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For the project Ikapa Izinto

Locomotives of South Africa

Review

2025

Introduction

Africa has one of the most underdeveloped rail networks in the world, yet the locomotive fleet in a number of countries (especially in South Africa, Egypt, Morocco, Algeria, Namibia, Botswana, Tanzania and Kenya) is being actively renewed.

It is estimated that about 10,000-12,000 locomotives are in operation in Africa, of which about 50% are freight locomotives (mainly in South Africa, Egypt, Morocco, Algeria), about 30% are passenger locomotives (including diesel trains and motorcar sections) and 20% are shunting and industrial locomotives (mine, port).

The undisputed leader in terms of quantity and quality of railroads on the continent, with developed infrastructure and its own production of locomotives, is the Republic of South Africa. South Africa accounts for about 40% of Africa's total locomotive fleet, amounting to approximately 4,000 - 4,500 units, a large proportion of which, however, are obsolete.

About 40% of the country's total fleet requires replacement and South Africa is currently in deficit with urgent needs for both diesel and electric traction locomotives.

An outdated fleet, spare parts shortages, accidents, vandalism and poor management negatively affect freight and passenger transportation.

For example, traffic on the critical Richards Bay Coal Terminal line for coal exports has fallen by a quarter to 50 million tons (2023) over the past five years due to a shortage of traction, a shortage of powerful Class 18E, 22E electric locomotives is causing longer delivery times on the Gauteng-Durban container traffic, and a shortage of Class 19E, 20E is delaying iron exports on the Sishen-Saldanha Iron Ore Line.

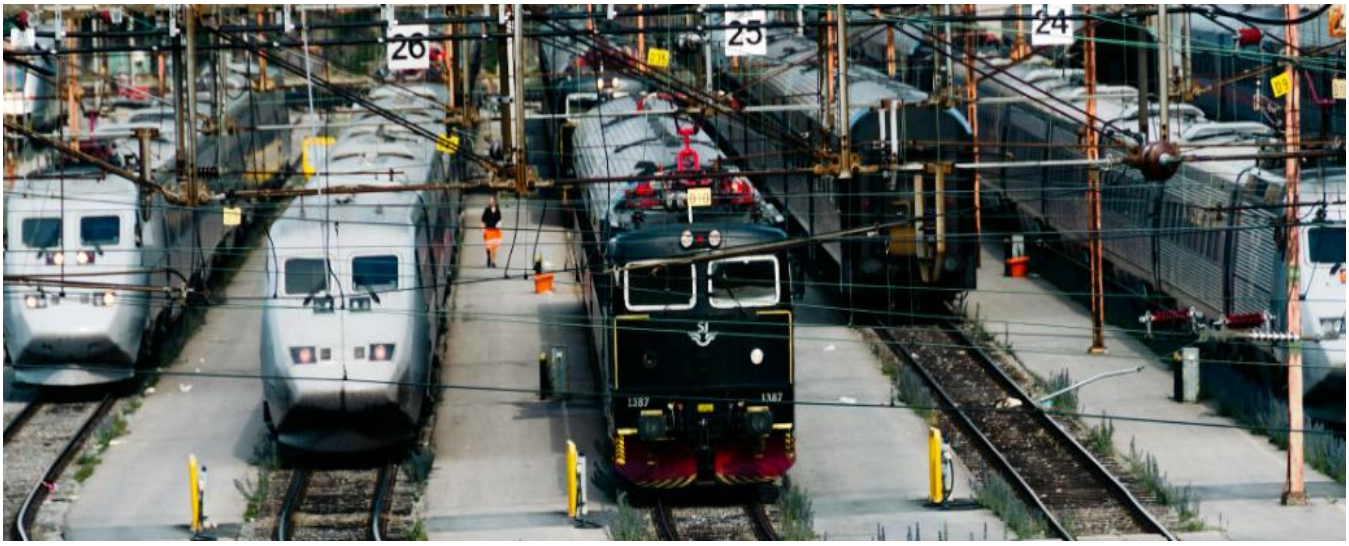
So why can't South Africa solve the problem quickly?

It's all about supply delays, corruption, outdated infrastructure (60% of tracks need repairs), which makes locomotives wear out faster. Let's try to understand how things are with this type of rolling stock in South Africa in more detail.

First, let us recall the standards of the international classification of locomotives.

International classification of locomotives

Locomotives are classified according to various characteristics, including service, gauge, body type, number of sections and other parameters. The international classification of locomotives allows standardization of technical characteristics for different countries and manufacturers.



1. By occupation (UIC classification)
(Union Internationale des Chemins de fer - International Railway Union)

Mainline locomotives

Freight

High tractive effort, moderate speed (example: **GE ES44AC, Siemens Vectron MS**), designed for transportation of heavy freight trains over long distances.

Passenger

High speed, smooth running (example: **TGV Duplex, Siemens Velaro**).

Mixed Traffic - combined transportation of cargo and passengers

- Combined application (example: B**ombardier TRAXX, EP20**).

Shunting / Industrial

- **Shunting** - for station operation (example: **EMD SW1000, TEM2).**
- **Industrial** - for factory and quarry tracks (example: **Caterpillar 797F** (autonomous tractors), narrow gauge locomotives).

High-Speed

- Speed **>200 km/h** (example: **Shinkansen E5, ICE 4**).

2. By track width

Track type	Width (mm)	Regions of application
Wide gauge	1520, 1668	CIS, Spain, Portugal
Standard gauge	1435	Europe, USA, China, Japan (Shinkansen)
Narrow gauge	1000, 1067, 762	Africa, mountain roads, industrial routes

3. By body type

- **Hood Unit**

Engine under the hood, convenient for maintenance (example: **EMD GP40, TEM18**). Purpose: Shunting and industrial locomotives

- **Cab Unit**

Streamlined aerodynamic body (example: **Siemens ES64U4, EP20**). Mainline transportation.

- **Modular**

The sections can be exchanged (example: **Bombardier ALP-45DP**). Versatile application

4. By number of sections

Type	Description	Example
Single-section	One body, one cab. Light haulage, shunting	Vossloh G1206, ChS7
Double-section	Two coupled sections. Heavy haulage	2ТЭ116, EMD SD90MAC
Multiple sections	3+ sections (flexible articulations). Heavy haulage	3ТЭ10М, Siemens Charger SC-44

5. By motor type and energy consumption

Diesel locomotives Diesel-electric (generator transmission) – **EMD SD70, TEP70**.

