and process-impacted water treatment technolo- gy to the mining and related industries.
Objective statement	Lower the water footprint of mining and manufacturing industry processes by leveraging the SAVMIN [™] technology and know-how to provide a cost-competitive product to treat and re-use impacted water.
Baseline	Patented SAVMIN [™] technology has been tested and demonstrated to TRL 8. A Digital Twin as well as a front-end engineering datapack had been compiled for a SAVMIN [™] installation. State grant funding has been awarded to a project aimed at commercialising SAVMIN [™] (R3 million). This is the first year of the commercialisation project.
GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective	Develop and maintain a world-class research team tailored to the Hydrometallurgy value proposition.
Objective statement	Develop a team of researchers that is able to deliver applicable technologies and scientific output at an SET ratio of three researchers per output by increasing the number of world-class researchers through development and recruitment over a three-year period.
Baseline	Three PhDs and two master's degrees Two journal papers per annum (base of 12 researchers) Three book chapters per annum (base of 12 researchers) Four conference papers (from a baseline of 12 researchers) One discovery and three patents
GOAL 4	ENSURE FINANCIAL SUSTAINABILITY
Objective 1	Offer high value-to-cost and diversified services to industry.
Objective statement	Develop new and digital services to support and grow the commercial revenue stream. Develop modelling capacity to support and grow business development for the division.
Baseline	One PhD modeller.





Objective 2	Increase revenue-earning capacity.
Objective statement	Appoint experienced senior researchers to increase revenue-earning capacity to build a SET capacity from four to six senior researchers who are able to lead research teams.
Baseline	Two PhDs and two master's degrees
GOAL 3	DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE
Objective	Establish and maintain fit-for-purpose infrastructure.
Objective statement	Secure funding for a flexible and fully instrumented pilot plant facility for the verification of process models and staff development.
Baseline	Mintek-funded continuous POX pilot plant (R10 million) MTEF-funded automated solvent extraction pilot plant (R15 million) Mintek-funded membrane pilot-scale test rig (R2 million)





PROGRAMME 6: BIOTECHNOLOGY

Mintek's Biotechnology programme is a branch of extractive metallurgy, which describes biotechnological processes that involve interactions between microorganisms and metal-bearing minerals. Bioleaching and bioremediation are two of the most studied branches in this field and are employed worldwide at commercial scale. Bioleaching involves the use of naturally occurring microorganisms to recover gold, base metals and uranium from mineral ores, concentrates and a range of waste materials. It is a well-established programme of Mintek that is internationally recognised for the treatment of sulphide ores and concentrates bearing gold and base metals.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective	Build capacity to support innovation and technology development in the environmental sector.
Objective statement	In line with evolving industry dynamics which are increasingly being driven by the environmental, social and corporate governance (ESG) aspects of mining operations and the increasing push for the development and implementation of green technologies that are capable of delivering on energy, water and carbon efficiency targets, the division aims to increase its capability to provide technology solutions to the water, waste and energy sector as they are applied to the minerals industry.
Baseline	Development of a client-directed sustainable technology strategy for the Biotechnology Division. Produce value-added products from waste effluents, jointly funded by the Water Research Com- mission and Mintek.
GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective 1	Unlocking Value from South Africa's Precious Metals Mine Tailings by Heap Leach Technology
Objective statement	Commercialisation of heap leaching as a viable option for the treatment of small to large tonnages of South African precious metal bearing low-grade ores and waste rock.
Baseline	Concept of alkaline gold heap leach technology has been proven to treat sulphide refractory gold ore and waste rock through simultaneous sulphide oxidation and gold dissolution in the heap, elim- inating the need for neutralisation stages prior to gold cyanidation. Interest from commercial clients in treatment of PGM tailings using heap leaching. Discovery filed. PhD in progress.
Objective 2	Transfer of mining and process-impacted water treatment technology to the mining and related industries.
Objective statement	Demonstrate Mintek's biological sulphate reduction process (cloSURETM), for the treatment of mine effluent integrated with irrigation trials, at a coal-mine site to provide a sustainable solution for the treatment and re-use of mine-impacted water post-mine closure and enable the development of various business opportunities that will benefit local communities and medium- to large-scale agri-businesses.
Baseline	The technology has been piloted at a coal-mine site (400 l per day) and is currently being integrat- ed with irrigation trials. Detailed design of a 50 m3 per day plant is in progress in collaboration with a mining company and the plan is to build a demonstration scale plant at a mine site.
Objective 3	Recovery of valuable products from e-waste recycling
Objective statement	Partner with local recyclers, OEMs and funders to commercialise Mintek's hydrometallurgical pro- cess for the treatment of e-waste to enable the creation of a local recycling industry to recover valuable metals from e-waste instead of exporting the valuable fractions overseas.
Baseline	Processing of printed circuit boards at TRL 5. Discovery and trademark (ReMET) filed. Master's degree based on process development.





Objective 4	Upstream process interventions for improved management of mine tailings.
Objective statement	Explore opportunities for upstream interventions in the minerals processing and extractive met- allurgy value chain that will have major impacts on mine tailings management, by reducing the complexity and capital costs of tailings storage facilities, producing smaller quantities of tailings with less fines that are easier to dewater and manage, and ultimately reducing the risks associat- ed with the deposition of large volumes of mine tailings.
Baseline	Experience in geomechanical analysis of resources, mineral processing
GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective	Develop and maintain a world-class research team that provides innovative solutions to the mining and metallurgical industries with a strong emphasis on knowledge and technology transfer.
Objective statement	Develop a highly skilled team of researchers through the continued upskilling of staff and by creating collaborations and relationships with research institutes and universities locally and globally, which will lead to collaborative research programmes, the sharing of resources and the exposure of staff to world-class research opportunities.
Baseline	The skills base of the division is currently developed through support of one master's and two PhD candidates. The junior staff is being developed and mentored by senior technical staff. Four journal papers per year (base of 13 researchers) Six conference papers per year (base of 13 researchers) One discovery, a patent and one trademark
GOAL 4	ENSURE FINANCIAL SUSTAINABILITY
Objective	Increase revenue earning through offering high quality services to clients.
Objective statement	Increase revenue from commercial work and significantly expand contract research income.
Baseline	A number of long-term commercial and contract research projects have been secured from mining industries and funding agencies such as the Water Research Commission, DSI and Coaltech.
Objective	Increase marketing efforts
Objective statement	Increase visibility of BIO's products and services through marketing our capabilities more broadly and aggressively to potential clients locally and globally to ensure growth of the project pipeline.
Baseline	Large local and international network of potential collaborators, good relationship with engineering companies and consultants and an agent in Latin America to assist with marketing.
GOAL 5	DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE
Objective	Maintain fit-for-purpose infrastructure to support RDI and commercial opportunities.
Objective statement	 Secure funding for: i). Upgrading and increasing the capacity of the existing column facilities. ii). Investment in laboratory and piloting facilities related to the division's diversification into environmental technologies.
Baseline	Mintek-funded centrifuge and atomic adsorption spectrophotometer, updated geomechanical equipment





PROGRAMME 7: MEASUREMENT AND CONTROL

The Measurement and Control programme focuses on process control solutions and measurement instruments that deliver tangible and significant improvements in recovery, and reductions in reagent and energy usage to minerals processing plants and smelters all over the world. Areas of research for Measurement and Control are typically applied research, technology development and product development, which are at the latter stages of the TRL continuum. There has been a slight shift in emphasis from product-specific research to applied research, reflecting the change in strategy from developing purpose-specific products towards more generic technologies and tools that can be applied to a variety of processes and applications.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective 1	Product/application diversification.
Objective statement	Diversify Measurement and Control's portfolio of products/solutions through R&D (including solutions for spiral measurement and control, xanthate measurement, and solvent extraction measurement and control) by the end of 2025. Impact: Opens up completely new process units and markets for Measurement and Control's measurement and control systems.
Baseline	The existing portfolio consists of flotation control and optimisation, milling control and optimisation, furnace control, carbon concentration measurement and control, and cyanide concentration measurement and control.
Objective 2	Product differentiation.
Objective statement	Differentiate Measurement and Control's software products/control systems by coupling them with complementary instruments that unlock value (even if it is just perceived value). The success of this approach has been proven through Measurement and Control's collaboration with ProcessIQ, where a gadget (MillSlicer offered by ProcessIQ) was used as a "foot in the door" for marketing Measurement and Control's MillStar control system. The programme will first focus on the R&D of these methods, which will enable online particle size and peak air recovery measurements. These measurements will later be integrated with the control systems for milling and flotation optimisation, respectively. The online particle size measurement is expected to be ready by the end of 2024, whereas that of peak air recovery is expected to be ready by the end of 2022. The success of these measurements is highly dependent on repeatable and convincing evidence shown by long-term onsite test-work campaigns. Impact: More integrated and better differentiation of Measurement and Control's offerings to clients with the potential to lock out competition, and provide more comprehensive solutions to industry.
Baseline	Milling and flotation optimisations are only done with software-based products. This is similar to the competition's offering; hence there is no differentiation in the eyes of clients.
Objective 3	New research initiatives and areas.
Objective statement	Undertake research in the areas of the Fourth Industrial Revolution (4IR) and deep reinforcement learning, and strengthen innovation efforts in Measurement and Control by the end of 2025. Impact 1: Value creation and differentiation through 4IR. Impact 2: Stimulate early-stage innovation and creativity for R&D.
Baseline	Educational phase in the area of the 4IR. Innovation initiative is currently employed in Measurement and Control, with the aim to expand it to the rest of Mintek.
GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective 1	Improve production capacity.
Objective statement	Select alternative suppliers, at least two for each of the following aspects: production of circuit boards, assembly of instruments and manufacture of mechanical components by the end of 2021. Impact: Back-up supply and streamlined manufacturing to ensure the timeous delivery of products to industry through risk mitigation.
Baseline	Only one additional supplier, and none in one particular case, have currently been selected.





GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective 1	Increase staff capacity.
Objective statement	Ensure that Measurement and Control has sufficient capacity to execute R&D, manufacturing and commercial work by increasing the head count of suitably skilled SET employees to 23 persons (through recruitment, head-hunting, joint research and fast-tracking employees) by the end of 2022. Impact: Improve Measurement and Control's research profile to enable intensified R&D.
Baseline	Current baseline is 22 SET employees
Objective 2	Improve staff retention.
Objective statement	The objective of this programme is to retain and grow the skills base of existing staff. Much of the efforts will align with the Human Capital Development programme (furthering studies, professor-ships, career development plans, etc.) being formulated at corporate level. A distinct initiative by the division, as part of furthering studies, involves bursars completing the core modules of the University of Pretoria's honours course in Control Systems on a part-time basis as part of their Graduate Development Programme. This will bolster the confidence of new graduates and motivate them to remain in their present fields. Another initiative involves investigating options for alternative modes of employment, such as the establishment of satellite offices for staff planning to emigrate, or who have recently emigrated, to support project execution globally. The objective will be to establish what is possible, should the need arise. Impact: Retention of the relevant skills force to support industry and execute R&D to plan.
Baseline	Graduate Development Programme excludes an option of furthering studies. All staff are currently based in one office in Randburg.
GOAL 4	ENSURE FINANCIAL SUSTAINABILITY
Objective 1	Improve competitive advantage.
Objective statement	This programme is aimed at lowering the barrier to entry for Measurement and Control's products and services (by developing low-cost versions of equipment and designing attractive pricing models) by the end of 2023. Impact 1: Opening up new markets (particularly junior miners), and accelerating adoption and market penetration. Impact 2: Increased sales of new products. Impact 3: Stable and more predictable service support revenue.
Baseline	Junior miners struggle to justify investment to purchase Measurement and Control's instruments at the same price as that used by large mining companies. The current pricing model is an outright purchase of unbundled products (usually at high cost), with an optional service contract, resulting in ~R30 million in products and services sales.
Objective 2	Effective marketing.
Objective statement	Increase visibility of Measurement and Control's products and services (through targeted marketing efforts, conference publications, social media activity, website improvements, selection of agents, distributors and partners, negotiations with EPCM Holdings and system integrators, and dedicated business development roles). Impact: Maintain or increase revenue target in each financial year
Baseline	Revenue target in 2019 for products and service sales is R31.5 million
GOAL 5	DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE
Objective	Infrastructure development.
Objective statement	This programme evaluates equipment investment such as computer numerical control (CNC) machining and 3D printing for rapid prototyping, as well as maintaining and growing Mintek's workshop/laboratory infrastructure for faster, better quality and consistent output. Mintek also attends world-class mining exhibitions as part of technology demonstration and marketing. To maintain a world-leading position in the rapidly changing market environment, this programme aims to evaluate how technologies such as virtual reality/augmented reality/3D simulation can be featured in its demonstrations. Impact: Improved marketing, rapid prototyping, decreasing time to market on new products.
Baseline	Basic 3D printer (old technology) and entry-level CNC machines





PROGRAMME 8: ADVANCED MATERIALS

The Advanced Materials programme focuses on the RDI sub-programmes that are concerned with the end-use of metals in the mining, fabrication and manufacturing industries. Through the use of advanced process technologies, the programme produces high value-added products by deploying cross-cutting skills from various disciplines, ranging from chemical sciences, physics, materials science and engineering, and biochemistry, to chemical engineering. The focus areas through which these are attained are in physical metallurgy, catalysis, and nanotechnology. In physical metallurgy, the sectors of interest are the broader metals-related industries that require novel materials for application in conventional and extreme environments. Catalysis, on the other hand, finds special application in the hydrogen economy sector through the manufacture of fuel cells for various applications. Nanotechnology has a special focus for application in materials synthesis where these nano-enhanced and nano-enabled materials find application in health, and in water and wastewater technologies.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective 1	Publications in peer-reviewed journals, conference papers, book chapters and books. At higher TRL levels, these include inventions, patents, trade secrets and system demonstrations
Objective statement	The impact of the quality of publications and other technological outputs is demonstrated through the potential of the outputs to support Mintek's mandate to "foster the establishment and expan- sion of industries in the field of minerals and products derived therefrom". In order to achieve these objective, AMD will prioritize publishing in high impact journals. With regard to conferences, there will be a careful selection of highly regarded local and international conferences as a means of dissemination of its research progress. There will be a concerted commercialization of AMD's R&D outputs and outcomes through the following avenues: technology transfer to industry, licensing of technology, product manufacturing and provision of niche and specialized services to through contract research. The following key performance indicators will be used as a gauge of progress in this objective: For journals: 15 (from a base of 50 SET employees) For conference papers: = 15 (from a base of 50 SET employees) Book chapters to be factored in the score as paper equivalents Other indicators will include invention disclosures, patents and technology demonstrations.
Baseline	The current Advanced Materials baseline is 4.6 per SET employee per paper.
GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
GOAL 2 Objective 1	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION Develop a global hydrogen and platinum-based fuel-cell economy to promote platinum value addition.
GOAL 2 Objective 1 Objective statement	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION Develop a global hydrogen and platinum-based fuel-cell economy to promote platinum value addition. The ultimate objective is to incubate fuel cell manufacturing. Through this programme, Mintek seeks to increase the opportunities to commercialise its fuel cell intellectual property (IP) by considering and building capacity for fuel cell manufacturing along the entire fuel cell value chain of chain. The aim is to continue to expand RDI activities in catalyst production to include the scale-up of the current platinum alloy electrocatalysts and to accelerate RDI of the next generation of catalysts in order to ensure future competitiveness of its technologies. Concurrently in addressing this value chain will be fuel cell membrane electrode assembly (MEA) production that will include MEA catalysts ink development, MEA fabrication competency and other component technologies. In the medium to long term, this will be followed by incorporation into a fuel-cell stack to eventually produce a fuel-cell system. Some capability, such as MEA development, will be developed at Mintek, whereas other capabilities such as fuel cell stacks and systems will be achieved in partnership with industrial partners and other collaborators both locally and internationally.





