

## LOCOMOTIVE HAULAGE

Hencon Turnkey Solution, full system design and production





PROJECT DETAILS

|                                |  |
|--------------------------------|--|
| Project partners               | Clayton Equipment Ltd                                  |
|                                | Galison Manufacturing (Pty) Ltd                        |
| Client                         | PhosAgro, Apatit JSC, Kirovsk branch                   |
| Location                       | Kirovsky mine, Kola Peninsula, Russia                  |
| Stage 1                        | 2020-2022  |
| Stage 2                        | In progress  |
| Specifics                      | 8km of T-Track ballast-less railway (10-year warranty) |
|                                | 4 x Clayton 30-ton hybrid electric locomotives         |
|                                | 36 x Galison 10m3 mine cars                            |
|                                | 15 x Galison loading stations with Hencon power packs  |
|                                | 4 x Galison unloading stations                         |
| Gauge 750mm, axle load 15 tons |  |
| Annual gross tonnage stage 1   | 7 million tons   |
| Annual gross tonnage stage 2   | 12 million tons  |

+10M LEVEL, PHOSAGRO

Apatit, Kirovsk branch

On 1 February 2022, PHOSAGRO successfully launched the extraction of ore on a +10m level locomotive haulage. The consortium responsible for the design and manufacture of the equipment consisted of Hencon, Galison and Clayton.

- **Hencon:** T-Track railway, power packs, project management
- **Galison:** Wagons, loading and unloading stations
- **Clayton:** 30-ton locomotives, grade computations



TRACTION MOTOR

|                         |                       |
|-------------------------|-----------------------|
| Type                    | Switch reluctance     |
| Power nominal output    | 52kW Continuous Rated |
| Power maximum output    | 104kW                 |
| Input current           | 325A                  |
| Speed                   | 1,800 rpm             |
| Quantity                | 2 motors              |
| Locomotive drawbar pull | 73,575 N              |

TRANSMISSION

Traction motors are rigidly mounted to the locomotive frame with drive transmitted to the rail wheels via axle-mounted gearboxes. The traction motors are connected to the gearboxes via drive shafts.

DRAW GEAR

Willison coupler and buffer assembly mounted at each end of the locomotive

RUNNING GEAR

Ø840mm Solid forged steel.  
Ringfeder locking device.

TRACTION BATTERY

|          |           |
|----------|-----------|
| Type     | Lead Acid |
| Voltage  | 250 Vdc   |
| Capacity | 11,5 kW   |

BRAKING SYSTEM

**Primary**  
Joystick-applied regenerative electric

**Secondary**  
Hydraulic mechanical spring applied failsafe disc brakes. Acts as a parking brake. The parking brake hold can also be applied during an inclined start to provide braking before the locomotive starts to move off.

CONTROLLER

|                 |                           |
|-----------------|---------------------------|
| Type            | IGBT Power Semi-Conductor |
| Input voltage   | 300 Vdc                   |
| Control voltage | 24 Vdc                    |

DRIVER INTERFACE

- Drive joystick
- Warning horn
- Master power key switch
- Emergency stop pushbutton
- Direction switch
- Pantograph up/down switch
- Pantograph /battery selector switch
- Cab light switch
- Park (brake) hold indicator
- Brake hold switch
- Seat belts indicator
- System reset switch
- Sounder

LIGHTING

- Two white 9 LED headlights are mounted at each end of the locomotive.
- Two red 4 LED tail light/reflectors are mounted at each end of the locomotive.
- LED coupler lights either end of the machine.
- Internal 2-position cab light.