- **Diesel-hydraulic** (hydraulic transmission) **- Voith Maxima, TGM6.**
- **Gas-turbine** (rare, experimental) – **GTEL Union Pacific**.

Purpose: Work in non-electrified areas

Electric

- **Direct current (DC) - VL10, SNCF CC 7100.**
- **Alternating current (AC) - Siemens ES64U4, EP1M.**
- **Dual-system (Multi-System) - Bombardier TRAXX, EP20**.

Purpose: Mainline transportation on electrified lines

Alternative technologies

- Battery – **Stadler FLIRT Akku**.
- Hydrogen – **Alstom Coradia iLint**.

6. According to the axial formula (UIC классификация)

A formula is written as **numbers + letters** (e.g., **Bo'Bo'**, **Co'Co'**):

- **Bo** – 2 axles in one bogie, individually driven.
- - Co - 3 axles in one bogie.
- - ' - bogie designation (example: Bo'Bo' - two two-axle bogies).

Example: Bo'Bo' – Siemens Vectron, **Co'Co'** – 2ТЭ116.

7. By type of transmission

- **Electric** - generator → traction engines (most modern ones).
- **Hydraulic** - diesel → torque converter (shunting, light diesel locomotives).
- **Mechanical** - direct transmission (rare, small locomotives).

A locomotive is not designed to directly transport passengers, cargo or perform any other work other than traction. In addition to the traction function, some locomotives can also be used to power the cars in a train.

Each type of locomotive is designed to optimally solve specific transportation tasks. The choice of a particular model depends on the nature of transportation, operating conditions, power and speed requirements, and the specifics of the railway infrastructure.

Modern locomotives often combine several characteristics to maximize efficiency in different operating conditions.

Let us now turn to the state of locomotive production in South Africa Each type of locomotive is designed to optimally solve specific transportation problems. The choice of a specific model depends on the nature of transportation, operating conditions, power and speed requirements, and the specifics of the railway infrastructure.

Locomotives in South Africa

Locomotive manufacturing in South Africa is a combination of local production and imports, supported by public and private participation.

In South Africa, the production of locomotives and railway equipment is largely centered around state-owned corporations and private companies, often in partnership with international giants such as **General Electric (GE), Alstom, CRRC and Siemens.** For example, Transnet Engineering manufactures and repairs locomotives, while GE has manufacturing facilities in South Africa. South Africa also imports locomotives.

Key locomotive manufacturers and models

Public and private producers

1. Transnet Engineering (TE) State company (Transnet SOC Ltd)

Products: Electric locomotives (series 10E, 15E, 18E, 19E)
Diesel locomotives (series 34, 35, 36)
Freight and passenger cars
Repair and modernization of rolling stock

Transnet Engineering is also the original equipment manufacturer for the Trans Africa Locomotive (TAL). This specialized locomotive is the first locomotive in Africa designed and built by Africans specifically for African needs and conditions.

Supplies locomotives throughout the African continent.

2. Gibela Rail Transportation Consortium (Alstom + South African Partners) A consortium led by Alstom (France)

Products: X'Trapolis Mega electric trains (for PRASA)
Locomotives and EMUs (electric trains)

Customers: PRASA (Passenger Rail Agency of South Africa)

3. CSR E-Loco Supply (CRRC Zhuzhou Locomotive + South African Partners) Subsidiary structure **CRRC** (China)

Products: Class 22E electric locomotives (for Transnet)
Freight locomotives

4. Wabtec (previously GE Transportation) Wabtec Corporation (USA)

Products: Diesel Locomotives (Series JT42C / Class 43)
Railway Components

5. Siemens Mobility (ЮАР)
Products: Class 20E locomotives (electric)
Signaling and Automation Systems

Model range

The Republic of South Africa has a wide range of locomotives of different generations and classes, adaptable to the specific needs of its extensive rail network.

From old, time-honored series to innovative 21st century designs, this selection ensures the stable operation of South Africa's railways.

Historically, the first locomotives to operate in what is now South Africa were steam locomotives.

These machines used steam power created by heating water in a boiler.

Although archaic by modern standards, steam locomotives played a key role in the development of the country's infrastructure and economy until the mid-20th century.

Today, some historic models have been preserved and are used for tourist purposes, attracting the attention of retro train enthusiasts and railroad history buffs.

Let's take a look at the main categories of locomotives previously and currently used as traction in the country:

1. Steam locomotives

Model	Class	Manufacturer	Years of use.	Power	Axial formula	Features
Class 19D	19D	Henschel	1937-1990	1200 hp	1-4-0	Latest steam locomotives SAR
Class 25NC	25NC	SAR	1953-1990	1600 hp	2-8-4	For arid regions

A total of **238** Class 19D locomotives were produced.

There are 5 examples preserved in museums. The **Class 25NC** was used on the Kimberley - De Aar route, 90 units were produced.

2. Diesel locomotives (diesel-electric)

Diesel locomotives appeared in South Africa in the first half of the 20th century and quickly replaced outdated steam engines.

They had the advantage of greater power, efficiency and ease of maintenance.

Today, diesel locomotives are widespread and actively used on various routes in the country and play a key role in rail transportation due to the large number of non-electrified lines and difficult terrain.

South Africa is now gradually renewing its fleet, but diesel-electric locomotives remain the backbone of freight transportation.

Manufacturer	Class	Manufacturer	Years of use.	Power	Axial formula	Features
U20C	34-000	GE	1972-present	2,000 hp	Co-Co	GE basic model
U23C	-	GE	1970-1990	2,250 hp	Co-Co	Improved version
Class 35	35-000	GE	1973-2010	3,300 hp	Co-Co	Modernization of 34 series
Class 36	36-000	GE	1980-2005	3,600 hp	Co-Co	For heavy trains
JT42C	43-000	GE	2014-present	4,300 hp	Co-Co	Modern heavy hauler
SD40-2	-	EMD	1972-2000	3,000 hp	Co-Co	American import
DDA40X	-	GM	1970-1980	6,600 hp	(Do-Do)	The most powerful diesel engine.