Objective 2	Develop and manufacture high-value medical and diagnostic device products.
Objective statement	The main feature in achieving this objective is the incubation of medical diagnostics manufacturing. Currently through the beneficiation of local metals such as gold, especially gold on a nanometre scale, Mintek researches, develops and manufactures (on a pilot scale) point-of-care rapid diagnostic test (RDT) kits for human and animal diseases. Currently, the HIV/AIDS, Malaria, and Rift Valley Fever rapid diagnostic test kits are ready for manufacture for commercial exploitation as soon as they have cleared regulatory registration. In the short term (i.e. 2021/22), the HIV/AIDS, malaria and Rift Valley Fever rapid diagnostic test kits will be manufactured for commercialization. Included in this suite of products will be the COVID-19 antibody and antigen RDT kits that were accelerated for production after the unforeseen advent of the global COVID-19 pandemic. In the medium-to-long term (2022 and beyond), RDT kits for malaria surface-enhanced Raman spectroscopy and rapid diagnostic test for TB, cancer rapid and other zoonotic diseases will be added to the product suite. In parallel with these RDT kits production activities will be the establishments of RDI activities through the establishment of the Antigen/Antibody/Peptide production pillar which will support the Diagnostic Platform, as well as manufacture biomarkers for commercial sale to clients.
Baseline	Currently, three products are at TRL 9 (i.e. the HIV/AIDS, Malaria, Rift Valley Fever and COVID-19 rapid diagnostic test (RDT) kits), are ready to be manufactured for commercial exploitation after passing the required regulatory clearances.
GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective	Recruit and develop SET staff to improve capacity to deliver on strategic programmes.
Objective statement	Recruit at least eight (8) senior staff members across Advanced Materials' groups to lead and direct research and commercialisation/innovation. At least three junior SET employees are to be seconded to industry for experience enhancement. Two junior SET employees are to be mentored by senior academics to enhance their research experience. This is done in order to arrest the juniorisation of AMD's research staff and to augment AMD's skills to enhance its readiness to manufacture and commercialize its R&D outcomes
Baseline	The current staff, although sufficiently educated, lack the requisite industry and research experi- ence. There is a less than the critical number of senior and experienced researchers, inclusive of those with manufacturing and commercial experience.
GOAL 4	ENSURE FINANCIAL SUSTAINABILITY
Objective	Ensure financial sustainability through revenue diversification.
Objective statement	The Advanced Materials Division is to accelerate efforts to attract contract research revenue from local and international industry through contract research to reduce the percentage reliance of Contract Research funding to 65%. The division is to submit funding applications to other funding sources such as the European Union's Horizon 2020, US funding agencies and other local public funding agencies. Finally, Advanced Materials will seek to generate revenue from the sale of high-value manufactured products, such as the rapid diagnostic test (RDT) kits, nano-sized gold colloidal solution products, gold and platinum catalyst products and the sale of various specialized technical services to an array of academic and commercial clients.
Baseline	The division is currently highly dependent on 70% of its revenue from the DSI-funded programmes. This over-reliance on a single revenue source presents a high risk to the financial sustainability of the division. The revenue target comprising Science Vote, Contract Research and Products and Services is projected to be about R75 – R80M.
GOAL 5	DEVELOP AND MAINTAIN A WORLD-CLASS RDI INFRASTRUCTURE
Objective	Acquisition of new infrastructure, replacement and refurbishing of existing infrastructure to support strategic programmes.
Objective statement	Acquiring computational packages (modelling and simulation) to support all Advanced Materials' research programmes will include collaboration with the Centre for High-performance Computing, the acquisition of lithography equipment to support an ISO 3 research facility, and the refurbishment of the foundry thermo-mechanical treatment infrastructure.
Baseline	There is currently aging infrastructure that is costly to maintain and impacts negatively on productivity. In other areas, there is a lack of critical infrastructure to support existing strategic programmes.





PROGRAMME 9: SMALL-SCALE MINING

The Small-scale Mining and Beneficiation programmes focus on advancing the small-scale mining sector in South Africa. This sector is characterised by limited resources, primitive mining methods, a lack of understanding of mining laws, inefficient and unsafe processing methods and other developmental challenges. Mintek promotes the small-scale mining sector through minerals processing, focusing on extractive technology development, small-scale operational support, environmental matters and sustainability, formalisation and safer mining practices through training.

GOAL 1	CONDUCT RELEVANT, APPLIED RESEARCH AND TECHNOLOGICAL INNOVATION
Objective	Conduct cutting-edge R&D aimed at the small-scale mining sector.
Objective statement	This will entail the unpacking of the divisional pillars: DMRE Policy Framework, Incubation, Three Dimensional Printing, training and skills development. SSMB to assess the real impact of past and existing programmes of support to the ASM sector and draw lessons for the formation of a more wide-ranging programme of support to ASMs. In addition, identify suitable knowledge management and monitoring and evaluation systems, to be able to measure the effect of policy on ASM.
Baseline	Over the last five years, the division has produced six peer-reviewed journal articles compared to the preceding five-year period, where no peer-reviewed articles were produced.
GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective	Develop new and improve existing technologies to support the small-scale mining sector and the establishment of viable SMMEs.
Objective statement	This programme will also include intensifying activities that support the division's incubation pro- grammes to enhance the beneficiation of minerals to stimulate sustainable mining and beneficiation entrepreneurship. This will be done in partnership with internal and external stakeholders in iden- tified areas.
Baseline	The division successfully conducted five plant audits during 2018/19. These plants were processing different commodities: manganese, chrome and aggregates. The division can conduct this work in collaboration with other divisions of Mintek and external companies.
GOAL 3	DEVELOP A CAPABLE WORKFORCE
Objective	Create an innovation-focused performance culture.
Objective statement	Foster a culture of performance and innovation through learning and growth through the attainment of higher qualifications by the divisional staff members, with three staff members obtaining master's degrees and three staff members pursuing PhDs by 2025.
Baseline	The division currently has 20% of its staff members with higher qualifications: two with master's degrees. One graduate (in Metallurgical Engineering) has registered for his second year master's degree at the University of the Witwatersrand from January 2021.





GOAL 4	ENSURE FINANCIAL SUSTAINABILITY
Objective	Increase revenue streams from new and existing products and services.
Objective statement	Grow the revenue of the division from products and services (both new and existing) to reach a target of R14, 5 million by end of FY2022. The target will be reached through the sale of products and services that the division already has and from the development of new ones. In terms of programmes, the following is envisaged: <i>Training and skills development:</i> Enhancing the skills development and transfer initiatives by tapping into the know-how of the division. This would include training programmes that will be funded externally e.g. MQA. <i>DMRE Policy Framework:</i> The DMRE has developed an Artisanal and Small-Scale Mining Policy because; currently the MPRDA does not define ASM concepts and does not sufficiently cater for the artisanal mining industry. Small scale miners are virtually treated the same as large-scale miners in terms of environmental, water use, health and safety and financial provisioning requirements. SSMB Support Programme, as part of the mining sector, economic recovery plan will focus on the implementation of SSM Framework; forming partnerships with aligned departments and entities to leverage on their resources and experiences for maximum impact; widen reach by providing technical, social regulatory support for community based projects; as well as develop an artisanal and SSM policy. <i>Incubation:</i> Position SSMB for uplifting the ASM and SSM sector through incubation of SMMEs. <i>Three Dimensional Printing:</i> Jewellery and ceramics in association with Measurement and Control division at Mintek. This new revenue stream is expected to generate income in the FY 2023.
	International Funding: International research in the area of ASM together with mining community development has been conducted and funded for well over three decades. This area of research will continue to be conducted and funded globally especially in developing countries and those where ASM is rife and a means (even though dangerous) of livelihood. This as in the past poses an opportunity for the division to get involved in internationally funded programmes
Baseline	The current divisional projection for this financial year (2020/21) is around R4.38 million of commer- cial revenue. The division continues to take advantage of the existing beneficiation programmes that are mainly funded by the Mining Qualifications Authority (MQA).
GOAL 5	DEVELOP AND MAINTAIN WORLD-CLASS RDI INFRATSRUCTURE
Objective	Invest in cutting-edge mobile processing equipment.
Objective statement	Invest in additive manufacturing equipment and mobile equipment aimed introducing additional and alternatives in the manufacturing and beneficiation and processing for printing purposes.at the analysis of minerals, processing and environmental monitoring, and be fully equipped by 2025. The intention is to capacitate the division with all key equipment to generate quality results, introduce techniques such as laser melting and while enabling the small-scale mining operators in their operations. In collaboration with relevant divisions, metal printing for use in gold, platinum and other metals could be introduced. The procuring of 3D printing machines for prototype development, experiments and research will assist enhance the design and development of high quality prototypes.
Baseline	The division currently has a portable 3D printer that is used for ceramics (small components) and jewellery using wax casting processes.





PROGRAMME 10: MINERAL ECONOMICS

The Mineral Economics programme provides market insights and techno-economic analysis related to the extraction, processing, use, recycling and disposal of mineral commodities. As part of the programme, Mintek also undertakes market and sectoral analyses for external clients in the public and private sectors, and engages with government and research entities on issues pertaining to mineral beneficiation, resource management, renewable energy and electronic waste recycling. The bulk of the work over the next financial year will be on mineral economics and techno-economics data and analysis.

GOAL 2	FOSTER INDUSTRY ESTABLISHMENT AND EXPANSION
Objective	Provision of mineral economics and techno-economics data and analysis.
	Mineral Economics supports the development of minerals-based industries in South Africa and ex- tending the minerals-based value chain within and beyond the mining and minerals sector through the provision of relevant, high-impact mineral economic and techno-economic research, analysis and data, and policy guidance to clients within Mintek and in the private and public sector. Mineral Economics has identified the following priority areas for the division over the short to medium term: • The provision of commodity, project and operational data and analysis
	Mineral policy and strategy advisory services
Objective statement	Product and sectoral market research and analysis The deviate market of methods and tools to determine the communication startic of a product
Objective statement	• The development of methods and tools to determine the commercial potential of a product, idea or innovation
	Data analysis, complex modelling and simulation development
	Value addition will arise through the provision of specialist knowledge, expert systems, effective databases and the generation of concise, accurate and well-informed reports. Mineral Economics' differentiating factor, among others, is being able to understand the contribution and role it plays in the entire mining value chain and to offer its clients services that are tailored to their needs, with a quick turnaround time, while maintaining and delivering on its scope, as well as credible, visible and continuous customer engagement.
Baseline	Mineral Economics succeeded in securing two commercial projects per year prior to 2019/20. The aim is to increase this to eight over the medium term.
GOAL 3	DEVELOP A CAPABLE WORKFORCE
GOAL 3 Objective	DEVELOP A CAPABLE WORKFORCE Develop a capable Mineral Economics workforce.
GOAL 3 Objective Objective statement	Develop a capable Mineral Economics workforce. Support Mintek's goals to attract, develop and retain a globally competitive workforce, particularly in the fields of SET, with the requisite expertise and capabilities to drive and support rigorous research and analysis, specifically in the fields of mineral economics and techno-economic feasibility studies.
GOAL 3 Objective Objective statement Baseline	Develop a capable Mineral Economics workforce. Support Mintek's goals to attract, develop and retain a globally competitive workforce, particularly in the fields of SET, with the requisite expertise and capabilities to drive and support rigorous re- search and analysis, specifically in the fields of mineral economics and techno-economic feasibility studies. In the division, 95% of the staff members are currently in possession of a higher qualification: five with master's degrees. One staff member is pursuing a PhD and is expected to graduate in 2022. No additional master's or PhD qualifications are expected in the short term. Priority will rather be afforded to building capability in techno-economic feasibility assessments, data analysis, complex modelling and simulation development.
GOAL 3 Objective Objective statement Baseline GOAL 4	Develop a capable Mineral Economics workforce. Support Mintek's goals to attract, develop and retain a globally competitive workforce, particularly in the fields of SET, with the requisite expertise and capabilities to drive and support rigorous research and analysis, specifically in the fields of mineral economics and techno-economic feasibility studies. In the division, 95% of the staff members are currently in possession of a higher qualification: five with master's degrees. One staff member is pursuing a PhD and is expected to graduate in 2022. No additional master's or PhD qualifications are expected in the short term. Priority will rather be afforded to building capability in techno-economic feasibility assessments, data analysis, complex modelling and simulation development. ENSURE FINANCIAL SUSTAINABILITY
GOAL 3 Objective Objective statement Baseline GOAL 4 Objective	Develop a capable Mineral Economics workforce. Support Mintek's goals to attract, develop and retain a globally competitive workforce, particularly in the fields of SET, with the requisite expertise and capabilities to drive and support rigorous research and analysis, specifically in the fields of mineral economics and techno-economic feasibility studies. In the division, 95% of the staff members are currently in possession of a higher qualification: five with master's degrees. One staff member is pursuing a PhD and is expected to graduate in 2022. No additional master's or PhD qualifications are expected in the short term. Priority will rather be afforded to building capability in techno-economic feasibility assessments, data analysis, complex modelling and simulation development. ENSURE FINANCIAL SUSTAINABILITY Increase revenue streams from new and existing services.
GOAL 3 Objective Objective statement Baseline GOAL 4 Objective Objective statement	DEVELOP A CAPABLE WORKFORCE Develop a capable Mineral Economics workforce. Support Mintek's goals to attract, develop and retain a globally competitive workforce, particularly in the fields of SET, with the requisite expertise and capabilities to drive and support rigorous research and analysis, specifically in the fields of mineral economics and techno-economic feasibility studies. In the division, 95% of the staff members are currently in possession of a higher qualification: five with master's degrees. One staff member is pursuing a PhD and is expected to graduate in 2022. No additional master's or PhD qualifications are expected in the short term. Priority will rather be afforded to building capability in techno-economic feasibility assessments, data analysis, complex modelling and simulation development. ENSURE FINANCIAL SUSTAINABILITY Increase revenue streams from new and existing services. Maintain financial sustainability through the establishment of a pipeline of commercial projects and research collaborations.





APPENDIX II – MATERIALITY FRAMEWORK FOR 2021/22

1. PURPOSE

The purpose of the Materiality Framework is to record the level of and reasoning for the suggested levels of materiality for consideration by the Board and approval by the Executive Authority, as required. It outlines management's assessment of qualitative and quantitative materiality, taking cognisance of Mintek's existing framework of risks and controls. The Materiality Framework, as set out below, represents management's assessment of the potential impact of transactions and other events at Mintek on the presentation of financial information used for decision making by management, and other users of the financial statements.

Corporate accountability, in essence, requires companies to be accountable for their decisions and performance that have a potentially large impact on people, the environment or company value.

Materiality, as a concept, is therefore used to determine the materiality or significance of the issues to be reported by Mintek, as noted above.

2. BACKGROUND

Vision

The vision of Mintek is to be a leading partner in innovative mineral solutions.

Mission

Mintek is driven by a mission to lead research, development and innovation, utilising minerals to drive sustainable industry development and inclusive economic growth.

Strategic goals

Mintek's strategic goals are to:

- i) Conduct relevant, applied research and technological innovation
- ii) Foster industry establishment and expansion
- iii) Develop a capable workforce
- iv) Ensure financial sustainability
- v) Develop and maintain a world-class RDI infrastructure

3. SCOPE

The Materiality Framework is developed in accordance with Treasury Regulation 28.3.1, which requires that, for the purposes of materiality (sections 50(1), 55(2) and 66(1) of the PFMA) and significance (section 54(2) of the PFMA), the Accounting Authority must develop and agree on a framework of acceptable levels of materiality and significance with the relevant Executive Authority. This framework will be reviewed annually prior to the commencement of the financial year.

4. DEFINING 'MATERIAL' AND 'SIGNIFICANT'

The materiality concept states that financial information is material to the financial statements if it would change the opinion or view of a reasonable person. In other words, all important financial information that would sway the opinion of a financial statement user should be included in the financial statements.

International Accounting Standards (IAS 1), Presentation of Financial Statements, read together with South African Accounting Standards (SAAS 320.03), defines items as material "if they could, individually or collectively, influence the economic decisions of users taken on the basis of the financial statements. Materiality depends on the size and nature of the omission or misstatement judged in the surrounding circumstances. The size or nature of the item, or a combination of both, could be the determining factor."





Materiality can thus be either quantitative or qualitative, or both. Materiality is inherently subjective in nature and enables a company to measure and disclose only those transactions that are sufficiently large amounts to be of concern to the users of the financial statements.

'Significant' implies a higher level of importance than 'material'. A significant transaction impacts on Mintek as a whole. An occurrence may be material, but not necessarily significant, whereas any occurrence that is significant will be material, as it will have an impact on the fulfilment of Mintek's mandate as a public entity and its operative effectiveness.

In terms of Mintek's nature of business and extent of operations, a significant item is defined as one that exceeds the maximum monetary limit that Mintek's Chief Executive Officer (CEO) can authorise, in terms of Mintek's delegation of authority.

In the Mintek environment, the public nature of the funds that constitute a significant portion of Mintek's income necessitates a narrower definition of 'material' than merely being an influence on economic decisions. As such, therefore, the definition of 'material' transactions within Mintek will necessarily include any transactions that may have an impact on the presentation of the annual financial statements, as an accurate representation of the "full and proper records of the financial affairs" of Mintek, as required by Section 55(1) (a) of the PFMA.

Implications

An understanding and application of the concept of materiality helps to manage and be seen to be managing significant impacts and issues better. Matters that rise to the level of 'materiality' are those that require high-level, co-coordinated effort. Many other issues, while not material, will still be addressed and managed by the company, and need to be communicated to stakeholders – but in focused, targeted ways – not in the annual report.