FIRE SUPPRESSION

**Automatic**  
Automatic fire suppression canister in the all- electrical cubicles.

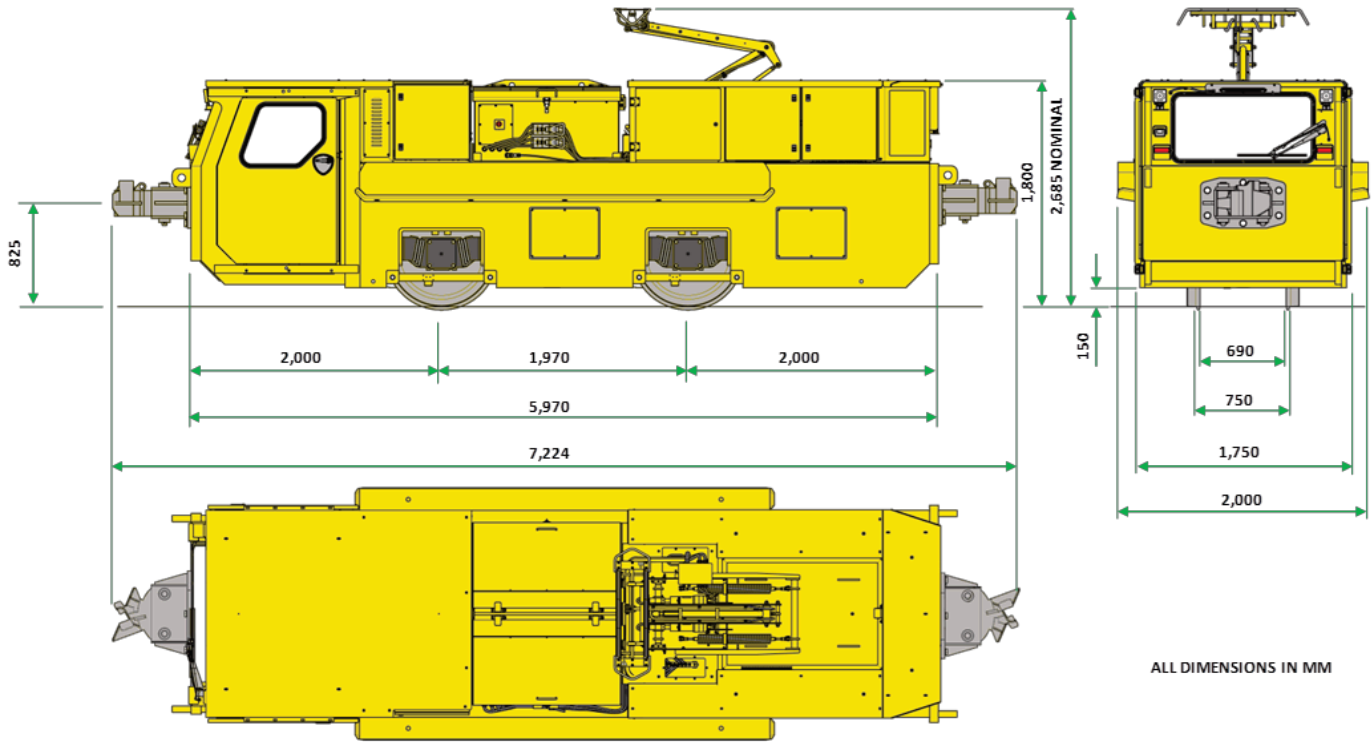
**Manual**  
1kg fire extinguisher located within the driver's cab.

**Fully automatic system**  
Fully automatic with manual override deployed within the chassis compartment.

AUTOMATION

Locomotive is automation ready, by adding the necessary sensors and updating the control logic it can be fully automated.

CLAYTON CBT30 LOCOMOTIVE



Dimensions and operating parameters

|                     |         |                 |                |
|---------------------|---------|-----------------|----------------|
| Height              | 1 800mm | Tractive weight | 30 000kg       |
| Width (over frame)  | 1 750mm | Max speed       | 20km/h         |
| Length (to buffers) | 5 970mm | Trolley voltage | 300 Vdc +/-10% |
| Length (overall)    | 7 224mm | Battery voltage | 250 Vdc        |
| Wheelbase           | 1 970mm | Motors          | 2 x 52kW       |
| Wheel diameter Ø    | 840mm   | Drawbar pull    | 73,575N        |
| Track clearance     | 150mm   | Rail gauge      | 750mm          |

Remote control

Remote control duplicates the main locomotive functions such as speed control, braking, direction switch, pantograph switch, horn and emergency stop. It enables locomotive movement on lower speed only to ensure safety. Remote control functionality allows better communication with the loading station operator when the ore is multi-dimensional, and better control over the unloading by managing processes from the outside.