3. Electric locomotives

Manufacturer	Class	Manufacturer	Years of use.	Power	Manufacturer	Features
Class 6E1	6E1	Hitachi	1969-present	3,000 kwt	Bo-Bo	First mass production
Class 10E	10E	UCW	1960-1975	2,400 kwt	Bo-Bo	Local development
Class 15E	15E	Siemens	2000-present	4,000 kwt	Co-Co	Based on Eurosprinter
Class 18E	18E	Bombardier	2010-present	4,500 kwt	Co-Co	For heavy loads
Class 19E	19E	CRRC	2018-present	4,800 kwt	Co-Co	Chinese deliveries
Class 20E	20E	Alstom	2022-present	5,000 kwt	Co-Co	Latest model
Class 22E	22E	Alstom	2020-present	3,600 kwt	Co-Co	Prima T8 AC3

Electric locomotives started to be used in South Africa at the end of the 20th century. They provide high power and efficiency, especially on high-speed lines and in heavy traffic. The electrification of railway lines has significantly increased transportation productivity and reduced air emissions.

4. Special and industrial locomotives

Model	Service life	Manufacturer	Years of use	Power	Type	Features
Vossloh DE1000H	25 years	Vossloh	2000-present	1,000 hp	Diesel-hydraulic	Shunting
BLAC	35 years	British Leyland	1960-1980	1,200 hp	Diesel-electric	Industrial
Deutz-Taurus	40+ years	Deutz	1960-1980	800 hp	Diesel	Mine

Operational problems: corrosion in coastal areas (Durban), shortage of spare parts for BLAC, Deutz overheating in deep mines.

All industrial locomotives in South Africa are certified to SANS 1718 standards. Modern models are equipped with Remote Monitoring systems.

Thus, we observe the evolution of the fleet: from steam locomotives (until 1990) to diesel locomotives (GE/EMD) and to modern electric locomotives (Siemens/Alstom), with a rapid increase in power from 800 hp (Deutz) to 6600 hp (DDA40X). Currently, GE dominates the market (70% of diesel locomotives), with the gradual replacement of Class 6E1 with Prima T8 (Alstom), new Chinese/European deliveries, and the planned introduction of hybrid models in 2025.

Let's take a closer look at the technical characteristics of the above models.

Diesel locomotives

Class 34-000 (GE U20C)

The main freight locomotive of the 1970s–2000s. Adapted for hot climates.
Manufacturer: General Electric (USA)
Years of operation: 1972–present
Number of locomotives produced: 143
Engine: GE 7FDL-12
Axle arrangement: Co-Co
Power: 2,000 hp (1,500 kW)
Maximum speed: 100 km/h
Weight: 115 t
Traction force: 30,000 kgf
Fuel consumption: 180 l/hour (≈220 g/kwt·h)

Class 35-000 (GE U23C)

For heavy freight transport
Years of operation: 1973-2010
Number: 100 units
Power: 3,300 hp
Engine: GE 7FDL-12 (modernized)
Axle configuration: Co-Co
Weight: 117 tons
Traction force: 32,000 kgf
Max. speed: 105 km/h
Specific fuel consumption: 190 l/hour (≈215 g/kwt·h)
Features: Improved cooling system compared to the 34th series.

Class 36-000 (GE U26C)

Manufacturer: General Electric (USA)
Years of production: 1980-1992
Number: 75 units
Power: 3,600 hp (2,685 kW)
Engine: GE 7FDL-16
Axle configuration: Co-Co
Weight: 120 tons
Traction force: 35,000 kgf
Max. speed: 110 km/h
Fuel consumption: 220 l/hour (210 g/kwt·h)
Application: Super-heavy coal trains
Features: Reinforced frame and bogies

Class 43-000 (GE JT42C)

A modern version with electronic control, operating on the Richards Bay Coal Terminal line, the main locomotive for coal transportation.

Manufacturer: General Electric (USA)
Years of operation: 2014-present
Number of locomotives produced: 110
Engine: GE GEVO-12
Power: 4,300 hp (3,200 kW)
Maximum speed: 120 km/h
Weight: 132 tons
Traction force: 45,000 kgf
Fuel consumption: 220 l/hour (≈200 g/kW·h)

EMD SD40-2

Manufacturer: Electro-Motive Diesel (USA)
Years of production: 1972-1989
Number: 50 units
Power: 3,000 hp (2,240 kW)
Engine: EMD 645E3
Axle arrangement: Co-Co
Weight: 125 tons
Traction force: 35,000 kgf
Max. speed: 110 km/h
Fuel consumption: 200 l/hour (225 g/kW·h)
Application: General freight transport
Features: High reliability

DDA40X "Centennial"

Manufacturer: General Motors (USA)
Years of production: 1970-1980
Number of units: 10
Power: 6,600 hp (4,920 kW)
Engine: 2×EMD 645E3
Axle configuration: (Do-Do)
Weight: 247 tons
Traction force: 60,000 kgf
Max. speed: 120 km/h
Fuel consumption: 400 l/hour (235 g/kwt·h)
Application: Super-heavy trains
Features: The most powerful diesel locomotive in the world

Electric locomotives

Class 6E1 (Hitachi)

The most widely used electric locomotive in South Africa. Operates on electrified lines in Gauteng.
Years of operation: 1969-present
Manufacturer: Hitachi (Japan)/UCW (South Africa)
Number: 1,015 units
Power: 3,000 kwt
Current system: 3 kV DC
Axle arrangement: Bo-Bo
Weight: 90 tons
Traction force: 25,000 kgf

Maximum speed: 100 km/h
Specific consumption: 8 kW·h/km (at full load)
Application: Main electric locomotive of the 1970s-2000s. First mass-produced model

Class 10E (UCW)

Manufacturer: Union Carriage & Wagon (South Africa)
Years of manufacture: 1960-1975
Number: 120 units
Power: 2,400 kW
Current system: 3 kV DC
Axle arrangement: Bo-Bo
Weight: 78 t
Traction force: 22,000 kgf
Max. speed: 90 km/h
Specific consumption: 8.5 kwt·h/km
Application: Freight transport
Features: Local development

Class 15E (Siemens)