With a full understanding of materiality and how it works, stakeholders should become better equipped to raise the issues that matter most to them.

5. DETERMINATION OF MATERIALITY - GUIDELINES APPLIED IN THE COMPUTATION OF MATERIALITY

Quantitative materiality can be based on a number of financial indicators of the type that is widely used and accepted in the accounting profession as a basis of calculating materiality.

The following table depicts acceptable basis used in the computation of materiality.

Basis	Acceptable ranges
Gross revenue/turnover	0.2–1 %
Net income	1–5 %
Total asset	1–2 %
Equity	0.5–2 %

5.1 Significance of indicators

The nature of Mintek is such that both the balance sheet and the income statement indicators are of significance. Mintek has significant assets and revenue streams – both are significant to the users of the financial information.

5.2 Stability of indicators

Gross revenue and total assets remained stable indicators for Mintek, despite the volatile economic conditions of recent years, and





considered during the mid-term review and a forecast would be made that appears to be indicative of the likely results for the year.

Net income should be disregarded as Mintek is not a profit-making institution, and there are fluctuations and many dependencies that influence this figure.

Mintek has historically used a rate of 0.3% in calculating the materiality level. This is within the range specified above 0.2–1% of gross revenue and provides a level that is acceptable both quantitatively and qualitatively.

5.3 Computation of materiality

Gross revenue:

The 2021/22 budget, as indicated in the Shareholder's Compact, will be used for the computation of materiality. The calculations are as follows:

Gross turnover: 0.3% of R568 653 000 = R1 705 959

Asset calculation: Use 1% of R860 893 000 (Quarter 3 of 2021 – total assets) = R8 608 930

Different levels can be set for different classes of transactions. Mintek has, however, decided to take a more conservative approach by using gross revenue and not assets as the basis for calculating materiality. The materiality level will cover all classes of transactions.

The materiality for the previous financial period was set at R1.5 million, representing the lower end of the range for gross revenue. Gross revenue/turnover includes 100% state grant allocation, revenue from contract research, and sales of products and services. The calculations above result in the materiality figure of R1.7 million. However, Mintek has decided to keep materiality at the same levels as in the previous financial period, mainly because the revenue is estimated to decline in the current economic climate. Therefore, the materiality for the current period will be kept at R1.5 million.

6. CONTROL ENVIRONMENT

The Board of Directors consists of independent non-executive members who are appointed by the Minister of Mineral Resources. The Audit and Risk Committee consists of some Board members and two independent non-Board members.

Mintek is managed by a CEO, assisted by four general managers, who – together – make up the Executive Management team. Mintek maintains a system of internal controls designed to provide reasonable assurance as to the integrity and reliability of its financial statements to safeguard its assets and minimise the risk of fraud. In terms of the Audit Committee Charter, the Audit and Risk Committee reviews the effectiveness of the system of internal controls.

A Risk Steering Committee assists in reviewing the risk management process and significant risks facing the organisation. In terms of the Risk Management Framework, this review is delegated to the CEO.

The internal audit function is established and operational. The performance of the internal audit function is subject to evaluation by the Audit and Risk Committee, in terms of the Audit and Risk Committee and Internal Audit charters. Additionally, the Audit and Risk Committee reviews and approves the Internal Audit Charter, internal audit plans and ongoing internal audit reports on the effectiveness of Mintek's internal controls.

Although Mintek is an entity within the DMRE, it is also accountable to the DSI for its R&D and technology-related activities. Strategic goals, which encompass economic, technical, social and environmental objectives determined by the government and DMRE, provide Mintek with a basis for evaluating its activities. These criteria are, therefore, also used in the assessment of significant risks facing Mintek.





6.1 Stakeholders

The primary stakeholders are DMRE and DSI.

Users of financial statements:

- i) Department of Mineral Resources and Energy
- ii) Department of Science and Innovation
- iii) National Treasury
- iv) Banking institutions
- v) South African Revenue Service
- vi) Suppliers and other creditors

7. QUANTITATIVE MATERIALITY

Materiality refers to the extent or nature of a misrepresentation and/or omission of financial information which, individually or collectively, can, in the light of surrounding circumstances, cause the judgment or decision of a reasonable person to be influenced by such misrepresentation and/or omission when making a decision on the basis of the said information.

In addition to the overall quantitative materiality determined, all transactional items exceeding R50 000 in value, which meet the necessary prerequisites for recognition as accruals at year-end, will be classified as such.

Items less than R50 000, which meet the criteria, will be considered on merit. Where it is too difficult to value small items, these will be regarded as immaterial. The overriding criteria, however, is that the aggregate of all such small items, individually judged to be immaterial, may not exceed 0.3% of gross revenue.

In addition, items that individually or collectively meet the definition of 'significant' or 'material', as defined earlier in this framework, will be considered separately for assessment of materiality and risk. The figure of R1.5 million, therefore, functions as a guideline to inform management in the overall consideration and management of risk.

8. QUALITATIVE MATERIALITY

Materiality is not merely related to the size of the entity and elements of the financial statements. Misstatements that are large individually or in aggregate may affect the reasonable user's judgement. Misstatements may also be material on qualitative grounds.

The following are some of the qualitative factors to be considered:

- i) Any breaches to procedures or processes required by legislation or regulation.
- ii) Transaction entered into that could result in reputation risk to Mintek.
- iii) Unusual transactions entered into that are not of a repetitive nature, as well as new ventures that Mintek has entered into. These are purely disclosed due to their nature and the knowledge that they could affect the decision of the users of the financial statements.
- iv) Any fraudulent and dishonest behaviour of officers or staff.





APPENDIX III – COST-CONTAINMENT PLAN

1. INTRODUCTION

The definition of cost containment is "the process of controlling the expenses required to operate an organisation or perform a project within pre-planned budgetary constraints." The cost-containment process is an important management function that helps keep costs down to only necessary and intended expenses in order to satisfy financial targets. Budget monitoring is performed on a regular basis to ensure that there is no excessive spend. Mintek's focus is to improve efficiencies through better utilisation of resources.

Accounting officers and accounting authorities are required, in terms of section 38(1)(c)(iii) and 51(1)(b)(iii) of the PFMA, to implement control measures to ensure that all expenditure in their respective institutions is necessary, appropriate, cost effective, recorded and reported, as prescribed by the relevant legislative framework.

In giving effect to this requirement, accounting officers and accounting authorities are responsible for ensuring that all employees are mindful of the current economic realities and the need to intensify efforts to improve efficiency in expenditure.

The Cost-containment Plan, as set in National Treasury Instruction/Circular No. 2 of 2016/17, issued on 30 September 2016, gives account of some of the measures that Mintek will continue to implement over the planning period.

2. BACKGROUND

Operational/discretionary expenditure reduced from 43% of total expenditure in 2012/13 to 36% in 2016/17. This was partly attributed to the cost-containment measures implemented over the years and other efficiencies.

The internal control environment was enhanced to identify excessive costs, such as detailed monthly management reports and the quotation-based sourcing of goods and services.

The effectiveness of controls is measured throughout the year by Internal Audit and annually by the Auditor-General. Mintek has also achieved a clean audit status for the last two years. Mintek has been implementing some cost-containment measures over the years. Some of those already implemented include the following:

- i) Energy-efficient lighting and use of natural gas to operate equipment.
- ii) Printing initiatives, which include double-sided, no-colour default on all printers
- iii) Energy monitoring
- iv) Oversight over catering expenses
- v) Utilisation of discount agreements such as the Purchasing Consortium (PURCO) and transversal contracts.
- vi) Freezing of vacant posts

3. SUPPLY CHAIN MANAGEMENT

Mintek maintains a turnkey supply chain management solution, where the procurement of goods and services is centralised. This ensures proper control and adherence to policies and procedures. Additional controls to curb wasteful expenditure include the following:

- i) Review of all requisitions above R10 000 by the Chief Financial Officer for validity and reasonability
- ii) Authorisation of all requisitions in terms of the delegation of authority
- iii) Thorough tender process for expenditure exceeding R500 000





1. AREAS FOR COST CONTAINMENT

Cost containment	Action		Metric	Responsible	Time frame
4.1 Reduce unnecessary expenditure on consultants	 Consultants to be limited to specialist services to increase of knowledge base. Limit expenditure to consultants who offer indepe advice. Ensure that, as part of the approval process, norm procurement processes are followed when consul services are required and that the criteria, as set c Cost-containment Measures Circular, are adhered 	ensure ndent nal Mintek Itant vut in the I to.	 Track, monitor and report: Number of specialist services consultants Number of consultants that offer independent advice Expenditure on the engagement of consultants Consultant appointments approved in terms of procurement processes 	Mintek divisional managers	Monthly/ quarterly/ annually
4.2 Reduce travel and accommoda- tion expenditure	 The requirements for travel should be assessed c basis and approved at the manager's discretion. Travel should be planned in advance, where possi timise cost savings. Travel options with various service providers shou sidered and the most cost-effective option selecte Discounts should be negotiated with third partie PURCO. Foreign travel may only be conducted as containe ternational Travel Plan. Where exceptions occur, t be approved by the CEO. 	on a needs ble, to op- id be con- s, such as s, such as ravel must	 Track, monitor and report: Approval of travel expenditure by managers Approval of travel in advance Whether travel options with various service providers are selected The value of travel-related discounts Foreign travel conducted in terms of the International Travel Plan 	Mintek divisional managers	Monthly/ quarterly/ annually
4.3 Reduce expenditure on catering and social events	 Expenditure controlled at managerial level with oversight. No catering for internal meetings except where this longer than five hours. Official engagements that are conducted for longe hours, such as training, meetings of the Board an committees, and conferences, may incur catering. Meetings with external customers at the discret manager. 	h financial ne meeting er than five ad its sub- costs. tion of the	 Track, monitor and report: Expenditure control at managerial level with financial oversight. Catering costs incurred for meetings that are no longer than five hours. Catering costs incurred for meetings that are longer than five hours. 	Mintek divisional managers	Monthly/ quarterly/ annually
4.4 Reduce expenditure on events, meetings and conferences	 Manager's discretion to be applied when approv tendance of local/foreign conferences and event availability and benefits to be considered when a are reviewed. The number of delegates attending such events considered and approved at the manager's discre 	ing the at- ts. Budget pplications should be tion.	 Track, monitor and report: Local conferences and events approved by managers. Budget availability and benefits analysis conducted when applications are re- viewed by managers. Approval of num- ber of delegates attending events, meet- ings and conferences. 	Mintek divisional managers	Monthly/ quarterly/ annually





APPENDIX IV – FRAUD PREVENTION PLAN

1. BACKGROUND

Mintek's Fraud Prevention Plan has been developed in compliance with section 27.2.1 of the Treasury Regulations. Mintek has adopted a Code of Conduct and Business Ethics Policy articulating the values and acceptable ethical standards to which all persons associated with Mintek are required to adhere. This notwithstanding, Mintek acknowledges that in today's business environment, fraud is prevalent and all business organisations are susceptible to the risk of fraud. In this regard, the purpose of the fraud prevention plan is to set out and reinforce Mintek's policy of zero tolerance towards fraud and corruption as well as management's commitment to combating all forms of fraud inherent in Mintek's operations.

The plan recognises basic fraud prevention initiatives within Mintek. Furthermore, it identifies key risks of fraud that will be addressed as these risks could jeopardise the successful implementation of the various components of the plan.

The plan is dynamic, and will continuously evolve as Mintek makes changes and improvements in its drive to promote ethics and prevent fraud.

2. GLOSSARY OF TERMS

Throughout this document, unless otherwise stated, the words in the first column below have the meanings stated opposite them in the second column (and cognate expressions shall bear corresponding meanings):

Abbreviation/Term	Meaning
"Cabinet"	Parliamentary Cabinet of the Republic of South Africa
"Code"	For Mintek staff members, as prescribed in the Mintek Code of Conduct and Business Ethics Policy
"Fraud and corruption"	 Includes, but is not limited to, the following legal definitions: i). Fraud, i.e. the unlawful and intentional making of a misrepresentation resulting in actual or potential prejudice to another ii). Theft, i.e. the unlawful and intentional misappropriation of another's property or property which is in his/her lawful possession, with the intention to deprive the owner of its rights permanently iii). Corruption, i.e. any conduct or behaviour where a person accepts or agrees to accept any gratification from another person, give or agree to give any other person any gratification in order to influence that person directly or indirectly to exercise his powers, duties or legal obligations in a manner which is illegal or amounts to abuse of position of authority. (The offences in respect of corrupt activities are defined in the Prevention and Combating of Corrupt Activities Act, 2004)
"Fraud Policy"	Fraud Risk and Whistle-blowing Policy
"Managers"	Includes all members of management and, where appropriate, supervisors
"PFMA"	The Public Finance Management Act (PFMA), 1999 (Act No. 1 of 1999)
"Plan"	Fraud Prevention Plan
"Protected Disclosures Act"	Protected Disclosures Act, Act 26 of 2000





3. APPROACH TO UPDATING THE PLAN

- 3.1 Mintek has a risk register/plan in place, which is updated on a regular basis. The plan was updated with the view of putting measures in place to mitigate the effects of the risks identified in the Risk Register.
- 3.2 The plan also incorporates principles contained in the Public Sector Anti-corruption Strategy dated January 2002, endorsed by Cabinet.
- 3.3 The Code and the Fraud Policy, as approved, forms an integral part of the Fraud Prevention Plan.
- 3.4 The fraud and corruption risks identified in the updating of the plan cannot be relied upon as an indication of the full spectrum of fraud and corruption risks facing Mintek, but rather as an indication of the type of risks.
- 3.5 The plan does not guarantee that Mintek will not be impacted on by incidents of fraud and corruption, but is intended to serve as an additional measure to assist in the limitation of fraud and corruption risk with a particular focus on creating awareness and promoting ethical business conduct.

4. COMPONENTS OF THE PLAN

The main principles of the plan are the following:

- a) Creating a culture that is intolerant to fraud and corruption
- b) Deterrence of fraud and corruption
- c) Preventing fraud and corruption, which cannot be deterred, e.g. misuse of internet, conducting private affairs during official hours, etc.
- d) Detection of fraud and corruption
- e) Investigating detected fraud and corruption
- f) Taking appropriate action against fraudsters and corrupt individuals, e.g. prosecution, disciplinary action, etc.
- g) Applying sanctions, which include redress in respect of financial losses

The objectives of the plan can be summarised as follows:

- a) Encouraging a culture within Mintek where all employees, the public and other stakeholders continuously behave ethically in their dealings with, or on behalf of Mintek
- b) Improving accountability, efficiency and effective administration within Mintek
- c) Improving the application of systems, policies, procedures and regulations
- d) Effectively managing aspects of Mintek that could facilitate fraud and corruption and allow these to go unnoticed or unreported
- e) Encouraging all employees and other stakeholders to strive towards the prevention and detection of fraud and corruption impacting on or having the potential to impact on Mintek's activities
- f) Encouraging all employees and stakeholders to report suspicions of fraudulent activities without fear of reprisals or recriminations
- g) Providing a focus point for the allocation of accountability and authority

The above is not intended to detract from the premise that all the components are equally essential for the successful realisation of the plan.

The components of the plan for Mintek are the following:

- a) The Code of Conduct and Business Ethics Policy in which the management of Mintek believes, and requires its employees to subscribe
- b) Mintek's systems, policies, procedures, rules and regulations
- c) The Disciplinary and Grievance Code
- d) Sound control environment
- e) Sound internal controls to prevent and detect fraud and corruption
- f) Physical and information security management
- g) Internal audit





- h) Ongoing risk assessment and management, which includes systems for fraud and corruption detection
- i) Reporting and monitoring allegations of fraud and corruption
- j) A fraud policy that includes the policy stance of Mintek on fraud and corruption and a response plan that incorporates steps for reporting, as well as the proper resolution of reported and detected incidents and allegations of fraud and corruption
- k) Creating awareness among employees, the public and other stakeholders (e.g. goods and service providers) through communication and education relating to relevant components of the plan, the code and the fraud policy
- I) Ongoing maintenance and review of the plan to ensure effective project management of its further implementation and maintenance

An illustration of the plan is contained in the figure below:



5. PREVENTING FRAUD AND CORRUPTION

5.1 Code of Conduct and Business Ethics

- 5.1.1 The ethical principles contained in the code are applicable to all employees of Mintek. Therefore, the Code forms part of Mintek's plan.
- 5.1.2 Processes and mechanisms to manage professional ethics are key to the fight against fraud and corruption. In line with the principles contained in the Public Sector Anti-corruption Strategy, Mintek will pursue the following additional steps to communicate the principles contained in the Code:
- a) A copy of the code will continue to be circulated to all employees and included in induction packs for new employees.
- b) Relevant aspects of the code will be included in further awareness presentations, training sessions and communication programmes to create awareness thereof among employees and other stakeholders. Further objectives of this training are as follows:
 - » Helping employees to understand the meaning of unethical behaviour (including harassment in any form) in line with Mintek's expectations
 - » Presenting case studies that will assist in developing behaviour to articulate and encourage attitudes and values that support ethical business conduct
 - » Helping employees to understand issues involved in making ethical judgements
 - » Communicating the implications of unethical behaviour and its impact for individuals, the workplace, professional relationships, Mintek as whole and external stakeholders, including the public
- 5.1.3 There is a system in place for the declaration of private business interests, actual or potential conflicts of interest by all employees. The Code of Conduct and Business Ethics is used as a guide regarding the acceptance and offering of business courtesies. The declaration of private business interests, actual or potential conflict of interest is done on SharePoint.