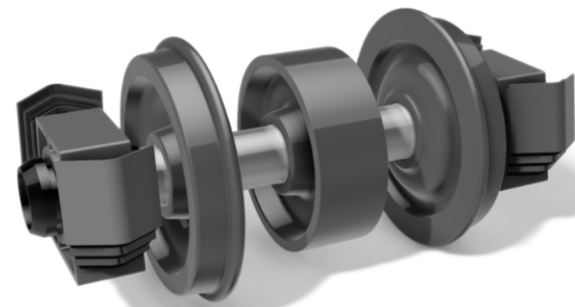


## PROJECT EQUIPMENT

### GALISON 10M<sup>3</sup> WAGON (BOTTOM DISCHARGE)

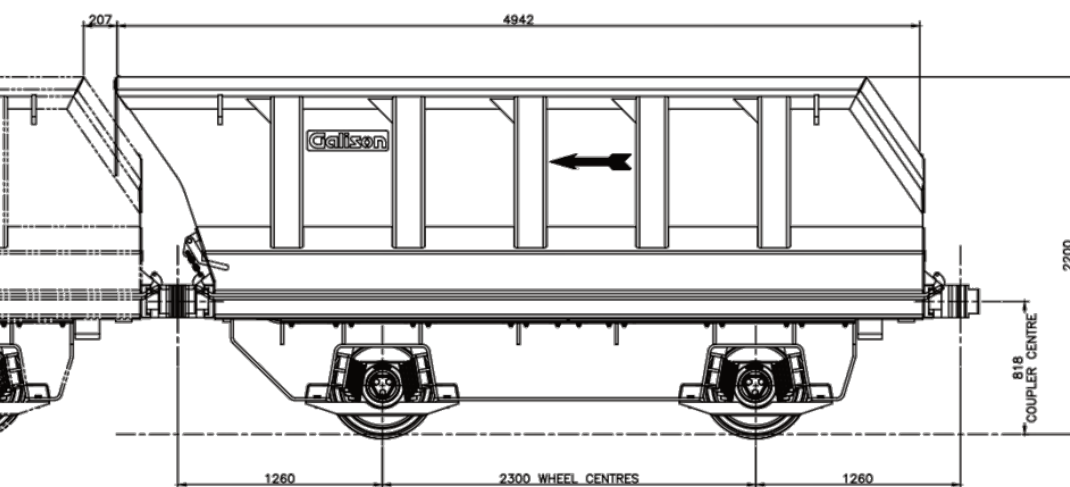
#### Bottom discharge ore cars

These cars provide quick and clean discharge of all ore whilst allowing for continuous loading with overlapped ends eliminating spillage. The cars have a very high volumetric efficiency and can operate at a high speed with good stability.

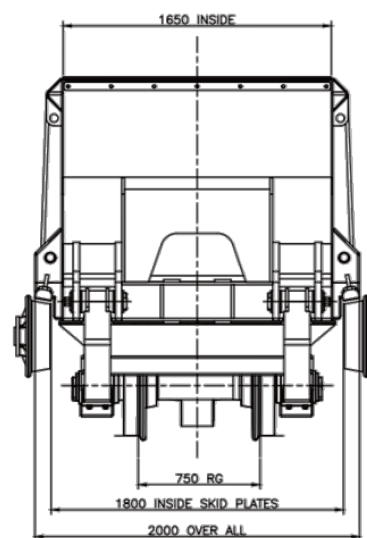


#### Material specifications

The wagons are constructed using high-grade steel specifications to ensure optimal life, strength and load tare weights. All surfaces that come into contact with the rock is made from hard-wearing Hardox 450 to increase the life of the body. The critical, replaceable door liner is made from 3CR12 stainless steel to further increase wearing life and ensure best possible sliding ability. The Chassis components and strength gussets are made from Strenx700 to increase strength and rigidity whilst lowering tare weight.



SIDE ELEVATION



END ELEVATION

#### Wheels and axle assembly

The cars are fitted with heavy duty wheel and axle assemblies with a load carrying capacity of 20 tons each. Wheel design and specifications are critical to service life longevity. Wheels are fitted with low maintenance SKF D-type AP bearing units.



## PROJECT EQUIPMENT

### Loading station 10m3

An in-line loading chute is a highly productive system to rapidly load ore into a span of wagons. Doors and chains are hydraulically operated. There are two safety cylinders on the sides of the chute door to lock the door in position when not in use. The chute is lined on the inside with changeable SSAB Hardox 450 steel for extra durability. It's a bolt-on structure to allow easier installation and moving to a different location or position. Control panels include options for onsite controls via manual levers, onsite control from pedestal, or remote control that allows control from any position. The loading station can also be remotely controlled from the surface.