Operates on the Pretoria-Cape Town line.
Manufacturer: Siemens (Germany)
Years of operation: 2000-present
Number: 150 units
Power: 4,000 kW
Current system: 25 kV AC
Axle arrangement: Co-Co
Weight: 88 tons
Traction force: 30,000 kgf
Max. speed: 120 km/h
Specific consumption: 6.5 kwt·h/km (with recuperation)
Application: Mainline transportation
Features: based on Eurosprinter ES40U2

Class 18E (Bombardier)

Manufacturer: Bombardier (Канада)
Years of manufacture: 2010-present
Quantity: 80 units
Power: 4,500 kW
Current system: 25 kV AC
Axle arrangement: Co-Co

Weight: 90 t
Traction force: 32,000 kgf
Max. speed: 120 km/h
Specific consumption: 6.2 kwt·h/km
Application: Heavy freight transport, reinforced construction

Class 19E (CRRC)

Manufacturer: CRRC (China)
Years of production: 2018-present
Number: 232 units
Power: 4,800 kW
Current system: 25 kV AC
Axle arrangement: Co-Co
Weight: 92 t
Traction force: 35,000 kgf
Max. speed: 120 km/h
Specific consumption: 6 kW·h/km
Application: Modern freight transport

Class 20E (Alstom)

Manufacturer: Alstom (France)
Years of production: 2022-present
Quantity: 50 units (ordered)
Power: 5,000 kW
Current system: 25 kV AC
Axle arrangement: Co-Co
Weight: 94 t
Traction force: 38,000 kgf
Max. speed: 130 km/h
Specific consumption: 5.8 kwt·h/km
Application: Promising freight transportation
Features: Latest technology

Class 22E (Alstom Prima T8)

Manufacturer: Alstom (France)
Years of production: 2020-present
Quantity: 100 units
Power: 3,600 kW
Current system: 25 kV AC
Axle arrangement: Co-Co

Weight: 88 t
Traction force: 30,000 kgf
Max. speed: 120 km/h
Specific consumption: 6.3 kW·h/km
Application: Replacement for Class 6E1
Features: Modular design

Special locomotives

Vossloh DE1000H

Shunting locomotive for port terminals.
Years of operation: 2000-present
Manufacturer: Vossloh (Germany)
Number: 45 units
Power: 1,000 hp (735 kW)
Type: Diesel-hydraulic
Specific fuel consumption: 80 l/hour
Engine: MTU 8V 4000 R41
Transmission: Voith L4r4zse hydraulic
Axle configuration: B'B'
Weight: 65 tons
Traction force: 18,000 kgf
Max. speed: 60 km/h (operating speed - 40 km/h)
Fuel consumption: 80 l/hour (195 g/kwt·h)
Turning radius: 50 m
Application: Port of Durban (container terminals), Cape Town industrial zones, shunting operations at Johannesburg stations
Features: Compact dimensions (length 10.5 m), soft start system, soundproof cab, ECO mode (automatic reduction of speed during idle time)

CZ LDH300

Manufacturer: CZ Loko (Czech Republic)
Years of delivery: 2015-2020
Quantity: 12 units
Type: Diesel-electric
Power: 300 kW
Axle arrangement: Bo
Weight: 28 t
Traction force: 8,000 kgf
Application: Sasolburg oil depot factory premises

Industrial locomotives

BLAC (British Leyland)

Manufacturer: British Leyland (United Kingdom)
Years of operation: 1960-1995
Number: 80 units
Type: Diesel-electric
Power: 1,200 hp (895 kW)
Engine: Leyland AL360
Axle configuration: C
Weight: 70 tons
Traction force: 15,000 kgf
Track width: 1,065 mm (special versions 610 mm)
Application: Witwatersrand mines (gold mining), Bushveld complex mines
Features: explosion-proof design, reversible cab, 60% of components manufactured in South Africa

Deutz-Taurus DH360

Manufacturer: Deutz (Germany)
Years of delivery: 1972-1988
Quantity: 35 units
Type: Diesel-hydraulic
Power: 360 hp (265 kW)
Engine: Deutz F8L614
Weight: 24 tons
Dimensions: 6.8×2.5×3.1 m
Application: Mpumalanga coal mines, intra-plant transport

Mining locomotives

GE 25-ton

Working depth: up to 1,500 m
Ventilation system: Forced
Safety: Intrinsically safe electrical equipment, methane sensors