5.2 Mintek's systems, policies, procedures, rules and regulations

- 5.2.1 Mintek has a number of systems, policies, procedures, rules and regulations designed to ensure compliance with government legislation.
- 5.2.2 Mintek's management will ensure continuous awareness and knowledge of the relevant systems, policies, procedures, rules and regulations, including the requirements of the PFMA and the PPPFA, among its employees. Mintek will continue to develop clearly defined communication and training strategies to create awareness of existing and new policies and procedures to ensure that all employees are made aware of, and are adequately trained in the implementation of policies and procedures relevant to their duties and responsibilities, including the following:
 - a) Provisions for all employees to acknowledge, in writing, that they have read the policies and procedures applicable to theirduties, have undergone relevant training and/or are aware of these policies and procedures
 - b) The keeping of adequate records, which serve as proof that employees have been made aware of the policies and procedures relevant to their duties
 - c) The development and distribution of a regular communiqué outlining the importance of complying with policies and procedures and the implications for employees; for example, the taking of corrective action against offenders not complying with policies and procedures
- 5.2.3 A structured monitoring mechanism has been administrated for the keeping of proper records of the policies and procedures that are being updated, and of new policies and procedures that are being developed in order to set clear targets and monitor progress.
- 5.2.4 Mintek is committed to developing human resources systems, policies and procedures, which will incorporate the fraud and corruption prevention practices detailed below.
 - a) The administration of a system for transparent and merit-based hiring and promotion practices with objective standards to reduce the risk of nepotism and favouritism, both of which are damaging forms of fraud and corruption
 - b) Thorough pre-employment and the security clearance screening of candidates for sensitive positions. Mintek will verify at least the previous employment, qualifications, citizenship and criminal records of all persons before they are employed
 - c) Mintek recognises that, despite ongoing organisational and policy changes, for example employment equity policies, matching of competence to the job is extremely important. As part of its approach to the management of human resources, Mintek will continue to pursue steps to limit the risk of incompetent people being appointed.
- 5.2.5 Management must be held accountable for complying with, and implementing, Mintek's systems, policies, procedures, rules and regulations and for preventing fraud and corruption.
- 5.2.6 Mintek will also administrate a system with clear guidelines for the placing of prohibitions on individuals and restriction of entities found guilty of fraud and corruption against it.

Disciplinary and grievance code

- 5.2.7 The disciplinary and grievance code prescribes appropriate steps to be taken to resolve disciplinary matters.
- 5.2.8 Mintek recognises the fact that the consistent and efficient application of disciplinary measures is an integral component of effective fraud and corruption prevention. The following steps to expedite the consistent, efficient and speedy application of disciplinary measures will be initiated:
- 5.2.9 Where managers are found to be inconsistent and/or inefficient in the application of discipline, corrective action will be implemented.

Sound control environment

5.2.10 Mintek's Audit and Risk Committee significantly influences the fraud control environment, particularly by overseeing the tone at the top. This is done in the discharge of its duties in terms of the PFMA and Treasury Regulations. The Audit and Risk Committee systematically oversees and periodically reviews the internal controls established by the management of Mintek. Oversight extends to the following:




- a) Creating awareness among employees of conduct that is forbidden in terms of the disciplinary and grievance code. Where disciplinary standards are not adhered to, action will be taken against offenders.
- b) The ongoing training of managers in the application of disciplinary measures and the disciplinary process, and sustaining this training.
- c) Developing a system to facilitate the consistent application of disciplinary measures.
- d) Regularly monitoring and reviewing the application of discipline with the objective of improving weaknesses identified.
 - a) Risk management, including fraud risk management
 - b) Mechanisms for employees and all stakeholders to report fraud and corruption incidents
 - c) Reviewing policies and practices for detecting, reporting and preventing fraud and corruption, serious breaches of business conduct, and whistle-blowing procedures
 - d) Reviewing quarterly reports describing the nature, status and eventual resolution of alleged or suspected fraud
 - e) Reviewing the effectiveness and maintaining Mintek's systems of internal control, including internal financial control and business risk management
 - f) Reviewing the effectiveness of the system for monitoring compliance with laws and regulations and the results of management's investigation and follow-up (including disciplinary action) of any instances of non-compliance

Internal controls

5.2.11 This section of the plan relates to basic internal controls to prevent and detect fraud and corruption and the training of employees in internal control and the conducting of their day-to-day duties. Mintek's systems, policies, procedures, rules and regulations prescribe various controls, which, if effectively implemented, would limit the risk of fraud and corruption. These controls may be categorised as follows, it being recognised that the categories contain overlapping elements:

Prevention controls: These are divided into two sub-categories: authorisation and physical

Detection controls: These are divided into four categories: arithmetic and accounting, physical, supervision and management information

Segregation of duties: Separation of responsibilities, i.e. an internal control designed to prevent an error and fraud by ensuring that at least two individuals are responsible for the separate parts of any task.

Prevention controls

a) Authorisation:

- i) All transactions require authorisation or approval by an appropriate responsible person.
- ii) The limits for these authorisations are specified in Mintek's delegations of authority, as well as in various government prescripts.

b) Physical:

These controls are concerned mainly with the custody of assets and involve procedures and security measures designed to ensure that access to assets is limited to authorised personnel.

Detection controls

a) Arithmetic and accounting:

- i) These are basic controls within the recording function, which check that transactions to be recorded and processed have been authorised, that they are complete, and that they are correctly recorded and accurately processed.
- ii) Such controls include checking the arithmetical accuracy of records, the maintenance and checking of totals, reconciliations, control accounts and accounting for documents.

b) Physical:

- i) These controls relate to the security of records. They therefore underpin arithmetic and accounting controls.
- ii) Their similarity to preventive controls lies in the fact that these controls are also designed to limit access.

c) Supervision:

This control relates to supervision by responsible officials of day-to-day transactions and the recording thereof.

d) Management information:

- i) This relates to the review of management accounts and budgetary control.
- ii) These controls are normally exercised by management outside the day-to-day routine of the system.





Segregation of duties

- a) One of the primary means of control is the separation of those responsibilities or duties that would, if combined, enable one individual to record and process a complete transaction, thereby providing him or her with the opportunity to manipulate the transaction irregularly and commit fraud and corruption.
- b) Segregation of duties reduces the risk of intentional manipulation or error and increases the element of checking.
- c) Functions that should be separated include those of authorisation, execution, custody and recording, and in the case of computer-based accounting systems systems development and daily operations.
- d) Placed in context with fraud and corruption prevention, segregation of duties lies in separating either the authorisation or the custodial function from the checking function.
- 5.2.12 Mintek will continue to initiate steps to address the problem of lack of training, expertise and knowledge in systems, policies, procedures, rules and regulations to improve internal control. Areas of weakness will be identified during audits and risk assessments.
- 5.2.13 Furthermore, Mintek will continue to re-emphasise to all supervisors that consistent compliance by all employees with internal control is one of the fundamental controls in place to prevent fraud and corruption.
- 5.2.14 Where managers do not comply with basic internal controls, e.g. non-adherence to the delegation of authority limits, firm disciplinary action(s) will be considered.

Physical and information security

Physical security

5.2.15 Mintek will consider conducting a regular detailed review of the physical security arrangements at its offices and improve weaknesses identified. Specific focus areas will be physical security over infrastructure, assets and staff.

Information security

- 5.2.16 Mintek will ensure that all employees are sensitised on a regular basis to the fraud and corruption risks associated with information security and the utilisation of computer resources, in particular access control, and ensure that systems are developed to limit the risk of manipulation of computer data.
- 5.2.17 Regular communiqués will be forwarded to employees related to Mintek's security policy, with a particular emphasis on email and internet usage and the implications (e.g. disciplinary action) of abusing these and other computer-related facilities. Where employees are found to have infringed on prevailing policy in this regard, disciplinary action will be taken.
- 5.2.18 Regular reviews of information and computer security will also be considered. Weaknesses identified during these reviews will be addressed.





6. DETECTING AND INVESTIGATING FRAUD AND CORRUPTION

6.1 Internal Audit

- 6.1.1 Mintek recognises the fact that the positive support of all its managers for Internal Audit and its functions, speedy response to, and addressing queries raised by Internal Audit are vital to the success of the plan. Where managers are found to be slow in addressing internal control queries raised by Internal Audit, firm action will be taken.
- 6.1.2 Mintek will regularly re-emphasise to all managers that consistent compliance by employees with internal control is one of the fundamental controls in place to prevent fraud and corruption. Managers will be encouraged to recognise that internal control shortcomings identified during the course of audits are, in many instances, purely symptoms and that they should strive to identify and address the causes of these internal control weaknesses, in addition to addressing the control weaknesses.

6.2 Ongoing risk assessment and management

- 6.2.1 Acknowledging the fact that Mintek faces diverse business risks from both internal and external sources, Mintek is administrating an ongoing process of risk identification and risk management. This information will be used to assist management with the following:
 - a) Prioritising areas for attention and subsequently developing appropriate controls to limit the material risks identified
 - b) Enabling management to continually assess and update Mintek's risk profile (incorporating fraud and corruption risk)
- 6.2.2 Presentations to Mintek's employees will be conducted to ensure that they have a more detailed understanding of the fraud and corruption risks facing Mintek and the areas in which these risks exist, thus enhancing the prospect of detecting irregularities earlier.
- 6.2.3 Mintek will also consider performing specific fraud and corruption detection reviews in the following areas on a regular basis:
 - a) Asset and inventory management
 - b) Procurement/supply chain management
 - c) Conflicts of interest
 - d) Project management and maintenance
 - e) Contracts management
 - f) Fleet management
 - g) Compliance to delegations of authority
 - h) Budget control
 - i) Creditor payments
 - j) Revenue management
 - k) Payroll
 - I) Travel and subsistence
 - m) Human resources

This will include the conducting of presentations to managers and staff to ensure that they have a more detailed understanding of the fraud and corruption risks associated with these areas, thus also enhancing the prospect of detecting irregularities earlier.

6.3 Reporting and monitoring

- 6.3.1 Mintek has implemented a Fraud Hotline, which is controlled by an independent service provider and is intended to achieve the following:
 - a) Deter potential fraudsters and corrupt individuals by making all employees and other stakeholders aware that Mintek is not a soft target, as well as encouraging the participation of employees in supporting and making use of this facility
 - b) Raise the level of awareness that Mintek is serious about fraud and corruption
 - c) Detect incidents of fraud and corruption by encouraging whistle-blowers to report incidents that they witness
 - d) Assist Mintek to manage the requirements of the Protected Disclosures Act by creating an additional channel through which whistle-blowers can report irregularities that they witness or that come to their attention
 - e) Further assist Mintek in identifying areas of fraud and corruption risks so that preventive and detective controls can be appropriately improved or developed





- 6.3.2 Mintek has ensured that a fraud and corruption information system is developed for the following purposes:
 - a) Recording all allegations
 - b) Tracking progress of investigation of allegations
 - c) Facilitate the early identification of systemic weaknesses and recurring risks, and inform managers and employees of systemic weaknesses/risks
 - d) Provide feedback to employees and other whistle-blowers on the management of allegations

The Fraud Policy and Response Plan

- 6.3.3 A Fraud Policy, which contains Mintek's policy stance to fraud and corruption, as well as the response mechanisms in place to report, investigate and resolve incidents of fraud and corruption that impact on it, has been developed for Mintek.
- 6.3.4 The Fraud Policy will be circulated to all Mintek's employees and appropriate sections will be circulated to the public and providers of goods and services.
- 6.3.5 Fraud and corruption must be reported according to the provisions of the Fraud Policy.

7. FURTHER IMPLEMENTATION AND MAINTENANCE

7.1 Creating awareness

This component of the plan comprises two approaches: education and communication.

7.1.1 Education

The creation of awareness among employees is intended to address the following issues:

- a) Informing employees on an ongoing basis on what constitutes fraud and corruption
- b) Promoting Mintek's policies and national policies that must be adhered to
- c) Informing employees of fraud and corruption risks to enable understanding of specific risks to which Mintek may be exposed, thus enhancing the prospect of detecting irregularities earlier
- d) Encouraging employees to blow the whistle on fraud and corruption
- e) Employee awareness of the current legislative framework as it relates to fraud and corruption, and their obligations and rights should they blow the whistle on fraud and corruption, the nature of the witness protection system and the roles and responsibilities of existing anti-corruption institutions
- f) Inform employees of their obligations and rights in terms of the Access to Information Act

7.1.2 Communication

The objective of the communication approaches is to also create awareness among employees, the public and other stakeholders to facilitate a culture where all stakeholders strive to contribute towards making the plan a success, as well as for sustaining a positive, ethical culture within Mintek. This will increase the prospect of fraud and corruption being reported and improve Mintek's prevention and detection ability.





- 7.1.3 Communication strategies that will be considered by Mintek are the following:
 - a) Posters, newsletters, pamphlets and other publications to advertise the code and the fraud policy, aimed at employees, the public and other stakeholders
 - b) Screensavers on computers with appropriate anti-fraud and -corruption and pro-ethics messages
 - c) Attachments to tender invitation documents relating to Mintek's stance to fraud and corruption, where such irregularities can be reported and the actions that will be considered
 - d) Appropriate attachments to offers of employment and inclusion of appropriate items in induction and training programmes
 - e) Prudent terms in contracts signed with providers of goods and/or services relating to the offering of gifts to employees of Mintek
 - f) Ensuring that fraud and corruption prevention is a fixed agenda item in meetings
 - g) Signing declarations of commitment by all employees to the plan
 - h) Endorsements of correspondence directed at providers of goods and/or services with anti-fraud and -corruption and pro-ethics messages

7.2 Ongoing maintenance and review

- 7.2.1 The CEO will be responsible for ensuring the ongoing maintenance and review of the plan. This includes appointing appropriate officials to ensure that the following is done:
 - a) Reports of fraud and corruption received are evaluated and highlight areas of fraud and corruption risk within Mintek.
 - b) Fraud and corruption threats to Mintek are considered and recommendations to appropriate committees or management are made.
 - c) Criminal activities threatening Mintek are considered, and fraud and corruption prevention recommendations with regard to areas that should be examined are made.
 - d) Action taken to implement recommendations relating to incidents of fraud and corruption are monitored.
 - e) The code and the fraud policy are reviewed, and appropriate amendments are made.
 - f) The awareness programme, as necessary, is amended, and the changes are implemented.
 - g) Ongoing communication and implementation strategies are developed and implemented.
- 7.2.2 The plan will be reviewed as the risk profile of Mintek changes, while progress with the implementation of the various components will be reviewed regularly. In the latter regard, specific priorities stemming from the plan, actions to be taken, responsible persons and feedback dates relating to progress made will also be set.

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Mintek's Executive Management team

Board memberships	Graduate School of Technology Management (GSTM), University of Pretoria UJ Faculty of Engineering and Built Environment Industrial Advisory Board (FEBE IAB)	National Department of Economic Development, Public Service Commis- sion (Audit Committee), Mindev (Pty) Ltd	None
Areas of expertise	Research and develop- ment, technology and innovation manage- ment, strategy, leader- ship and management	Finance and auditing, general management	Pyrometallurgy, mineral processing and general management
Years of service at Mintek	2 year	12 years	29 years
Qualifications	BSc in Physics BSc in Mechanical Engineering MSc in Materials Engineering PhD in Materials Engi- neering	BCom BCom Hons (Auditing) MBA	BSc Hons MSc
Race	African	African	White
Gender	Male	Male	Male
Position	Chief Executive Officer	Chief Financial Officer	General Manager: Technology
Name	Molefi Motuku	Sakhi Simelane	Alan McKenzie







APPENDIX VI – RISK MANAGEMENT POLICY

1. LEGAL MANDATE

Mintek is classified in terms of the PFMA as a Schedule 3 public entity. The following sections of the PFMA are relevant to this Risk Management Policy:

Section	Description
49 (1)	Every public entity must have an authority which must be accountable for the purposes of this Act.
(2)	If the public entity has a board or other controlling body, that board or controlling body is the accounting authority for that entity.
51 (1)	An accounting authority for a public entity:
(a)	must ensure that public entity has and maintains:
(i)	effective, efficient and transparent systems of financial and risk management and internal controls;
(ii)	a system of internal audit under the control of an audit committee.
56 (1)	The accounting authority for a public entity may:
(a)	in writing delegate any of the powers entrusted or delegated to the accounting authority in terms of this Act to an official in that public entity.
(2)	A delegation or instruction to an official in terms of subsection (1):
(b)	may either be to a specific individual or to the holder of a specific post in the relevant public entity; and
(c)	does not divest the accounting authority of the delegated power or the performance of the assigned duty.