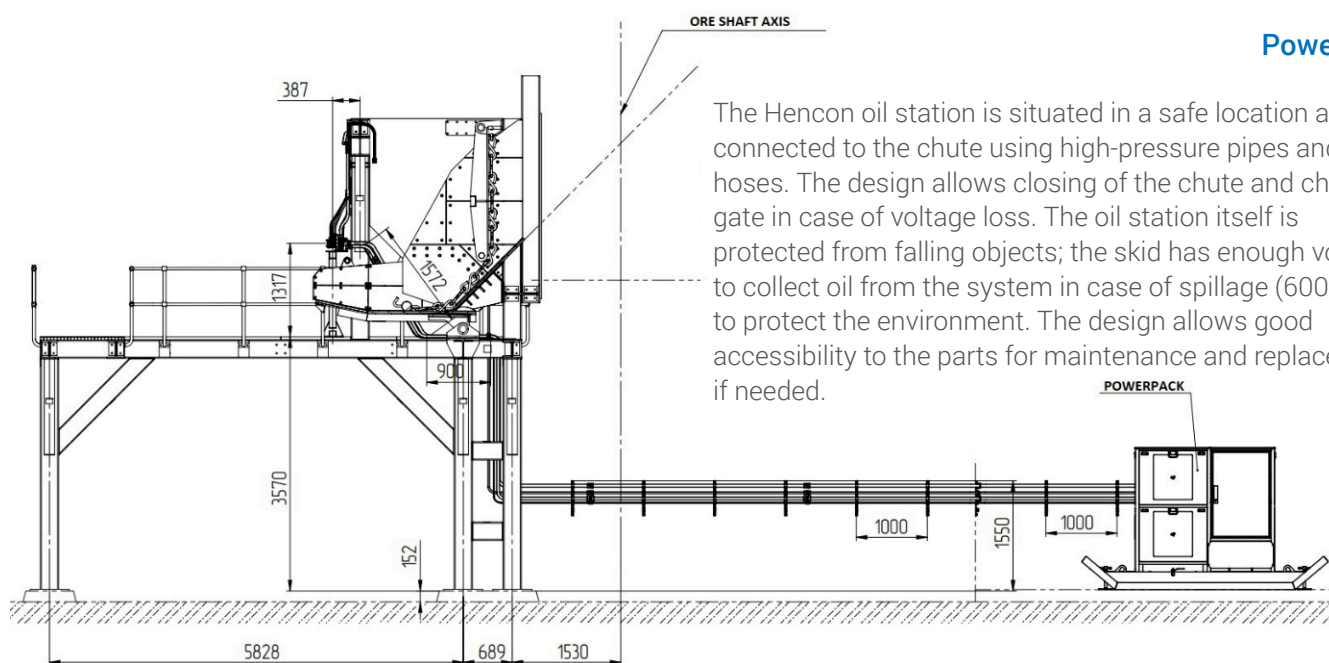
### Loading process

The ore is loaded from the deadbox, in the lower part where there is a loading lip with a locking system and a chain gate blocking the loading of ore. Hydraulic cylinders move the loading chute and chain gate and activate the system chute fixation. The hydraulic pump used to power the hydraulic functions has an electric drive. The hydraulic system is equipped with hydraulic accumulators to block lift, lock the loading chute, and close the chain gate in case of power loss.



### Power pack

The Hencon oil station is situated in a safe location and connected to the chute using high-pressure pipes and hoses. The design allows closing of the chute and chain gate in case of voltage loss. The oil station itself is protected from falling objects; the skid has enough volume to collect oil from the system in case of spillage (600 litres) to protect the environment. The design allows good accessibility to the parts for maintenance and replacement if needed.



## GALISON LOADING STATION 10M<sup>3</sup>





## PROJECT EQUIPMENT

### Unloading station 10m<sup>3</sup>

The tipping station has been purpose designed for the wagons, quick and efficient dumping of the ore, and for use of a locomotive at the end of the train. It's powered by 10 x 11kW Siemens gearboxes and motors, driving horizontal rubber tyred rollers on the entry and exit to the dump station. These drive units control the train through the dump station which allows for an adjustable, controlled tipping speed of up to 4km/h, using Siemens Variable Speed Drive (VSD) units. The Siemens VSD units are housed in dustproof stainless steel cabinets to minimise maintenance issues. It's a low energy tipping system that ensures low maintenance requirements.