AEG Grubenlok

Voltage: 550 V DC
Type: Contact-battery

Military locomotives

Class MF

Manufacturer: Transnet Engineering

Features: armored cab, mine protection, diesel-hydraulic transmission

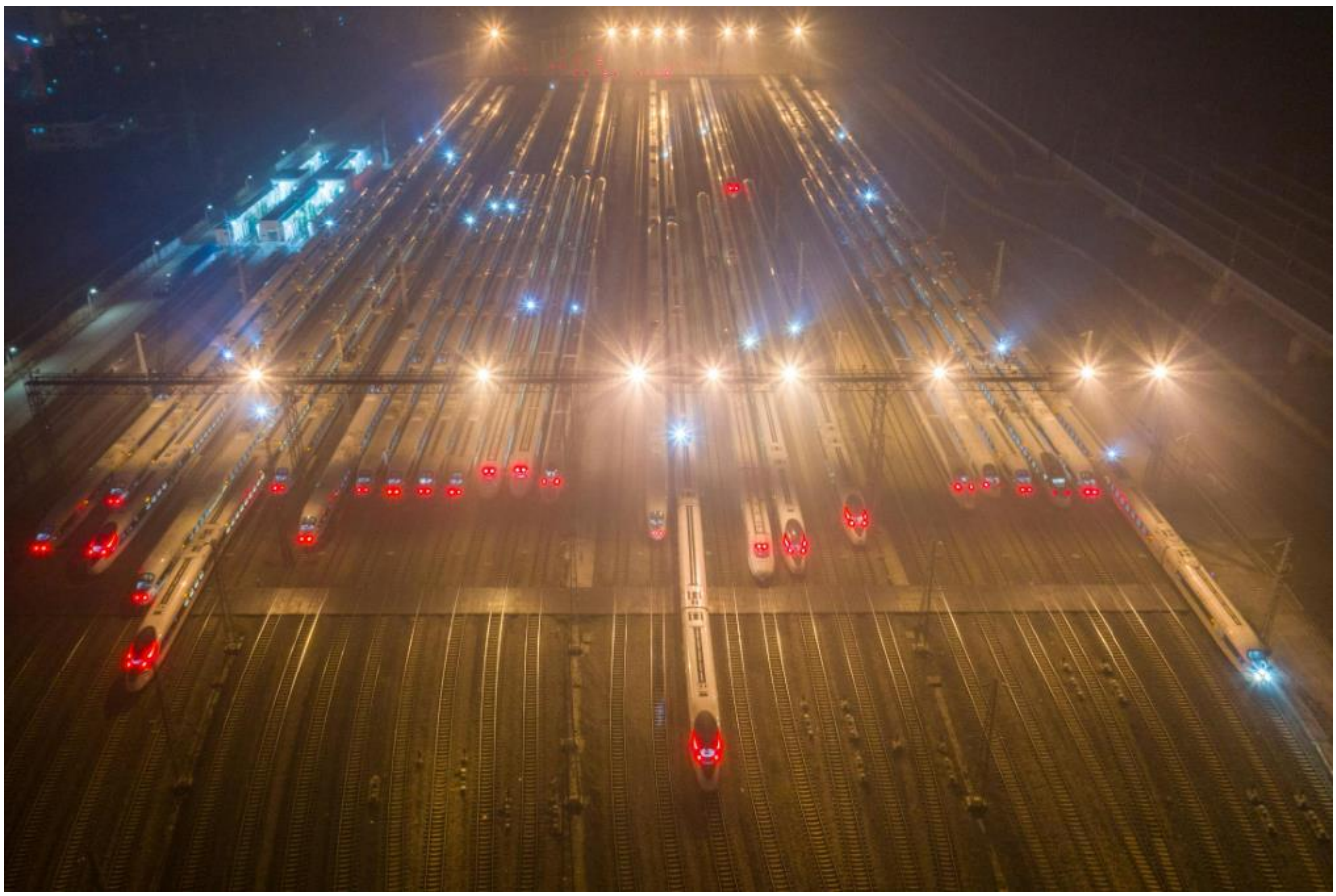
Thus, South Africa has a wide range of diesel and electric locomotive capacities, which demonstrates the diversity of the country's traction fleet. The efficiency of the best diesel locomotive models meets modern standards, while their electric counterparts demonstrate high energy efficiency.

The key technical trends presented show a significant improvement in the efficiency of railway engines over time — from steam locomotives with low efficiency of about 6–8% to modern diesel engines with efficiency of up to 38%, as well as electric locomotives with high efficiency in the range of 85–90%.

Classic diesel locomotives have achieved significant success in reducing specific fuel consumption, as exemplified by the Class 43-000 model with a figure of just 200 g/kwt·h. Electric locomotives, on the other hand, are distinguished by their minimal energy consumption per kilometer traveled, with the Class 20E being the most efficient, with a consumption of only 5.8 kwt·h/km.

In terms of load capacity, both types of locomotives can transport large volumes of cargo over difficult terrain: the most powerful diesel locomotive can transport up to 3,800 tons of cargo, while the electric locomotive can lift loads of up to 4,200 tons on gradients of up to 1%.

Thus, the modern railway fleet demonstrates high efficiency, environmental friendliness, and productivity, ensuring the sustainable development of South Africa's transport infrastructure.



Let's consider which sections of South African railways are operated by traction rolling stock.

Routes of operation of South African locomotives

1. Diesel locomotives

- **Class 34-000 (GE U20C)**
  - Johannesburg – Durban (general cargo)
  - Krugerdorp – Feriniching (coal trains)
  - Regional transport in the Eastern Cape

Operating features: operate on non-electrified sections with steep gradients (up to 2‰)

- **Class 35-000**
  - Sisicheng – Saldanha (iron ore, 860 km)
  - Maputo (Mozambique) – Comatieport (international transport)

Cargo traffic: up to 80 million tons of ore annually

- **Class 36-000**
  - **Richards Bay –** Ermelo (coal corridor, 580 km)
  - **Witbank** – Musina (heavy trains with 200+ wagons)

Record: Transporting 21,000 tons of coal in a single trip

- **Class 43-000 (JT42C)**
  - Freight hubs: Johannesburg – Durban – Port Elizabeth
  - Export routes to Botswana and Zimbabwe

Innovations: Real-time GPS monitoring of all trains

- **EMD SD40-2**
  - Reserve park on the Kimberley–De Aar line
  - Western Cape industrial zones (chemical cargoes)

- **DDA40X "Centennial"**

  Historical routes:
  - Trans-Cape Railway (1980s)
  - Currently: Cape Town–Stellenbosch museum trains

2. Electric locomotives

- **Class 6E1**
  - Suburban lines: Pretoria – Johannesburg – Feriniching
  - Gauteng industrial zones

Plans: Gradual replacement with Class 22E by 2027.

- **Class 10E**

- Mountainous sections: Durban – Pietermaritzburg (gradients up to 3‰)
- Decommissioned in 2005.

- **Class 15E (Siemens)**
  - "Coal Corridor": Witbank – Richards Bay (electrified sections)
  - International: Johannesburg – Harare (Zimbabwe)

- **Class 18E (Bombardier)**
  - Ore transportation: Postmasburg – Saldaña
  - Durban container terminals
  -

- **Class 19E (CRRC)** – new projects:
  - Trans-Kalahari Line (under development)
  - Eastern Cape Industrial Parks

- **Class 20E (Alstom)** - promising routes:
  - High-speed freight: Johannesburg – Cape Town (night flights)
  - Hub system "Blue Train 2.0"

Class 22E (Prima T8)

- Replacement 6E1: All electrified sections of Gauteng
- Port terminals: Durban – Ngqura

3. Special locomotives

- **Vossloh DE1000H**
  - Container terminals:
    - Durban (Pier 1-3)
    - Cape Town (Saldanha)
  - Sekundy Oil Terminals

- **BLAC (industrial)**
  - Gold mines: Welkom – Orient and Carltonville
  - Platinum: Rustenburg Belt

- **Deutz-Taurus**
  - Appington Salt Mines
  - Lange Baa Phosphate Mines

International corridors

Route	Main locomotives	Freight traffic (year)
Durban – Lubumbashi (DRC)	Class 19E + 43-000	12 million tons
Musina – Beitbridge (Zimbabwe)	Class 35 + 15E	8 million tons
Saldanha – Walvis Bay (Namibia)	Class 18E	15 million tons of ore

Problem areas and solutions

1. **Johannesburg – Durban**:
   - Problem: Cable theft (15 km without electrification)
   - Solution: Use of Class 43-000 in diesel mode
2. **Border with Zimbabwe**:
   - Problem: Different track gauge (1065 mm vs 1435 mm)
   - Solution: Transshipment terminals in Mus

Train formation schemes in South Africa

Let us consider the train formation schemes in South Africa using the example of coal and ore routes, indicating the number of locomotives, wagons, and control technologies.