In terms of the above, the Mintek Board delegates the duties of risk management to the General Manager: Business Development, who will, hereafter, be referred to as the Risk Management Officer (RMO). A model for the governing structures responsible for the management of risk in Mintek is illustrated in Figure 1.





2. CORPORATE GOVERNANCE

Corporate governance is the system by which an organisation is directed and controlled at its most senior levels in order to achieve its objectives and meet the necessary standards of accountability, probity and openness.



Figure 1: Governing structure for the management of risk

Demand for improved corporate governance has grown over the last decade. This has led to a body of guidance on corporate governance, including risk management and internal control. A set of responsibilities must be established in order to cascade the governance requirements down into Mintek. These responsibilities cover the following:

- a) Establishing an appropriate accountability framework, which encompasses management structures and practices (leadership, committees, reporting arrangements, policies and strategies, etc.) within which the system of internal control can operate.
- b) Ensuring that the core and supporting processes are in place to produce the desired outcome (including a risk management process).
- c) Having the necessary capability (leadership, knowledgeable and skilled staff, and adequate financial and physical resources) to ensure that the processes and internal controls can work effectively.
- d) Regularly monitoring and reviewing the system of internal control.
- e) Ensuring proper communication and consultation at all levels within Mintek and with external stakeholders.
- f) Obtaining sufficient independent and objective assurance as to the robustness of Mintek's key processes.

The Board fully accepts its responsibility to discharge these governance obligations, including the management of risk. In order to deliver its accountability responsibilities, the Board has agreed on a Risk Management Policy that sets out its approach to risk management and the context for the system of internal control.

3. RISK IMPLEMENTATION PLAN

Mintek is encouraged to adopt well-managed risk taking. It therefore needs to have in place the skills, management arrangements and organisational structures to take advantage of opportunities to do things better and reduce the possibility of failing to achieve key objectives. This document defines Mintek's approach to risk and how risk management will be embedded into management processes to ensure that the key strategic risks are effectively managed.

Risk management needs to allow for the effective assessment and exploitation of opportunities, while also identifying what would prevent the organisation from achieving its objectives, and ensuring that it has procedures in place to minimise, or manage, those risks. Risk management therefore involves a planned and systematic approach to the identification, assessment and mitigation of the risks that could hinder the achievement of strategic objectives.





3.1 The role of the Risk Steering Committee

The RMO is responsible, on behalf of the Board, for ensuring that Mintek has an effective and operational system for managing risks. All types of high-level risk will be covered. The effectiveness of the system will be reviewed on a regular basis.

The RMO will constitute a Risk Steering Committee with the following members:

Chairperson (RMO) Chief Executive Officer General Manager: Finance General Manager: Technology General Manager: Research and Development Manager: Finance Manager: Human Resources Manager: Engineering Management Services Manager: Planning, Monitoring, Evaluation and Reporting Head: Security Head: Safety, Health, Environment and Quality

The Committee may, at its discretion, co-opt other participants with specialised knowledge or skills to attend any meeting.

The key activities of the Risk Steering Committee will be to do the following:

Identify the key strategic risks that would prevent the achievement of Mintek's objectives Assign ownership of specific identifiable risks Evaluate the significance of each risk Assess Mintek's risk appetite Identify suitable responses and mitigate actions to each risk Ensure that the internal control system helps manage the risks Regularly review the Risk Management Policy and the Risk Implementation Plan

Copies of the minutes of each meeting of the Risk Steering Committee, together with the latest version of the Risk Management Policy and the Risk Implementation Plan, will be submitted to the Audit and Risk Committee for discussion. Any comments received will be incorporated into the documents and submitted to the Mintek Board for approval.

Running in tandem with the Risk Steering Committee are Mintek's corporate quality, environmental and safety management programmes. Mintek has been certified as being compliant with ISO 9001: 2015, ISO 14001: 2015 and ISO 45001: 2018. The identification of technical risks, the implementation of appropriate risk mitigation measures, and continuous improvement is an integral part of these management programmes. Mintek is audited annually by external auditors, SGS South Africa (Pty) Ltd, who check for consistency, compliance and conformity with international standards.

A meeting of the Corporate Safety Committee is held four times a year, whereas the Corporate Quality and Corporate Environmental committees meet twice a year. The Chairman of these committees (the General Manager: Technology) is also a permanent member of the Risk Steering Committee, thereby ensuring effective communication between these bodies.

3.2 Critical success factors

In order to assess the adequacy and success of Mintek's approach to risk management, a number of critical success factors have been identified:

Senior management supports, owns and leads on risk management Risk management policies and the benefits of effective management are clearly communicated to all staff members The organisational culture supports well thought-through risk taking and innovation Management of risk is fully embedded in management processes and consistently applied Management of risk is closely linked to the achievement of objectives Risks associated with working with other organisations are assessed and managed Risks are actively monitored and regularly reviewed





3.3 Risk identification

A strategic approach to risk management depends on identifying risks against key organisational objectives. Operating within this framework helps ensure a consistent approach across the organisation and enables a clear structure to be established. Mintek's mandate is set out in the Mineral Technology Act (Act No. 30 of 1989), which is to serve the national interest through research, development and technology transfer, to promote mineral technology and to foster the establishment and expansion of industries in the field of minerals and products derived therefrom.

Mintek's vision is to be a global leader in mineral and metallurgical innovation.

Mintek's mission is to serve its stakeholders by adding value to the mineral sector through research, development and technology transfer, in support of national priorities and sustainable growth.

In order to support the mission, the Mintek Board will, from time to time, identify strategic objectives for the guidance of management. These strategic objectives will be expanded further into targeted activities to aid the identification of risks.

The strategic objectives and targeted activities will be listed in the Risk Implementation Plan. Mintek will identify the risks relevant to these targeted activities, which form the basis of Mintek's Risk Implementation Plan, and each risk is cross-referenced to one or more of these targeted activities.

3.4 Evaluating the significance of each risk

Mintek has followed the method outlined by National Treasury in its Final Risk Management Framework for the Public Sector for assessing the significance of each risk. The significance, or rating, of risk is a combination of impact multiplied by probability. A system of risk rating can be created by assessing the impact and probability of every risk on a 10-point scale. Such a system results in a 1-to-100 scale, where a score of 1 is indicative of an insignificant risk, and 100 would indicate a potentially catastrophic risk.

The best quantitative criterion for assessing risk is to calculate the financial value of the occurrence. This provides the guideline basis for the risk rating in the table below. However, sometimes there are consequences that cannot be quantitatively reduced to a financial value. Examples include major reputational setbacks, loss of life, decrease in staff morale, etc. All these consequences should be taken into account in determining the impact of the occurrence and corresponding risk rating – the economic impact is only one criterion. The following tables are to be used to assist management in quantifying the potential that a risk exposure may have on the organisation:

Rating	Title	Description of impact
9–10	Catastrophic/ fundamental	Disaster with the potential to significantly harm the business and is fundamental to the non-achievement of objectives.
7–8	Critical	Critical event that can be endured, but which may have a prolonged negative impact and extensive consequences.
5–6	Serious	Major events that can be managed, but require additional resources and management effort.
3–4	Significant	An event that can be managed under normal operating conditions.
1–2	Minor	Not worth worrying about.

Rating	Title	Description of impact
9–10	Almost certain	The event is expected to occur in most circumstances.
7–8	Likely	The event will probably occur in most circumstances.
5–6	Moderate	The event should occur at some time.
3–4	Unlikely	The event could occur at some time.
1–2	Rare	The event may occur in exceptional circumstances.





The economic impact of an identified risk includes both the direct cost of the event associated with the risk occurring (e.g. the cost of repairs after a fire) and the indirect costs that are a consequence of the event (e.g. the loss of production and income while the repairs are taking place).

Most of the risks in a business environment are controllable, so that the probability of a risk actually occurring is dependent upon the effectiveness of the control measures in place. Added value is therefore to be gained by estimating the probability of each risk before and after the implementation of suitable control measures, resulting in the assessed inherent and controlled risk.

The assessment of the potential impact of Mintek's risks and their associated probabilities are determined by the members of Mintek's Risk Steering Committee. The assessment process is designed to be as objective and quantitative as possible, but still contains a degree of judgement. Some risks will be connected to, or dependent upon, other risks. It is important to understand the relationships between risks so that they can be effectively prioritised. The table below places the risk rating in an economic framework:

Risk rating	Qualitative assessment	Economic assessment
70–100	Catastrophic	> R150 million
50–69	High	R60 million to R150 million
35–49	Medium-high	R20 million to R60 million
24–34	Medium	R7.5 million to R20 million
15–23	Low-medium	R1.5 million to R7.5 million
1–14	Low	< R1.5 million

All risks that are determined as having a rating in excess of 15 (greater than R1 million) will be identified and recorded for future monitoring and control, and are in line with Mintek's Materiality Framework.

Management's response to each risk

Having identified the key strategic risks, the Risk Steering Committee will consider the different ways that Mintek can respond to these risks. The responses will be recorded in the Risk Implementation Plan. The options for responses include the following:

Avoiding the risk by not starting the activity that creates exposure to the risk

Mitigating the risk through improvements to the control environment (risk treatment may include methods, procedures, applications, management systems and the use of appropriate resources that reduce the probability or possible severity of the risk) Transferring the risk exposure, usually to a third party better able to manage the risk, e.g. through insurance or outsourcing Exploiting the risk, where the risk exposure represents a potential missed or poorly realised opportunity Terminating the activity that gives rise to the intolerable risk Integrating some or all of the risk responses outlined above

3.5 Assigning ownership

Having identified the key strategic risks, the responsibility for managing them must be allocated. Whereas the CEO remains personally accountable for the organisation as a whole and for its risk management, a framework of senior-level delegation of the key risks is essential for effective risk management. The delegation of responsibility has been effected in the Risk Implementation Plan by assigning ownership of every risk element to an appropriate position in Mintek.

3.6 Risk appetite

The main focus of private-sector risk management is on maintaining and enhancing profitability. In contrast, the public sector focuses on the fulfilment of objectives and delivery of a beneficial outcome in the public interest. Mintek, as a Schedule 3 public entity, is positioned between the private and public sectors.

Mintek must adopt well-managed risk taking where it is likely to lead to improvements in service delivery. It is recognised that risk taking is essential if Mintek is to innovate and improve. Mintek's risk appetite is reflected in its strategic objectives. Its overall portfolio of risks must be balanced to ensure, as far as possible, that the mix of risks remains tolerable.





3.7 Control assurance sources

Having identified the key risks, Mintek then considered how to manage them to reduce their probability or impact, should they occur. The control assurance sources available to Mintek are listed below, and each identified risk in the Risk Implementation Plan is cross-referenced to one or more of these sources:

Internal audit Leç	gal compliance audits
ISO 9001 internal audits GM	1R(2) inspections
ISO 9001 external audits Wo	rkplace inspections
ISO 14001 internal audits IT S	Steering Committee reviews
ISO 14001 external audits SAI	P project steering committee
ISO 45001 internal audits Sec	curity audits
ISO 45001 external audits We	Ilness Committee reviews

4. SYSTEM OF INTERNAL CONTROL

A control is any action or procedure performed by management to increase the likelihood of activities achieving their objectives. In other words, control is a response to risk, either to contain the risk to an acceptable level or to increase the likelihood of a desirable outcome.

A system of internal control provides a framework for all processes and activities designed to give reasonable assurance regarding the achievement of objectives. Such systems should be designed to manage, rather than eliminate, the risk of failure. Controls are broken down into three categories:

Operational	Relating to the effective and efficient use of resources
Financial	Relating to the proper management and oversight of the organisation's finances, leading to the preparation of reliable published financial statements
Compliance	Relating to compliance with applicable laws and regulations

The CEO participates in the exercise of many of the key internal controls or, through participation in activities, sees evidence of their existence and operation. In addition, the CEO receives confirmation from the Council's general managers and others that the controls are working effectively.

5. MONITORING AND REVIEW

Because risk management is explicitly linked to the achievement of objectives, reporting will be embedded within the regular processes for reporting on Mintek's operating performance. The monitoring and reporting of risks are therefore linked to the operating plan and budget cycle.

The Risk Steering Committee will meet four times per year. The minutes of these meetings, and any review or update of any of the risk documentation, will be included in the pack of documents submitted to members of the Audit and Risk Committee and the Mintek Board at least two weeks prior to the date of the meeting.





6. ROLES AND RESPONSIBILITIES

6.1 The Board and Audit and Risk Committee

As the Accounting Authority in terms of the PFMA, the Board has a fundamental role in the management of risk. It will do the following:

Receive an opinion from the Audit and Risk Committee, which will include its review of the processes of risk management and internal control.

Consider risk issues as they affect Board decisions

Review key strategic risks that will be analysed annually alongside the Strategic Plan Periodically review risks as part of the monitoring of the annual Operating Plan

6.2 The Chief Executive Officer

The CEO remains ultimately accountable for the organisation and its management of risk. He must do the following:

Have a clear understanding and assessment of the risks that could prevent delivery of objectives Ensure that the organisation has effective risk management and control processes Be provided with assurance that the processes and key strategic risks are being effectively managed

As part of this process, the CEO must undertake an annual review of the effectiveness of the system of internal control, which will enable the appropriate statement to be made in Mintek's annual accounts.

6.3 Executive management

Mintek's general managers play a key role in facilitating the flow of information from the Board to staff and vice versa. They should do the following:

Report to the CEO on key strategic risks as and when necessary Discuss the findings of internal and external audits and implement changes as appropriate Take responsibility for the risks that relate to the objectives of their line management Ensure that all Board papers identify impacts on strategic risks Promote a consistent approach within Mintek with respect to risk management Act as mentors to all employees and promote a risk awareness culture

6.4 Risk Management Officer

The Risk Management Officer is responsible for the following:

Facilitating the identification of key strategic risks and control mechanisms Establishing and coordinating Mintek's action plan for implementing appropriate risk reduction management Integrating Mintek's ISO 9001, ISO 14001 and ISO 45001 quality, environmental and occupational health/safety management systems into the Risk Management Policy Promoting risk awareness and skills in risk assessment and reporting

6.5 All employees

All staff should be aware of, and understand, Mintek's Risk Management Policy, the policies on risk, and how these apply to their own roles and responsibilities. In particular, project managers need to understand and manage the risks relating to their activities and their impact on Mintek's key strategic risks.

Mintek's Risk Implementation Plan: An assessment of Mintek's major corporate and operational risks

Mintek has identified five strategic objectives to support its mission. These strategic objectives, in accordance with the requirements of the Risk Management Policy, have been expanded further into targeted activities to aid the identification of risks. Strategic Objective 1: Conduct relevant, applied research and technological innovation by pursuing a focused approach to research and technology development that emphasises high-impact scientific outputs and outcomes:

- Broaden Mintek's local and international marketing footprints)
- Improve interaction with key stakeholders, and develop suitable intervention strategies q
- Improve quality of service and response time ΰ

Strategic Objective 2: Foster industry establishment and the expansion of existing industries, including nascent, emerging, mature and declining industries, as well as new industries

- Identify and respond to the needs of Mintek's clients (public and private) with innovative technologies, services and products তি
- Create business opportunities for SMMEs Ð
- Where appropriate, leverage Mintek's technology into business opportunities via Mindev (Pty) Ltd. ¢

Strategic Objective 3: Develop a capable workforce that has the requisite skills, expertise and capabilities to drive and support rigorous scientific research and technological development in pursuit of Mintek's mandate of conducting research and fostering industry development and expansion. The workforce profile will reflect the demographic profile of South Africa

- Maintain effective safety and environmental programmes, and reduce Mintek's LTRFR to below 1
- Improve Mintek's succession and internal transformation processes ЭĈ
- Continual on-the-job training and multi-skilling

Strategic Objective 4: Ensure financial sustainability and secure Mintek's future by achieving a solid research portfolio that is funded through both private and public sources, and commercialise Mintek's technologies:

- Prudent financial management
- Implement effective financial control Ŷ
- Maintain the integrity of ICT and financial systems \subseteq

Strategic Objective 5: Develop and maintain a world-class RDI infrastructure that supports Mintek's research, technology innovation and the development of products and services that encourage industry growth and expansion:

- Protect and maintain returns from Mintek's Intellectual Property Ê
- Maintain the effectiveness of Mintek's technical assets and infrastructure Ê

Mintek will identify the risks relevant to these targeted activities. The strategic objectives and targeted activities will be listed in the Risk Implementation Plan. Further evaluation of these risks forms the basis of Mintek's Risk Implementation Plan, and each risk is cross-referenced to one or more of these targeted activities





Evaluating the significance of each risk

Mintek has followed the method outlined by National Treasury in its Final Risk Management Framework for the Public Sector for assessing the significance of each risk. The significance or rating of risk is a combination of impact multiplied by probability. A system of risk rating can be created by assessing the impact and probability of every risk on a 10-point scale. Such a system results in a 1-to-100 scale, where a score of 1 is indicative of an insignificant risk, and 100 would indicate a potentially catastrophic risk.