### Unloading process

The body of the car is held up by the tip support rollers, whilst the door of the car falls away to a steep angle of 55° with a large opening to allow the discharge of very large rocks. Tipping a whole train can therefore be done in a matter of seconds. Access to the tip area is controlled by automatic traffic booms – ideally suited for driverless locomotives.

### Tipping rollers

Tipping roller assemblies have been specifically designed for the large cars to be used at the mine. They are spaced to carry the load as it reduces through the tip. Rollers are tightly spaced at the entry point and spread out at the exit point as the load reduces. There are 40 rollers per tipping station. Each roller consists of a high chrome 450mm wheel casting, taper roller bearings, 100mm shaft and locking plates. An easily accessible grease nipple is provided at the back.

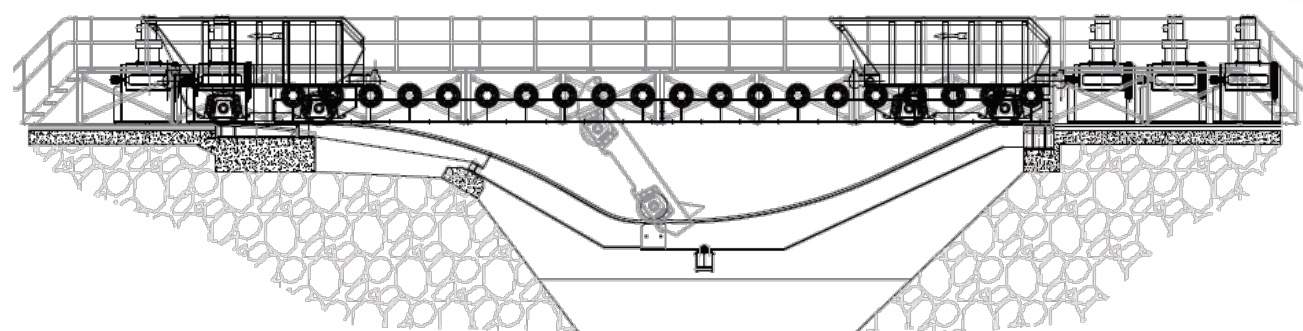
### Propulsion unit

- Right hand and left hand construction
- Siemens parallel helical gearbox
- Siemens 11kW motor, 1 450 rpm, Siemens frequency converter
- Variable output speed
- Hinged drive frame fitted with truck tyre
- 152 x 290 stroke double-acting air cylinder