1. Coal trains (Richards Bay Coal Terminal – RBCT)

Route: Emalahle (Witbank) → Richards Bay (~580 km)
Cargo: Coal (export)
Features: One of the busiest freight routes in the world, using extra-long trains (up to 375 cars).

Previously, an old scheme of 10 locomotives (a mixture of 9E + diesel) was used, 342 (CR-type, 80 t → 100 t after modernization) cars, with a total weight of ~41,400 tons, a train length of 3,780 m, control - distributed traction + manual switching. It caused difficulties due to high track wear caused by uneven loads and locomotive synchronization.
Since 2019, a new scheme with RDP technology has been used.

New schema

Parameter	Designation
Locomotives	Locomotives 5 × 15E (electric, 3,300 kW each)
Carriages	Carriages 375 (modernized, 100 tons of cargo)
Total weight	Total weight ~44,000 tons
Train length	Train length ~4,200 m
Control	Control Distributed radio power supply (RDP)*

How RDP works? *

- *1 lead locomotive (with driver) + 4 remote locomotives (without crew).*
- *All locomotives are controlled via radio channel from the lead locomotive.*
- *Traction and braking are synchronized automatically.*
- *Energy consumption reduced by 15–20%.*

2. Ore trains (Sishen – Saldanha, "Orex Line")

Route: Sishen → Saldaña (~861 km)
Cargo: Iron ore (exported to China and other countries)
Special features: One of the heaviest regular trains in the world, dynamic braking is used on descents.

Current schema (2024)

Parameter	Designation
Locomotives	8–9 × Class 15E / 18E
Carriages	342 (load 100 t)
Total weight	~38,000 tons
Train length	~3,500 m
Control	Distributed traction + rheostatic braking

Locomotive layout:

1. 3 in the front (main traction).
2. 2 in the middle (unload couplings).
3. 3–4 in the rear (braking + pushing).

Features: on the descent from the Hex River ridge, rheostatic braking is activated (to avoid overloading the pneumatics), average speed: 50–60 km/h.

3. Short freight trains (containers, general cargo)

Example: Johannesburg → Durban
Difference from coal/ore trains: fewer locomotives (usually 2–3), no distributed traction (only the lead group).

Parameter	Designation
Locomotives	2 × Class 19E
Carriages	60–80 (containers, cars)
Total weight	~4,000–6,000 tons
Train length	Classic (without RDP)

Locomotive fleet Transnet Freight Rail (TFR)

The locomotive fleet for 2024 consists of ~1,840 locomotives, of which ~1,640 are electric (89%) and ~200 are diesel (11%).

Model	Type	Years of production	Number (active)	Main application	Status
9E	Electric	1970–1990	~100	Coal, ore (reserve)	Gradually being phased out
15E	Electric	1980–2010	~800	Coal and ore trains	Main workforce
18E	Electric	2000–present	~300	Heavy ore trains	Actively used
19E	Electric	2010–present	~200	Containers, general cargo	Promising model, future of container transport
20E	Electric	2016–present	~240 (planned)	Replacement of 9E and 15E	Being introduced
43-000	Diesel-electric	2010–present	~150	Non-electrified lines	Main diesel engines

Transnet Freight Rail (TFR) locomotive crews in South Africa

Depending on the type of train and train control technology, crews can consist of 1–3 people. Let's take a look at all the options.

1. Standard freight trains (2–3 locomotives, without RDP)

Crew composition:
1 driver – train control.
1 assistant driver/shunter – coupling control, brakes, communication with the dispatcher.
(Sometimes) 1 technician – if the train is experimental or requires repairs en route.

Examples:

- Container trains (Johannesburg – Durban).
- General cargo (without automation).

2. Heavy ore/coal trains (5+ locomotives, with RDP)

Crew composition:
1 driver (in the lead locomotive) – controls all locomotives via the RDP (Radio Distributed Power) system.
1 assistant – monitors systems, communicates with the dispatcher.
0 people in remote locomotives – they are controlled by radio.

Examples:

- Coal trains with 375 cars (Emalaheni – Richards Bay).
- Ore trains with 342 cars (Sishen – Saldaña).

3. Diesel locomotives (non-electrified lines))

Crew composition:

1 driver – main control.

1 assistant – especially on difficult sections (mountain passes).

Examples:

- Freight transportation to Namibia.
- Backup routes in case of accidents on electrified lines..

4. Promising (driverless) trains

Crew composition:
1 operator in the control room – remote control.
0 people in the cab – tested on coal lines.

TFR plans: by 2030 – complete transition to automation of coal trains.

After examining the state-owned company's fleet, we will consider importing locomotives (HS Code 8601 – Railway locomotives).

Analysis of locomotive imports into South Africa (2015–2023)

Year	Approximate number	Major manufacturers (models)	Contract amount (USD)
2023	~50–70	CRRC (DF8B, HXN3), Wabtec (JT42C)	$200–300 million
2022	**232**	CRRC (Class 45-000)	**$600 million**
2021	~60	Siemens (Vectron), Progress Rail	$180 million
2020	~30 (COVID fall)	CRRC, Alstom	$90 million
2019	~120	GE (ES40ACi), CRRC (Evolution)	$400 million
2018	**233**	GE (Class 43-000)	**$450 million**
2017	~80	CSR (ныне CRRC), Bombardier	$250 million
2016	~50	GE (Class 39-000), Siemens	$150 million
2015	~40	General Electric, Alstom	$120 million

Trends:

Record deliveries in 2018 and 2022 are linked to the renewal of Transnet's fleet.
China (CRRC) is increasing its share from 30% in 2015 to 70% in 2022.
The US (GE/Wabtec) is losing market share due to high costs and sanctions risks.