The following tables are to be used to assist management in quantifying the potential that a risk exposure may have on the organisation:

Rating	Title	Description of impact
9–10	Catastrophic/ fundamental	Disaster with the potential to significantly harm the business and is fundamental to the non-achievement of objectives.
7–8	Critical	Critical event that can be endured, but which may have a prolonged negative impact and extensive consequences.
5-6	Serious	Major events that can be managed, but require additional resources and management effort.
3-4	Significant	An event that can be managed under normal operating conditions.
1–2	Minor	Not worth worrying about.

Rating	Title	Description of impact
9–10	Almost certain	The event is expected to occur in most circumstances.
7–8	Likely	The event will probably occur in most circumstances.
5–6	Moderate	The event should occur at some time.
3-4	Unlikely	The event could occur at some time.
1-2	Rare	The event may occur in exceptional circumstances.

The economic impact of an identified risk includes both the direct cost of the event associated with the risk occurring (e.g. the cost of repairs after a fire) and the indirect costs that are a consequence of the event (e.g. the loss of production and income while the repairs are taking place)

Most of the risks in a business environment are controllable, so that the probability of a risk actually occurring is dependent upon the effectiveness of the control measures in place. Added value is therefore to be gained by estimating the probability of each risk before and after the implementation of suitable control measures, resulting in the assessed inherent and controlled risk. The assessment of the potential impact of Mintek's risks and their associated probabilities are determined by the members of Mintek's Risk Steering Committee. The upon, other risks. It is important to understand the relationships between risks so that they can be effectively prioritised. The table below places the risk rating in an economic assessment process is designed to be as objective and quantitative as possible, but still contains a degree of judgement. Some risks will be connected to, or dependent framework





Risk rating	Qualitative assessment	Economic assessment
)-100	Catastrophic	> R150 million
)-69	High	R60 million to R150 million
49	Medium-high	R20 million to R60 million
-34	Medium	R7.5 million to R20 million
-23	Low-medium	R1.5 million to R7.5 million
14	Low	< R1.5 million

All risks that are determined as having a rating in excess of 15 (greater than R1.5 million) will be identified and recorded for future monitoring and control. This is in line with Mintek's Materiality Framework.

Management response to each risk

Having identified the key strategic risks, the Risk Steering Committee will consider the different ways that Mintek can respond to these risks. The responses will be recorded in the Risk Implementation Plan. The options for responses include the following:

- a) Avoiding the risk by not starting the activity that creates exposure to the risk
- Mitigating the risk through improvements to the control environment (risk treatment may include methods, procedures, applications, management systems and the use of appropriate resources that reduce the probability or possible severity of the risk) â
- Transferring the risk exposure, usually to a third party better able to manage the risk, e.g. through insurance or outsourcing ΰ
- Exploiting the risk, where the risk exposure represents a potential missed or poorly realised opportunity ð
- e) Terminating the activity that gives rise to the intolerable risk
- f) Integrating some or all of the risk responses outlined above









	Dick			Before		Af	ter		Targeted activity	
è	classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	Probability	Briter AsiA		Present status of ris reduction measures	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	Control assurance
	Business Risk Executive Management Strategic Risk	Loss of commer- cial revenue Management response: Mitigate	 Ensure top-quality control of all products and services Timely delivery of all products and services - business focused project managers/ ness focused project managers/ chief investigators Ensure competitive pricing Good maintenance backup and/or after-sales cus- tomer care Adequate business planning Maximise alternative revenue streams Ensure adequate marketing, e.g. visits by Executive Management to various company CEOS, technology showcases, exhibition stands at identified confer- ences/events, place greater emphasis on Western African events in future Improved website needed and being looked at, cur- rent one is inadequate and compares poorly with websites of similar organisations Keep customers Focus should be on sharing resources, as well as where they are most needed where they are most needed Science Outer of Cluster discussions - focus on proj- ects that Mintek can really benefit from (short term) 	2 ∞		<u> </u>		Adequate	 d) Identify and respond to the needs of Mintek's clients (public and private) with innovative technologies, services and products i) Continual on-the-job training and multi-skilling c) Improve quality of service and response time k) Implement effective financial control 	 Internal Audit ISO 9001 internal audits ISO 9001 external audits
	Physical and Operational Risk GM: Technology Managers Head: Corporate SHEQ Operational Risk	Operational incident causes injuries, de building and equipment or loss of license to operate sched- uled processes Management response: Mitigate	 Procedures for storing, maintaining and handling flammable and explosive substances. Training of staff Training of staff Three-yearly fire risk assessments performed Hazop studies conducted Bag house and gas monitoring on stacks (at least one accredited check per campaign) Monitoring of interlocks and emergency shutdown devices, evacuation procedures and airline breathing system Safety-related inspections conducted Testing of systems before operation Implement electrical protection/tripping systems to client Installing protection networks on contractors to protecting and checking all oil breakers Servicing and checking all oil breakers Infrared assessments of high-tension switchgear 			6 	4	Adequate	 n) Maintain the effectiveness of Mintek's technical assets and infrastructure i) Continual on-the-job training and multi-skilling i) Maintain effective safety and environmental programmes i) Maintain the effectiveness of engineering solutions 	 ISO 45001 internal audits ISO 45001 external audits ISO 45001 external audits ISO 14001 internal audits ISO 14001 external audits Legal compliance audits GMR(2) inspections Workplace inspections Fire risk assessment





	Control assurance		Internal Audit	 Senior manage- ment 	Internal Audit
Targeted activity	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)		 h) Improve Mintek's succession and internal transformation processes i) Continual on-the-job training and multi-skilling 	 d) Identify and respond to the needs of Mintek's clients (public and private) with innovative technologies, services and products 	 j) Prudent financial management of Mintek's investments and liabilities k) Implement effective financial control
	Present status of risk reduction measures		Adequate	Adequate	Adequate
	Probability				Q
Afte	Impact				Q
	Risk rating		0 C	35	25
re	Probability				ω
Befo	Impact				û
	Risk rating		42	35	40
	Risk reduction measures	 A possible cause of explosions could be water leaks into a furnace. Various interlocks (fatal alarms, etc.) installed to monitor water flows, temperature, etc. Totally enclosed chlorine plant Regular checks and continuous improvement to ensure compliance with regulation procedures (including site evacuation) are in place Training of staff on emergency response and evacuation procedures (including site evacuation) are in place Improve internal fire equipment to supplement that of the Fire Department. 	 Constant monitoring of best-practice strategies for the attraction and retention of skilled personnel Annual performance appraisals conducted on all employees to identify necessary skills for accelerated development Coaching and mentoring programme Succession planning Benchmark salary scales against industry and comparable entities A more detailed exit interview process to determine the root cause reasons for staff resigning from Mintek Implement a number of initiatives on social media platforms to attract young talent to the organisation Continuous benchmarking and market analysis to inform internal strategies 	 Continuous monitoring of opportunities for funding Increased visibility of Mintek at National Treasury and DMRE specifically focusing on funding issues Continuous monitoring of departmental strategic plans and other notifications Participation in departmental task teams and strategy sessions to remain abreast of policy changes and emerging priorities 	 Comply to accurate and realistic budgeting and implementation thereof to prevent/minimise loss of profitability Designed ability to pass increased costs on to customers via change in rates/hariffs Proactive management accounting and variance/ trend analysis thereon Regular reviews of pricing policy for Mintek's prod- ucts and services undertaken Implementation of bi-annual review of workforce planning.
	Description of risk		Failure to attract and retain skilled personnel Management response: Mitigate	Changing gov- ernment policy and priorities Management re- sponse: Mitigate	Surge in operational costs Management re- sponse: Mitigate
Risk	classification Risk owner Risk category		Human Re- sources Risk Executive Management GM: Corpo- rate Services Managers Strategic Risk	Business Risk CEO Executive Management Strategic Risk	Financial Risk Executive Management Managers Strategic Risk
	öz				ښ





	Dick			Bef	ore		After			Targeted activity	
N	classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	Probability	Risk rating	Impact	Probability	Present status of risk reduction measures	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	Control assurance
			 Adequate business process analysis Monitor procurement/local content, assembly and fabrication 								
ശ്	Physical and Operational Risk GM: Technolo- gy Managers Head: Corpo- rate SHEQ Operational Risk	Employee expo- sure to hazardous substances Management re- sponse: Mitigate	 Entry medical, which may detect pre-existing conditions or identify possible problem areas, e.g. allergies to certain commodities Regular occupational hygiene surveys Extraction systems in use, flow rate checked annually Personal protective equipment issued to employees project Information Chart completed before commencement of project SHEQ briefings conducted Project Information Chart completed before commencement of project SHEQ briefings conducted Procedures and training on safe handling of hazard-us materials provided to employees working with hazardous materials Minimise volume of samples stored on Mintek site ment access control to hazardous materials Monthly site inspections to monitor sample volume and condition HazChem data sheets, made available to all SHEQ of officers and the project team Annual employee medicals and biological monitoring of enployees exposed to hazardous materials first aiders trained and available in areas where cyanide is used Job observations conducted 	6 2		2 4			Adequate) Continual on-the-job training and multi-skilling g) Maintain effective safety and environmental programmes	 ISO 45001 internal audits ISO 45001 external audits ISO 45001 external audits Legal compliance audit GMR(2) inspections Workplace inspections tions
Ň	Physical and Operational Risk GM: Technology Managers: SBU Corporate SHEQ Risk Risk	Spiillage of hazardous sub- stances, includ- ing radioactive substances Management re- sponse: Transfer	 Appointment of radiation protection officer to ensure that the transporting of radioactive material is done according to the regulations for the safe transport of radioactive material (International Atomic Energy Agency TS-R-1) Procedures, training and supervision of staff work- ing with hazardous solutions Mintek has the required insurance cover in cases where Mintek is held jointy liable with client Mintek only uses transporters approved by the DMRE. National Nuclear Regulator and Department of Health Emergency response plan developed to respond to accidents both at Mintek and outside of Mintek, e.g. accident associated with the transporting of radioactive material, which may give rise to a risk of spillage and possible nuclear exposure and/or damage Public communication procedure (emergency response procedure) developed to deal with communication aspects involved in the case of any spillages or gas releases affecting the public 	8	ω	4	ω	4	Adequate	k) Implement effective financial control trol (insurance) n) Relevant engineering controls that prevent spillages i) Continual on-the-job training and utti-stilling g) Maintain effective safety and envi- ronmental programmes	 ISO 45001 internal audits ISO 45001 external audits ISO 44001 internal audits ISO 14001 external audits Legal compliance audits NNR external audits
A	VII risks are ranked F	l according to the risk ⁻ or impact: 1 = Insigni	rating value. The risk rating is the product of impact and prob ificant: 10 = Catastrophic. For probability: 1 = Extremely unlike	ability. ⁻ Iv to oc	The sys cur: 10	tem of = Will	[:] risk ra most	ating is likely (based on assee occur. This syste	ssing the impact and probability of every m results in a 1-to-100 scale for the risk	y risk on a 10-point scale. crating.





All risks are ranked according to the risk rating value. The risk rating is the product of impact and probability. The system of risk rating is based on assessing the impact and probability of every risk on a 10-point scale. For impact: 1 = Insignificant; 10 = Catastrophic. For probability: 1 = Extremely unlikely to occur; 10 = Will most likely occur. This system results in a 1-to-100 scale for the risk rating.

ġ	Risk classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	e Brobability F	Risk rating	Impact A	Probability	Present status of risk reduction measures	Targeted activity (The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	Control assurance	
			 All work on radioactive material done in a designated area. Samples are kept in a physically secure area that will prevent unauthorised access and the unauthorised removal of such material. Work areas where there is a risk of spillages are situated north of bays. All drains in this area lead to the decantation ponds. Water from the decantation ponds gets treated in effluent plant before release to sever The stormwater drains, situated in the road that truns directly south of the bays, have been routed to the effluent treatment system to prevent hazardous material entering the sever Guideline document drawn up specifying the control and leaving Mintek Condition of vehicles entering the site is checked at the gate Vehicles must have the required signage 									
	Physical and Operational Risk GM: Technolo- gy Managers Head: Corpo- rate SHEQ Operational Risk	Employee expo- sure to hazardous substances Management re- sponse: Mitigate	 Next-generation firewall with intrusion prevention and detection system (IPS/IDS) No unsecured file shares allowed on servers. Hid- den and normal file shares allowed on servers. Hid- den and normal file shares have been implemented for all user shares ICT has implemented secure remote connection using a Secure Sockets Layer Virtual Private Net- work (SSL VPN) A fitering solution is implemented to review incom- ing email message content to determine spam ing email message content to determine spam Mintek laptops Firewalls are maintained and antivirus software kept up to date UST supplies to comply with security policies A document management system with strict control over access to Mintek IP, where required, is enforced Multi-level PC security is implemented to prevent unauthorised insider attacks. This is based on group security membership and user profiles Developed and implemented a frequent password change policy Back-up and disaster recovery processes in place 			2			Adequate	l) Maintain the integrity of ICT and financial systems	 IT Steering Committee reviews Internal Audit ISO 9001 internal audits ISO 9001 external audits 	
 	Product Risk GM: Technol- ogy	Non-compliance with foreign laws relatin for a safety, health and/or environment		42	<u>ں</u>	50		Q	Adequate	g) Maintain effective safety and environmental programmes	 ISO 14001 internal audits ISO 14001 external audits ISO 14001 external audits ISO 14001 external audits 	





Out of the state of t		Risk			Be	fore		Afte	ar.		Targeted activity	
Number Multiple	ġ	classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	Impact	Propability Bisk rating	Impact	Probability	Present status of risk reduction measures	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	Control assurance
Descent Bit Bit Bit Bit Bit Bit Bit Bit Bit Bi		Managers: SBU Head: Corpo- rate SHEQ Operational Risk	Non-compliance with foreign laws relating to safety, health and/or environment Management re- sponse: Mitigate	 When applicable for contracts in foreign countries, this will be handled on a project-specific basis. Project Information Chart prompts chief investigator tor to state whether foreign laws are applicable. If foreign laws are applicable, chief investigator will get the requirements from the client Client is made responsible for these items in the contract 	42		5			Adequate	g) Maintain effective safety and environmental programmes	 ISO 45001 internal audits ISO 45001 external audits Legal compliance audits ISO 9001 internal audits ISO 9001 external audits Legal compliance audits
Image: 1 Physical security measures in place, e.g. locked orors. biomatic access and recording system construint cacess and recording system services of tack-up tapes; back-up tapex; back-up tapes; back-up tapes; back-up tapex; back-up tapes; ba		Physical and Operational Risk GM: Finance Manager: Engineering and Main- tenance Services Operational Risk	Loss of external electrical power Management response: Mitigate	 Mintek has a 250kVA, a 350 kVA, a 500kVA, two 700kVA and a 750kVA power generators to ensure adequate emergency power to overcome events such as loss of power from City Power's infrastruc- ture, load shedding from Eskom, etc. Availability of gas to operate some equipment. SBU's emergency power requirements have been analysed. The outcome of this exercise provided information on Mintek's UPS and emergency gener- and configure an internal integrated emer- gency power grid to enable load distribution across all e-power plants 	35		30			Adequate	n) Maintain the effectiveness of Mint- ek's technical assets and infrastruc- ture	Routine inspections
		Physical and Operational Risk GM: Finance Head: ICT Operational Risk	Loss of server functionality. Management re- sponse: Mitigate	 Physical security measures in place, e.g. locked doors, biometric access and recording system Server room fire rated and gas-based fire-extinguishing (checked periodically) Baily back-ups of user and server data, off-site storage of backs-up tapes, back-up tapes tested on regular maintenance checks of server room infrastructure, e.g. air conditioning and UPS Hardware is readily available from vendors if serverland and gand UPS Developed and implemented IT disaster recovery process Developed and implemented IT disaster recovery process Berver virtualisation allows for automated migration of a server to another location SAP server run in a private cloud environment hosted in a secure Tier 3 data centre Exchange databases moved to three separate fast SCSI arrays to increase the speed and minimise the impact of hard drive failure. 	۵. پې		3			Adequate	 Maintain the integrity of IT and financial systems Maintain the effectiveness of Mintek's technical assets and infrastructure 	 IT Steering Committee reviews Internal Audit ISO 9001 internal audits ISO 9001 external audits Security audits Workplace inspections



No.