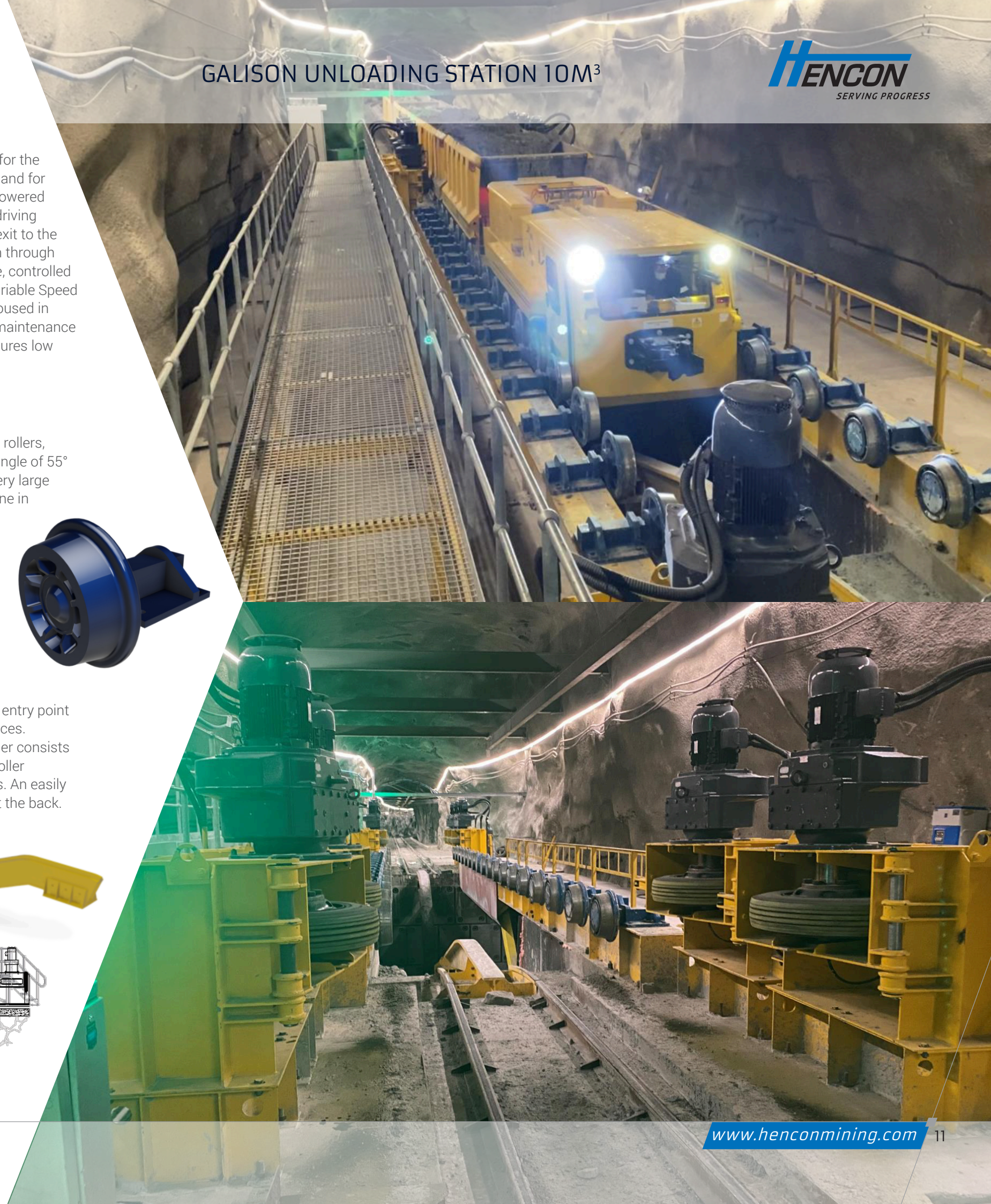
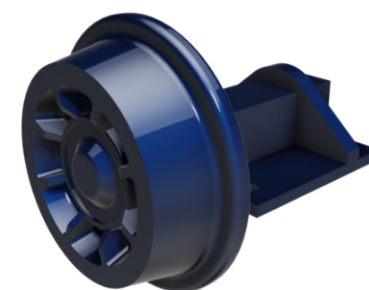


### Camel back

The camel back is made from fabricated sections, which are easily transported and mounted on supporting plinths. A 200x40mm SS10/200 flat bar with high Brinell hardness is used to guide the tipping roller. The camel back is supplied in sections for easy installation and is bolted together by the client to ensure alignment.