Distribution by locomotive type (2020–2023)

Type	Market share	Major manufacturers
Diesel	65%	CRRC, GE, Progress Rail
Electric	20%	Siemens, Alstom, CRRC
Hybrid	10%	Wabtec, Siemens
Other	5%	Stadler, Bombardier

Why does diesel dominate?

Weak electrification of freight routes (especially in coal and ore mining regions). CRRC supplies cheap diesel models (e.g., Class 45-000 for $2.5 million/unit versus $4 million for GE).

Top 5 manufacturers by volume (2015–2023)

1. CRRC (China) – 55% of the market (main contracts with Transnet).
2. General Electric (USA) – 25% (but after 2020, deliveries decreased).
3. Siemens (Germany) – 10% (hybrid and electric locomotives).
4. Wabtec (USA) – 5% (acquired GE Transportation in 2019).
5. Alstom (France) – 3% (participation in metro and suburban train projects).

Key contracts

CRRC (China)

- **2022**: 232 Class 45-000 diesel locomotives ($600 million).
- **2024**: Delivery of 100 locomotives (expected)).

General Electric (USA)

- **2018**: Class 43-000 locomotives ($450 million)).
- **2020**: Sanctions against South Africa for cooperating with Russia – GE deliveries frozen.

Siemens (Germany)

- **2021**: 50 hybrid Vectron locomotives ($150 million) for freight transport.

Future: A new round of contracts is expected in 2024–2025 – South Africa plans to purchase another 150+ locomotives.

Largest contracts broken down by payments

CRRC (China) – 2022 Contract

- **Quantity:** 232 Class 45-000 diesel locomotives
- **Amount:** $600 million ($2.6 million per unit)
- **Payment terms**:
  - 30% advance ($180 million) – 2021
  - 50% ($300 million) – in stages as production proceeds (2022)
  - 20% ($120 million) – upon delivery and acceptance (2023)
- **Financing:** China Exim Bank (preferential rate of 2.5% per annum).
- **Delivery dates:** 2022–2024 (some locomotives are delayed due to logistics).

Additional expenses:

- Staff training: $15 million (included in the contract).
- Technical support: $10 million/year (for 10 years).

General Electric (USA) – 2018 Contract

- **Quantity:** 233 Class 43-000 locomotives **(GE ES40ACi modification)**
- **Amount**: **$450 million** ($1.93 million per unit)
- **Payment terms**:
  - 20% prepayment ($90 million) – 2017
  - 60% ($270 million) – according to the production schedule (2018–2019)
  - 20% ($90 million) – after commissioning (2020)
- **Financing**: **J.P. Morgan** (rate 5% per annum).

Problems:

- In 2020, deliveries were frozen due to sanctions risks (South Africa cooperated with Russia).
- 12 locomotives were delivered 18 months late.

Siemens (Germany) – 2021 Contract

- **Quantity**: 50 hybrid locomotives **Vectron DE**
- **Amount**: **$150 million** ($3 million per unit)
- **Terms**:
  - 100% prepayment (secured by guarantees) **Deutsche Bank**).
- **Delivery date: 2021–2023** (completed ahead of schedule).

Features:

- Included the modernization of the Johannesburg depot ($20 million).

Comparison of pricing strategies of manufacturers

Manufacturer	Price per locomotive (million USD)	Financing terms	Delivery times
CRRC	$2.5–2.8	Chinese state banks (2-3%)	24–36 months
GE/Wabtec	$3.5–4.0	Private banks (5-7%)	18–24 months
Siemens	$3.0–3.5	European loans (4-5%)	12–18 months

Why is CRRC cheaper??

Government support (subsidies from China).
Mass production (economies of scale).
Minimum localization requirements (GE/Siemens – up to 30%).

Scandals and lawsuits

Transnet-CRRC case (2023):
• Alleged $50 million price gouging (South African investigation).
• CRRC denies wrongdoing but agrees to additional parts for free.
GE vs. Transnet (2020): Dispute over 15 locomotives not delivered (settled out of court).

Risks for investors in South Africa's locomotive import sector

Risks for investors in South Africa's locomotive import sector

🔴 **Sanctions Pressure (USA vs. China/Russia)**

- **US imposes restrictions** on rail equipment supplies to South Africa due to its ties to Russia (2023).
- **Risk for GE/Wabtec:** Contract freezes, as in 2020.
- **CRRC protected:** China ignores sanctions, but difficulties with USD payments are possible.

🔴 **Corruption and reputational risks**

- **Transnet case (2023):** Management accused of overcharging by $50 million in CRRC contracts.
- **Consequences:** Payment delays, lawsuits, contract renegotiations.

🔴 **Changes in legislation**

- **New "Localization Act" (2024)**:

- Requires 40% local production for new supplies.
- Threat for CRRC: Chinese companies are not ready to relocate capacity.
- Opportunity for Siemens/Alstom: They have factories in South Africa.

2. Financial risks

🔴 **Transnet default**

- **Debt:** $7 billion (2024), of which $2 billion is overdue.
- **Problems**:
  - Delays in payments to suppliers (CRRC expects $120 million in 2022–2023).
  - Risk of contract cancellations (as in the case of GE in 2020).

🔴 **Rand (ZAR) exchange rate fluctuations**

- **Over the last 5 years: Rand has depreciated by 45% against USD.**
- **Consequences**:
  - Imports are more expensive (CRRC locomotives are up 15% in ZAR).
  - Risks for Rand investors.

🔴 **Dependence on Chinese loans**

- **CRRC is financed through Exim Bank (China) at 2.5%.**
- **Risk:** If China tightens Terms, Transnet will not be able to pay.

3. Commercial and operational risks

🔴 **Falling demand for coal transportation**

- **EU and China reduce coal imports from South Africa (green energy).**
- **Transnet loses** $300 million/year – less money for new locomotives.

🔴 **Vandalism and theft on the railway**

- **Losses:** $30 million in 2023 (copper, cables, fuel).
- **CRRC** demands additional payment for "enhanced protection" of locomotives.

🔴 **Competition with recycled materials**

- **50% of South Africa's** fleet are used locomotives from the US and EU (2 times cheaper than new ones).

- **Pressure on prices:** CRRC forced to reduce margins.