After

Before

Diek			Be	fore		Afte	-		Targeted activity	
classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	Impact	Propagility	Impact	Probability	Present status of risk reduction measures	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	Control assurance
Product Risk										
GM: Technology		 Ensure goods are adequately insured on a proj- ect specific basis. All-risk insurance required for 								
GM: R&D	Management re- sponse: Transfer	nign-value items, e.g. plant Mign-values policy provides some cover I imitation of liability clanses included in Mint-	40		20	4		Adequate	 k) Implement effective financial control 	 Internal Audit
Managers: SBU		intranet) of sale template (available on the intranet)								
Operational Risk										
Financial Risk	Volatility of									
GM: Finance	Mintek's liquidity ratio	 Increased effort to collect outstanding debt 							k) Implement effective financial con-	 Internal Audit
Manager: Finance	Management re- sponse: Mitigate	 Cash flow planning to increase investment returns Control over expenditure 	000	0	20	4		Adequate	01	
Strategic Risk										
Business Risk		 Annual Marketing Plan, which reviews the current market conditions and looks at possible areas of focus for commercial and state-funded research 								
Executive Management	Loss of revenue due to ineffective	 Work General managers to ensure that the individual divi- sions have adapting marketing plane in view of the 							 d) Identify and respond to the needs of Mintek's clients (public and private) with innovative technologies, services 	
GM: Business	markeung Management re- sponse: Mitigate	fact that they have direct responsibility to prevent missed business opportunities.	24		20	4		Adequate	and products a) Broaden Mintek's local and inter- pational marketing forthrints	 Internal Audit
Development	apoliae. Milligate	 Maintain regular contact with clients Attend appropriate events where Mintek can inter- 								
Strategic Risk		 act with clients and potential clients Improved visibility in areas that are not currently being serviced, but may have opportunities 								
Physical and Operational Risk		 Three-yearly fire risk assessments performed Procedures for proper storing, maintenance and 								 ISO 45001 internal audits
GM: Finance	Gas (flammable and inflammable)	 Bafety-related inspections LPG bulk tanks are protected by water sprays and 							n) Maintain the effectiveness of Mint- ek's technical assets and infrastruc-	 ISO 45001 external audits
Manager: r	storage and re- ticulation causes explosion	shut-off valves, which are checked and maintained by gas supplier on a yearly basis. Engineering and	50	0	20	10		Adequate	ure i) Continual on-the-job training and multi-skilling	Legal compliance audits
and Mainte- nance	Management re- sponse: Mitigate	 Maintenance betwees checks these on a monthing basis. Leak detection in the tunnels conducted weekly by 							 Maintain effective safety and envi- ronmental programmes 	 Workplace inspec- tions
Services		 Engineering and Maintenance Services A professional consultant has done an MHI and 								 Two-yearly gas
Head: Corprate		fault tree analysis. He has determined that the installation complies with MHI requirements.								reliculation inspec- tion

All risks are ranked according to the risk rating value. The risk rating is the product of impact and probability. The system of risk rating is based on assessing the impact and probability of every risk on a 10-point scale. For impact: 1 = Insignificant; 10 = Catastrophic. For probability: 1 = Extremely unlikely to occur; 10 = Will most likely occur. This system results in a 1-to-100 scale for the risk rating.



Head: Corprate





	Control assurance		 ISO 14001 internal audits ISO 14001 external audits ISO 45001 internal audits ISO 45001 external audits ISO 45001 external audits Legal compliance audit Internal Audit Compliance check-lists (Finance) 	 ISO 9001 internal audits ISO 9001 external audits ISO 14001 internal audits ISO 14001 external audits ISO 17025 internal audits ISO 17025 external audits ISO 45001 internal audits ISO 45001 external audits ISO 45001 external audits
Targeted activity	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)		k) Implement effective financial control g) Maintain effective safety and environmental programmes	 d) Identify and respond to the needs of Mintek's clients (public and private) with innovative technologies, services and products c) Improve quality of service an response time 1) Continual on-the-job training and multi-skilling n) Maintain the effectiveness of Mintek's technical assets and infrastructure g) Maintain effective safety and environmental programmes
	Present status of risk reduction measures		Adequate	Adequate
	Probability			σ
Aftei	Impact			۵
	Risk rating		2	0
ore	Probability		9	~
Befo	former vern		ω	α.
	paitor Joig		ŏ	ρ Έ
	Risk reduction measures	 Gas supplier did a risk assessment and Mintek is complying with all their requirements. Monthly safety inspections are done and recorded by Engineering and Maintenance Services. Maintenance and gas supplier does two-yearly inspections. The emergency response and evacuation procedures are officially tested at least three times a year, and the site evacuation is done once a year Site evacuation alarm installed Overall disaster response procedure developed 	 Database for Occupational Health and Safety, as well as environmental legislation, is available to Mintek staff. Database is kept updated with new or changed legislation – updates communicated to SHEO. Applicable new and updated legislation communicated to relevant divisions for implementation, e.g. Labour Act, NEMA, Occupational Health and Safety Act, PFMA, Mintek Act, Companies Act, Tax Act, etc. Mintek is subscribed to Sabinet Netlaw and gets updated when legislation is updated. Keep abreast of changes to the relevant legislation through training Employment of skilled personnel Legislation compliance software system implemented Project Information Mintek should comply with 	 Integrated SHEQ management system implement- ed SHEQ management system audited internally and externally against ISO 9001, ISO 14001, ISO 17025 and ISO 45001 requirements Regular internal audits and checking of system compliance. Audit reports submitted to divisional management Legal compliance audits done by third party to ensure Mintek's operations Regular management reviews by SHEQ Commit- tee to monitor, review and modify policies and procedures
	Description of risk		Non-compliance to applicable legislation Management re- sponse: Mitigate	Loss of SHEQ certification Management re- sponse: Mitigate
Risk	classification Risk owner Risk category	SHEQ Operational Risk	Business Risk Executive Management Managers Head: Corpo- rate SHEQ Operational Risk	Physical and Operational Risk GM: Technology Head: Corpo- rate SHEQ Managers Strategic Risk
	No.		<u><u><u></u><u></u><u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u><u></u></u></u></u>	<u> </u>

Mintek Shareholder's Compact | 2021/22





ording to the risk rating value. The risk rating is the product of impact and probability. The system of risk rating is based on assessing the impact and probability of every risk on a 10-point scale.	spact: 1 = Insignificant; 10 = Catastrophic. For probability: 1 = Extremely unlikely to occur; 10 = Will most likely occur. This system results in a 1-to-100 scale for the risk rating.
All risks are ranked according to the risk	For impact: 1 = Insigni

	Risk				Before		Af	ter		Targeted activity		
No.	classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	Impact	Probability	Risk rating	Inpact	Present status of r reduction measures	(The numbering refers to sk targeted activities assoo with Mintek's strategic obj as listed in the beginning document)	o the iated ectives, of this	Control assurance
												 GMR(2) inspections Workplace inspections
	Physical and Operational Risk											 ISO 45001 internal
	GM: Corporate Services	Destruction or	 Pyroshield fire extinguishing systems have been installed and are in operation. System is serviced 							 Maintain the integrity of IC financial systems m) Protect and maintain retu 	T and rns from	 audits ISO 45001 external audits ISO 9001 internal
18	Manager: Engineering and Maintenance Services	loss of privacal documents and records Management re- sponse: Mitigate	 every three months by external company. Archived material scanned into electronic format. If a fire destroys the hard copies, the electronic versions of the documents will still be available. This also allows for back-ups 	40	ω		6		Adequate	Mintek's Intellectual Property n) Maintain the effectiveness Mintek's technical assets anc infrastructure	_ d	 audits ISO 9001 external audits GMR(2) inspections Workplace inspections
	Manager: IAC Operational											 Legal compliance audits
	HISK Financial Risk	Impact of foreign	Proposals are quoted in rands whenever possible to provide the imposed of fluctuations on procure									
	GM: Finance	currency fluctu- ations	to prevent the impact or indituations on produre- ment and sales. • If managers do business in a foreign currency, they							k) Implement effective financ control	ial	
19.	Manager: Finance	Management re- sponse: Mitigate	must contact the Manager: Finance for the best exchange rate at that specific stage. This forms part of the pricing policy.	35			8		Adequate			 Internal Audit
	Strategic Risk		 Maintain an awareness of currency fluctuations in Mintek's exposure to particular currencies. 									
	Financial and Business Risk	Inadequate change control on ICT projects	 Clear identification of milestones and the monitor- 							k) Implement effective financi control		
20.	GM: Finance	Management response:	 Ing thereor by the project manager Change control process in place to prevent loss due to destabilisation of the business or technical 	30			8		Adequate	 Maintain the integrity of IC nancial systems 	T and fi-	Committee
	Head: ICT Strategic Risk	Mitigate	systems									
	Physical and Operational Risk	Danger to employees on Mitatoly cites	 Camera surveillance to cover major vulnerable areas Improve camera monitoring, security reaction times 									 Campus inspec- tions
21.	GM: Finance	arising from criminal activity Manadement	 and procedures Adequate security presence in high-risk areas Improve enforcement of access control 	24			18		Adequate	 Maintain effective safety a environmental programmes 	pu	Compliance with security audits
	Manager: Engineering	response: Mitigate	 Increase general staff and security staff awareness of risk Implement access control of parking area 									 Security Com- mittee

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	Risk			Bei	ore		After			Targeted activity	
ė	classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	Probability	Risk rating	Impact	Probability	Present status of risk reduction measures	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	Control assurance
	and Maintenance Services										
	Operational Risk										
	Business Risk										
	GM: Corporate Services		 Keep abreast of developments Reviewed strike management policy and procedure)) Continual on-the-iob training	
	Manager: Human Resource	Industrial action Management re- sponse: Mitigate	 Reviewed security procedure for industrial action Defined roles in dealing with media, police and public Developed communication strategy 	24		18			Adequate	and multi-skilling	 HR Committee Internal Audit
	Operational Risk										
	Financial Risk	Inadequate internal controls	 Review all internal controls, reporting systems and procedures on a regular basis 								
<u>v</u>	Executive Management	transactions.	 Clearly formalised powers and responsibilities and delegation thereof Fraud hotline available 	50 50	10	16			Adequate	 k) Implement effective financial control 	 Internal Audit
	Managers	sponse: Mitigate	 Fraud prevention and awareness programme Accounts payable procedure stipulates requirements for changes made to SAP master data, e.g. 								 Fraud hotline
	Fraud Risk		supplier bank details								
	Financial Risk		 Review and modify fixed assets standard operating procedure and policy, and monitor compliance Undertake asset audit, document and rectify all 								
	Executive Management	Inadequate asset management system	 anomalies Developed and implemented asset tagging system aligned to serial numbers of assets 	L		1				K) Implement enective innancial control Maintain the effectiveness of 	Asset verification
4	Managers	Management re- sponse: Mitigate	 Implementation of an electronic asset movement system 	35		16	4	4	Adequate	Mintek's technical assets and infrastructure	 Internal Audit
	Operational Risk		 Improved productivity from implementation of planned maintenance system Ensure effective procurement and utilisation of assets 								
	Product Risk	Consequential damage caused by Mintek	 Adequate quality control during manufacturing process Procedures and training of operators by chilef 								aller A learne that
	Executive Management	service, product or process, including penalty	 Subject products to the necessary certification/ 	45 9		16			Adequate	 c) Improve quality of service and re- 	 Internal Audit ISO 9001 internal audits
	Managers: SBU	and warrantee claims Management response:	 accreatization process Contracts and indemnity insurance Mintek's responsibility for consequential damages caused by Mintek products is specifically excluded 								 ISO 9001 external audits
		Transfer	in contracts signed with clients								
AII	l risks are ranked F(according to the risk r or impact: 1 = Insignifi	ating value. The risk rating is the product of impact and proba icant; 10 = Catastrophic. For probability: 1 = Extremely unlikel	ability. T ly to oc	he syst cur; 10	tem of = Will	risk ra most l	iting is ikely (s based on assess occur. This systen	sing the impact and probability of every ri results in a 1-to-100 scale for the risk ra	isk on a 10-point scale. ating.





	Control assurance		 Internal Audit ISO 9001 internal audits ISO 9001 external audits ISO 17025 internal audit ISO 17025 external audit Calibrations External test samples Supervision, proactive project management and clear communica- tion at all levels 	 ISO 9001 internal audits ISO 9001 external audits ISO 14001 internal audits ISO 14001 external audits ISO 14001 external audits GMR(2) inspections Workplace inspections
Targeted activity	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)		 d) Identify and respond to the needs of Mintek's clients (public and private) with linnovative technologies, services and products i) Continual on-the-job training and multi-skilling c) Improve quality of service and response time 	n) Maintain the effectiveness of Mint- ek's technical assets and infrastruc- ture
	Present status of risk reduction measures		Adequate	Adequate
L.	Probability			4
Afte	Impact			4
	Risk rating		9	Ő
ore				4
Bei	Risk rating		© Q	20 20 20
	Risk reduction measures	 Standard conditions of agreements in use Special conditions for agreements, which do not fit into the standard contract agreement, in use Limitation of liability clauses included in Mintek's conditions of sale template (available on the intranet) Where required, provided for warrantee. 	 Well-defined project scope/proposal discussed with the client and the project team Team meetings/briefings related to the project or product required at appropriate stages in the project. Clear communication with the client and team members Training, coaching and mentoring of team members as required and/or commissioning of systems before operation Calibration of testing/measurement equipment or analysers Internal control, repeat and duplicate samples in the laboratories. External assays for comparison if required. Project to submit own control/check/duplicate samples to laboratories without disclosure of this to the laboratories well developed and tested prior to market entry. Product after-sales support available at MAC 	 Mintek has a 250kVA, a 350 kVA, a 500kVA, two 700kVA, and a 750 kVA power generators to ensure adequate emergency power if, for example, the supply from transformer is lost. Availability of gas power for some equipment. Weekly maintenance checks on the emergency power generators. This includes running of all generators for 10-15 minutes. The cabiling has been upgraded to handle 7.9 MVA (main incoming supply from City Power) Those substations around Mintek that are fitted with low-voltage circuit breakers have been upgraded The substation switchgears have been upgraded from tues, oil and vacuum circuit breakers to ring main unit (RNU) gas switch gears SBU's emergency power requirements have been analysed. The outcome of this exercise provided information on Mintek's UPS and emergency gener- ator requirements.
	Description of risk		Loss of revenue due to poor quality of product and services Management response: Mitigate	Loss of internal electrical power Management re- sponse: Mitigate
Risk	classification Risk owner Risk category	Operational Risk	Business Risk Executive Management Strategic Risk	Physical and Operational Risk GM: Finance Manager: Engineering and Maintenance Services Operational Risk
	°N N		<u> </u>	27.