4. Opportunities to Minimize Risks

Supplier diversification

• Example: Transnet plans to buy 20% of locomotives in India (cheaper than China).

Currency risk insurance

• Hedging the USD/ZAR rate (as Siemens does).

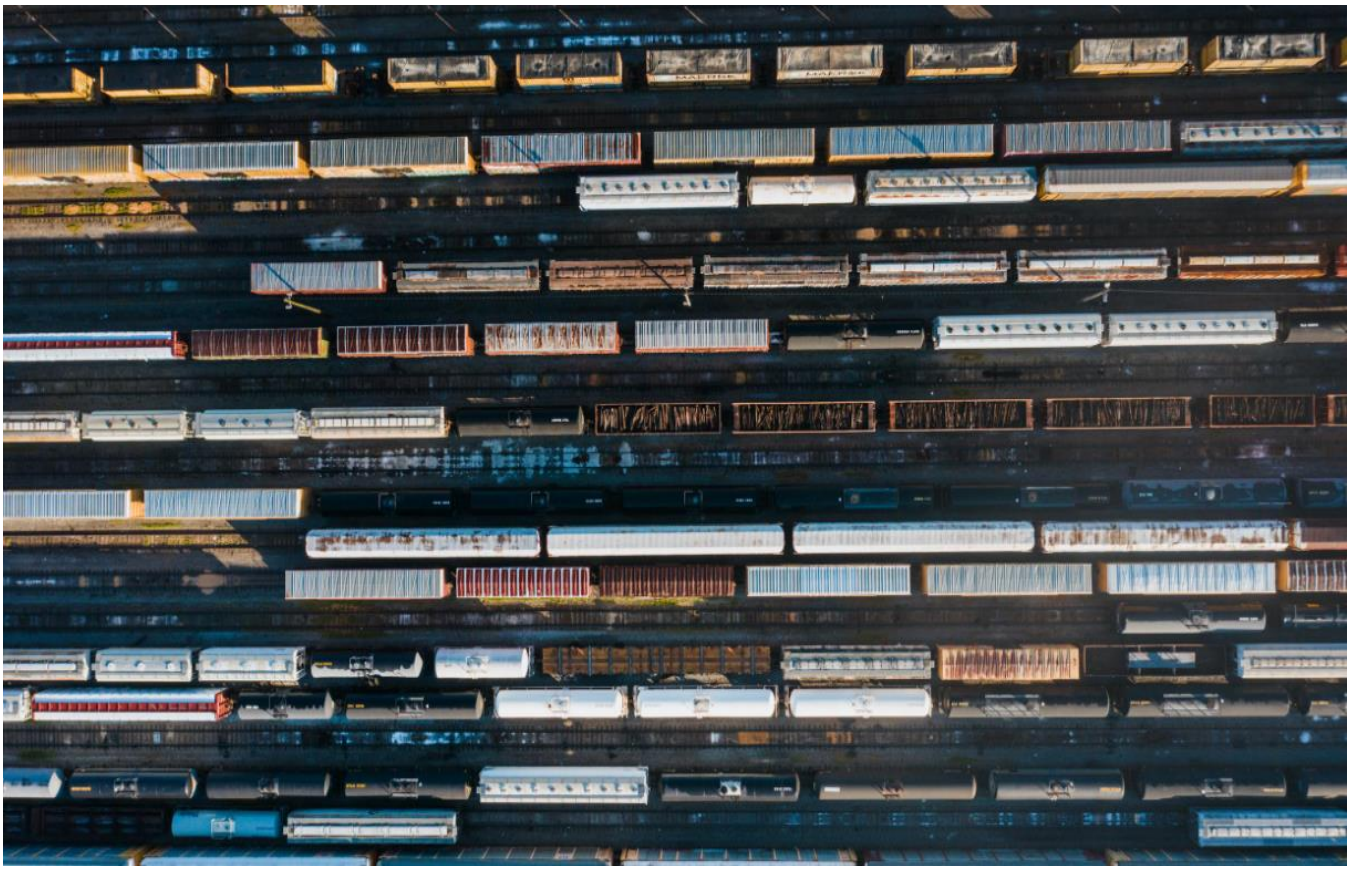
Partnership with local manufacturers

• Alstom already assembles some components in Durban – lower duties.

Riskiest scenario:

If Transnet defaults, **CRRC loses $1bn+** and South Africa's locomotive market collapses.

Our company wishes you prosperity!



Links

1. *Transnet Engineering https://www.transnet.net/Divisions/Pages/Transnet-Engineering.aspx*
2. *Gibela Rail Transportation Consortium https://www.gibela-rail.com*
3. *CRRC Zhuzhou Locomotive https://www.crrcgc.cc/en*
4. *Wabtec https://www.wabteccorp.com*
5. *Siemens Mobility https://www.mobility.siemens.com*
6. *Transnet Freight Rail (TFR) – Operational Data https://www.transnet.net/OurBusinesses/FreightRail/Pages/default.aspx*
7. *Siemens Mobility – Locomotives for South Africa https://www.mobility.siemens.com/global/en/portfolio/rail/rolling-stock/locomotives.html*
8. *Bombardier (Alstom) – Electric Locomotives https://www.alstom.com/our-solutions/rolling-stock/locomotives*
9. *Railway Gazette – South Africa's heavy haul operations https://www.railwaygazette.com/*
10. *International Mining – TFR's record-breaking trains https://www.im-mining.com/*
11. *Railways Africa Magazine https://www.railwaysafrica.com/*
12. *Heritage Railway Association of South Africa http://www.hrasa.org.za/*
13. *Vossloh Locomotives Catalog https://www.vossloh.com/en/locomotives_1003.php*
14. *Deutz Industrial Engines https://www.deutz.com/en/products/*
15. *Tenders South Africa*
16. *ITC TradeMap https://www.trademap.org/*
17. *UN Comtrade https://comtradeplus.un.org/*
18. *SARS https://www.sars.gov.za/*
19. *Transnet Freight Rail https://www.transnet.net/*
20. *Railway Gazette International https://www.railwaygazette.com/*
21. *BMI Research (Fitch Solutions) https://www.fitchsolutions.com/*
22. *South African Judiciary*
23. *https://www.transnet.net/tenders.html*