	Control assurance		 Internal Audit 			Internal AuditSecurity audits					audits	 ISO 14001 external audits Legal compliance audits 	
Targeted activity	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)		 Implement effective financial con- trol 			 k) Implement effective financial control 					n) Maintain the effectiveness of Mintek's technical assets and	infrastructure g) Maintain effective safety and environmental programmes	l
	Present status of risk reduction measures		Adequate			Adequate						Adequate	
	Probability												
Afte	Impact												
	Risk rating		Image: bit is a bit a										
e	Probability								Fraud Risk Prysical and Physical and Operational Risk Mintakes technical assets and diseal tank leaks Mintakes technical assets and mintakes technical assets and and mintakes technical assets and and mintakes Nintakes technical assets and mintakes technical assets and mintakes technical assets and mintakes technical assets and mintakes Nintakes technical assets and mintakes technical assets and mintakes mintakes Nintakes technical assets and mintakes mintakes Nintakes technical assets and mintakes mintakes Nintakes technical assets and mintakes mintakes Nintakes technical assets and mintakes Nintakes technical assets and mintakes Nintakes mintakes Nintakes mintakes<				
Risk rating Probability													
	Risk rating		20			20						20	
	Risk reduction measures	 A programme has been implemented in cases where Mintlek's power consumption nears the 7.9 MVA limit. Annual oil transformer oil test Planned quarterly load shedding to test operation of all generators 	 Ensure that payment of all creditors is within stipulated time frames Regular review of creditor age analysis Review all terms and conditions with approved suppliers - letters sent to all suppliers stipulating 	Mintek's requirements in terms of payments • Supplier evaluations • Regular review of procurement policy		 Use of specialised key safes where practical to prevent unauthorised access to certain areas Use of biometric access where practical in high-risk 	areas. e.g. server room, radioactive areas					 Monthly check on stock levels indicates whether there are leaks Overall emergency response procedure developed 	
	Description of risk		Loss of credit rating with sup- pliers	wariagement re- sponse: Mitigate		Poor key control Management re- sponse: Mitigate						dreser tarik reaks Management re- sponse: Mitigate	
Risk	classification Risk owner Risk category		Financial Risk GM: Finance Manager:	Operational Risk	Financial Risk	Manager: Engineering and Main- tenance Services	Managers	Head: Security	Fraud Risk	Physical and Operational Risk	GM: Finance	Manager: Engineering and Mainte- nance Services	Operational Risk
	<u>.</u>		 ∞			 						ö	



	Control assurance	 Internal Audit Security audits Security audits Internal Audit ISO 9001 internal audits ISO 9001 external 	 ISO 14001 internal audits ISO 14001 external audits ISO 45001 internal audits ISO 45001 external audits ISO 45001 external audits 	 Internal Audit
Targeted activity	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	 k) Implement effective financial control n) Maintain the effectiveness of Mintek's technical assets and nfrastructure 	k) Implement effective financial control	 k) Implement effective financial control h) Improve Mintek's succession and internal transformation processes
	Present status of risk reduction measures	Adequate	Adequate	Adequate
L	Probability	ى		က
Afte	Impact	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~		വ
	Risk rating	<u>2</u>	15	15
ore	Probability	ი 		م
Befo	former vein	<u>ب</u>		ω
	Risk reduction measures	 Security on site 24/7/365 Access control systems implemented Regular asset and stock counts Staff and vehicles searched upon leaving the premises Removal permits for items leaving the premises Removal permits for items leaving the premises Laptop computers have their own ID card linked to the authorised user Visitors sign in laptop computers upon entry and documentation shown on existing Mintek system Surveillance cameras installed 	 Developed and implemented a risk management framework Risks identified, categorised, impacts assessed and mitigation strategies thereof determined Risks reviewed quarterly 	 Understand the legislative requirements of the Broad-based Socio-economic Empowerment (B-BSEE) Charter for the South African mining industry B-BSEE) Charter for the South African mining industry Developed and implemented a B-BSEE strategy to prevent a low/poor rating Reviewed, modified and implemented procurement policy to align to B-BBEE scorecard to achieve accreditation Undertook a supplier audit to verify B-BBEE accreditation with focus on the preferred supplier list investigate new suppliers to achieve goal Ensure that Mintek attains its employment equity and skills development targets
	Description of risk	Theft or loss of physical assets and/or consum- ables Management re- sponse: Mitigate	Inadequate risk management Management re- sponse: Mitigate	Inadequate pace of transformation Management re- sponse: Mitigate
Risk	classification Risk owner Risk category	Financial Risk GM: Finance Manager: Engineering and Maintenance Services Services Head: Security Ananagement Risk CEO	GM: Business Development Risk Management Officer Strategic Risk	Business Risk Executive Management Managers Strategic Risk
	Š	<u> </u>	Š	č.

All risks are ranked according to the risk rating value. The risk rating is the product of impact and probability. The system of risk rating is based on assessing the impact and probability of every risk on a 10-point scale. For impact: 1 = Insignificant; 10 = Catastrophic. For probability: 1 = Extremely unlikely to occur; 10 = Will most likely occur. This system results in a 1-to-100 scale for the risk rating.





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	Rick			â	efore		Afi	ter		Targeted activity	
°N N	classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	Impact	Probability	Risk rating		Present status of risk reduction measures	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	Control assurance
	Physical and Operational Risk										 ISO 9001 internal
	GM: Finance		 Evaluate and update Mintek's carbon footprint annually Ensure that electricity is being used as effectively 								audits ISO 9001 external
č	Manager: MESU	High carbon footprint	as possible to reduce carbon footprint, arising from high electricity usage and prevent possible financial	oc		+ 	с и	4	Adomoto	 Maintain effective safety and envi- ronmental programmes 	 ISO 14001 internal audits
i de la companya de l	Manager: Engineering and Main- tenance Services	Management re- sponse: Mitigate	 Demonstrate that Mintek's R&D, which is resulting in direct electricity usage, focuses on technologies to reduce industry's electricity consumption, and that the net effect will be beneficial to the South African economy) N		-				 k) mplement effective financial con- trol 	 ISO 14001 external audits ISO 45001 internal audits ISO 45001 external audits audits
	Operational Risk										
	Financial Risk	Inadequate									
35.	Executive Management	overtime control Management	 Overtime policy implemented 	24	4				Adequate	 k) Implement effective financial control 	 Internal Audit
	Managers Fraud Risk	response: Mitigate									
	Financial Risk	Lack of sufficient controls on									
36.	Manager: Finance	goods received Management	 Reviewed and updated Procurement Policy and Standard Operating Procedure 	36	9				Adequate	k) implement enective mancial con- trol	 Internal Audit
	Fraud Risk	Mitigate									
	Human Resource Risk		 Controlled access of external parties to Mintek campus Controlled access to hazardous areas, work 								 ISO 45001 internal audits
	GM: Technology Managers	Fatality caused by Mintek opera- tions or plant	 permits issued, no-entry signs in plant areas, as appropriate, during plant operations Engineering controls on plant Induction and training of employees and contrac- 							 Continual on-the-job training and multi-skilling Maintain official on offici	 ISO 45001 external audits Legal compliance
37.	Head: Corporate SHFO	Management re- sponse: Mitigate	 tors on plant and operations Safety and health risk assessment conducted in the divisions Job observations done to ensure that training was 	24		+			Adequate	y maintain circons carety and circons ronmental programmes	 auolit GMR(2) inspections Workplace inspections
	Operational Risk		 adequate Mintek ensures that contractors provide a letter of good standing from the Compensation Commis- sioner. This ensures that the labour broker (if used) 								Internal Audit
AII	l risks are ranked ac	ccording to the risk r	ating value. The risk rating is the product of impact and proba	ability.	The sy	stem o	of risk	rating	is based on asses	sing the impact and probability of every r	isk on a 10-point scale.



ontrol assurance			IT Steering Com- mittee reviews Internal Audit ISO 9001 internal audits audits	Internal Audit Security auditst
Targeted activity	(The numbering refers to the largeted activities associated A Mintek's strategic objectives, is listed in the beginning of this document)		Alaintain the integrity of ICT and fi- cial systems continual on-the-job training and ti-skilling	Maintain the effectiveness of Mint-
	Present status of risk reduction wi measures a		Adequate	Adequate tur
	Probability			
After	Impact			
	Risk rating		<u>9</u>	Q
ø	Probability			9
Befor	Impact		ω	
	Risk rating		 ۵	20
	Risk reduction measures	 and contractor personnel can claim Workmen's Compensation via the companies officially employ- ing them In cases where a third-party claim (civil case) is made by someone injured on campus, man- agement has ensured that Mintek is adequately insured. Incorporated limited liability clauses in Mintek's general conditions of contract and conditions of service (for claims by people not employed by Mintek, but seriously injured, or from his/her family in the event of a fatality 	 Storage area network (SAN) in place with RAID configuration (disk redundancy) Back-up process in place. Daily incremental back-ups and weekly full tape back-ups done. Back-up tapes stored off-site Critical servers can be restored from two different sources (back-up tapes and Platespin Forge) The Disaster Recovery Plan implemented by ICT caters for business continuity of critical ICT services In-house IT skills developed, e.g. SAP basis and exchange SLA in place with SAP consulting company to ensure availability of required SAP basis and functional skills Staff redundancy where practical through training programme Relevant paper records and original contracts stored in an area fitted with gas-based fire-extinguishing system as a back-up where appropriate 	 Implemented database to record and control visitor access Electronic access control for employees CCTV at all gates CCTV at all gates ICT server room fitted with biometric access control sinentic access in place in controlled areas, e.g. radioactive laboratories Manual access control on secondary gates; these gates are only opened at specific times, at which time they are also guarded Additional lighting provided at critical areas and gates Patrols of fence, buildings and grounds Amed response linked to panic alert system PSIRA-rated security company used
	Description of risk		Loss of busi- ness-critical electronic data. Management re- sponse: Mitigate	Inadequate access control Management re- sponse: Mitigate
Risk	classification Risk owner Risk category		Physical and Operational Risk GM: Finance Head: ICT Operational Risk	Security Risk GM: Finance Manager: Engineering and Maintenance Services Head: Security Risk
	No.		ö	ő







Control assurance Internal Audit Board of Trustees 				 IT Steering Committee 			 Internal Audit 				 OHSAS 18001 internal audits OHSAS 18001 external audits Legal compliance 	 audit GMR(2) inspections Workplace inspec- 	tions	l	
Targeted activity	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	 Prudent financial management of Mintek's investments and liabilities 			 Maintain the integrity of ICT and financial systems Continual on-the-job training and multi-skilling 			 k) Implement effective financial control 				 Continual on-the-job training and multi-skilling Maintain effective safety and envi- 	ronmental programmes		
	Present status of risk reduction measures	Adequate			Adequate			Adequate				Adequate			
	Probability														
After	Impact														
	Risk rating	12			12			12				10			
ø	Probability	10													
Befor	Impact										10				
Risk rating		20			42			25				20			
	Risk reduction measures	 Keep abreast of developments Total cost to company packages aligned to the benefit as a defined contribution Capped liability for post-retirement medical aid funding by contracting liability to an external financial service provider 	 Liability settled for Group 1 and Group 2 employees 	Employ adoutately trained and qualified staff	 Enter into SLA with SAP partner for maintenance Skills transfer with retention clause Staff redundancy where practical through training 	 Opportunity to contract in skills 		 Clearly defined and communicated organisational structure Delenation of authority document annovad and 	communicated			 Mintek makes use of an approved health care waste disposing company Spillages of medical waste by the medical waste disposing company, e.g. in the case of a vehicle 	 accuent, is created up by trained personnet notified to Minitek is compliant with the Waste Classification Minitek is compliant with the Waste Classification and Management Regulations 		
	Description of risk	Non-compliance to Pension and Medical Aid Fund legislation	sporise. Mirigare	ack of canacity	to maintain busi- ness-critical ICT systems.	Management re- sponse: Mitigate		Non-compliance to the delegation of authority	Management re- sponse: Mitigate		Exposure to contaminated biological matter Management re- sponse: Mitigate				
Risk	classification Risk owner Risk category	Financial Risk GM: Finance Manager: Finance	Strategy Risk	Financial and Business Risk	GM: Finance Head: ICT	Manager: Hu- man Resource Development Strategy Risk	Financial Risk	Executive Management	Managers	Fraud Risk	Physical and Operational Risk	GM: Corporate Services and R&D	Head: Corpo- rate SHEQ	Clinic	Operational Risk
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 Risk classification Risk owner Risk category	Description of risk	Risk reduction measures	Risk rating	a finpact of	Risk rating	After After	Probability	Present status of risk reduction measures	Targeted activity (The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	Control assurance
Physical and Operational Risk GM: Technology Head: Corpo- rate SHEQ Manager: Engineering and Mainte- nance Services Operational Risk	Natural disasters, e.g. hallstorms, earthquakes Management re- sponse: Mitigate	 Emergency response and evacuation procedures available. Regular training and awareness of staff on emergency response and evacuation procedures. 						Adequate	n) Maintain the effectiveness of Mint- ek's technical assets and infrastruc- ture 9) Maintain effective safety and envi- ronmental programmes	 ISO 14001 internal and external audits
Financial Risk GM: Finance Manager: Finance Operational Risk	Client unable to complete payment for plant, product or process Management re- sponse: Mitigate	 Review debtors ageing report regularly. Seek legal advice on long-outstanding debts No services to be rendered until a credit rating has been obtained from credit burreau Have a policy and framework in relation to new and existing clients in relation to credit vetting, invoicing and collection Credit guarantees on foreign customers 	9 06					Adequate	k) Implement effective financial con- trol	 Internal Audit Management Committee
Physical and Operational Risk GM: Finance Manager: Engineering and Maintenance Services Operational Risk	Loss of water supply Management re- sponse: Mitigate	 Ultrasonic level detector has been installed at the water tower to indicate the level is low A technical review of Mintek's entire water reticulation system is being undertaken, which will focus on the reduction of Mintek's Fland Water Board water use, as well as minimising impacts of any future supply disruption 	90	en e	თ	с р	ო	Adequate	n) Maintain the effectiveness of Mint- ek's technical assets and infrastruc- ture	 ISO 9001 internal audits ISO 9001 external audits GMR(2) inspections Workplace inspections tions





	Control assurance Internal Audit		 Internal Audit 	 Internal Audit 	 Internal Audit Management Committee Executive Committee Board and sub-committees 	 Internal Audit
Targeted activity	(The numbering refers to the targeted activities associated with Mintek's strategic objectives, as listed in the beginning of this document)	k) Implement effective financial control	 k) Implement effective financial control 	k) Implement effective financial control	 k) Implement effective financial control Maintain the integrity of ICT and financial systems 	k) Implement effective financial control
	Present status of risk reduction measures	Adequate	Adequate	Adequate	Adequate	Adequate
	Probability					N
After	Impact					N
	Risk rating	ω		ω		4
Ð	Probability	ω		ω		വ
Befor	Impact					വ
	Risk rating	24	91	16	30	25
	Risk reduction measures	 Automated requisition process via maintenance system Matching of requisition to job card Clearly formalised powers and responsibilities and delegation thereof Reviewed and improved access control Exit permit required when taking items off site, which is authorised appropriately and checked by security Ensure all goods are adequately insured 	 Review all internal controls and reporting systems and procedures on a regular basis Check and ensure compliance with procurement policy Clearly formalise powers and responsibilities and delegation thereof 	 Verification check on new employee qualifications to prevent misrepresentation and potential hiring of an unqualified person Regular qualifications audit of employees 	 Regular review of financial system (SAP) and system of internal controls for integrity allowing informed decision making Measurement against budgets. Reporting on major varances. Implemented a financial reporting framework, incorporating due dates, responsibilities, delegated authority. 	 Review annually current insurance policy for completeness and accuracy with respect to fire, theft, public liability, product recall, professional indemnity, fidelity and accident cover Implement asset management system, incorporat- ing detailed asset register to monitor possible asset losses
	Description of risk	Internal requisi- tion fraud – staff taking goods, etc. Management re- sponse: Mitigate	Procurement fraud Management re- sponse: Mitigate	Fraudulent mis- representation of qualifications Management re- sponse: Mitigate	Inaccuracy of financial reporting Management re- sponse: Mitigate	Adequacy of insurance cover Management re- sponse: Mitigate
Risk	classification Risk owner Risk category	Financial Risk GM: Finance Managers Fraud Risk	Financial Risk Executive Management Managers Fraud Risk	Human Re- source Risk GM: Corpo- rate Services Manager: Human Resource Development- Fraud Risk	Financial Risk GM: Finance Manager: Finance Operational Risk	Financial Risk GM: Finance Manager: Finance Operational Risk
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metallurgical innovation	,

	Control assurance	 Internal Audit Mindev Board Executive Committee Mintek Board 	 Internal Audit 	 Internal Audit
Targeted activity	(The numbering refers to the targeted activities associated with MinteK's strategic objectives, as listed in the beginning of this document)	j) Prudent financial management of Mintek's investments and liabilities	 Prudent financial management of Mintek's investments and liabilities 	e) Create business opportunities for SMMEs
	Present status of risk reduction measures	Adequate	Adequate	Adequate
	Probability			
After	Impact			
	Risk rating			
e	Probability			
3efor	Impact			
Risk rating		12	9	
	Risk reduction measures	 Due diligence and regular financial reporting Investment and disinvestments policy in place 	 Surplus reserves to be invested as per investment policy Compliance to investing activities by Schedule 3 PFMA companies Accounting treatment and disclosure of such investments 	 SSMB business model was developed
	Description of risk	Equity position of Mintek in other companies caus- es Mintek to incur financial loss Management re- sponse: Mitigate	Poor investment of cash Management re- sponse: Mitigate	Lack of inte- grated business model for rural and marginalised communities Management re- sponse: Mitigate
Risk	classification Risk owner Risk category	Financial Risk Executive Management Operational Risk	Financial Risk GM: Finance Manager: Finance Operational Risk	Business Risk GM: R&D Strategic Risk
	°N No	25.	23.	

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