## GALISON UNLOADING STATION 10M<sup>3</sup>

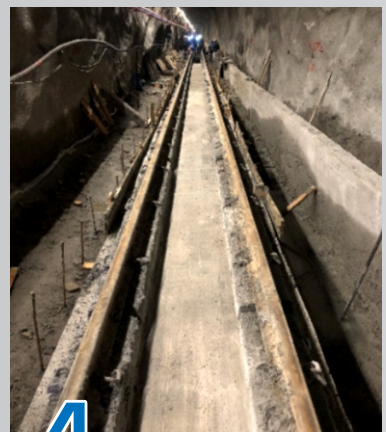




## TYPICAL UNDERGROUND INSTALLATION SEQUENCE



**1** Transport modules underground



**4** Remove shutters. T-Track installation complete



**7** Train loading station



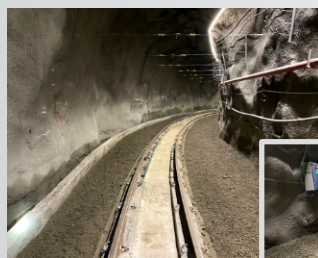
**2** Footwall preparation



**5** Backfill side of track for walk ways

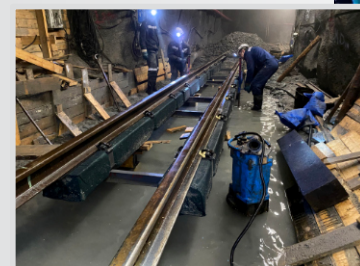


**8** Train unloading station

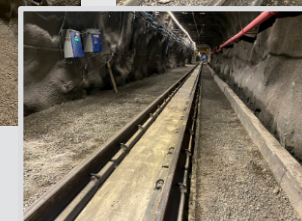
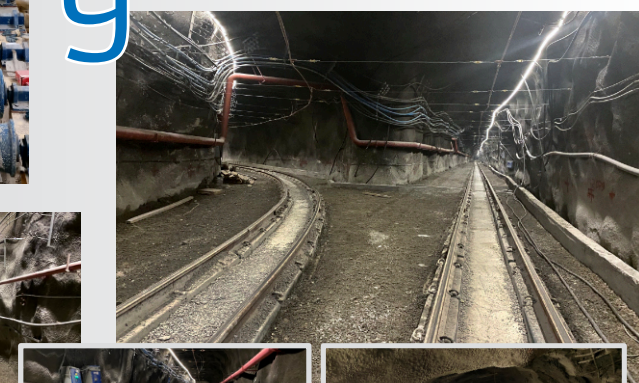


**9** Finished T-Tracks

**3** Place modules along centre line, install rail and fasten to module, lift and align track to specification and install shutters. Place concrete (filler grout) under modules.



**6** Open line for operations



## T-TRACK BALLAST-LESS RAILWAY SYSTEM

The T-Track system offers continuous support to the rails which are braced on longitudinal reinforced concrete beams. Galvanised steel gauge bars provide the desired track gauge by spacing them according to the particular application and design requirements.

T-Track can be used for any track gauge, rail size and axle loads. Current application designs in service run from 5-ton axle loads in the mining industry to up to 32,5-ton axle loads on surface applications. Due to the continuous support of the rails including the continuous resilient pad between the rail and the beam, rail stresses and fatigue are reduced offering longer service life.

### GEOMETRICAL PARAMETERS OF THE TRACK

- Vertical deflection is less than 2mm, horizontal deflection is less than 1mm
- No longitudinal creep

### CONTINUOUS BEAM SUPPORT

- It allows for a smaller rail size for the same load
- Reduced rail corrugation
- Reduced vertical rail deflection – less rail fatigue and stresses
- Equal load distribution along the welded rail
- Continuous support at rail breaks reducing potential derailments
- Eliminates rail creep

### NO SLEEPERS AND BALLAST

- Reduced environmental footprint
- No high-cost ballast maintenance and on-track maintenance machine

### LOWER OPERATION AND MAINTENANCE COSTS

- No need to tamp, screen and profile ballast
- No need for ballast trains to deliver ballast
- No need to keep ballast stock piles and quarries
- Operational availability of T-Track higher than CBT

### QUICK REPLACEMENT AND REPAIR IN CASE OF DAMAGE ON THE LINE

- Modular system allows quick installation of the track by means of replacing modules if required

The modules are cast for open track and turnouts in dedicated moulds in a factory environment to maintain absolute quality assurance and control. Manufacturing tolerances of 1mm are achieved in the moulds offering the T-Track system excellent track geometry.

T-Track modules are logistically convenient and can be easily transported by road or rail. Modules will always be around 3m to 6m in length depending on the application. T-Track components are manufactured by the OEM and easily transported to any destination where the modules are physically cast.

- Traffic can be quickly recommenced at restricted speeds if required in the affected area

### BETTER DRAINAGE FEATURES

- Water is not collected by contrast to ballast
- Water concentration can be visually detected and dealt with immediately
- Simple/easy water drainage systems
- Corrosion resistance (components are hot dip galvanised)
- Reinforcing in the modules are protected with concrete cover of low permeability

### MODULE STRUCTURES ARE NOT EXPOSED TO CRACKING

- Concrete does not crack because of localised settlement of formation – modules have bridging effect
- No cracking of sleepers when ballast is contaminated
- Simplicity and low cost of grout refilling in case of embankment dipping
- Elasticity is achieved through use of rubber pads

### STABILITY OF THE CROSSING CONSTRUCTIONS

Pre-cast level crossing blocks simple to install between the rails and creates safe access across tracks

### REDUCED TIME FOR REPAIR

- 80-90% of maintenance is visual inspection of the tracks, 10-20% is physical work
- Various T-Track installations have been in operation in excess of 12 years with no maintenance
- Turnouts on the T-Track system have extended life. In SA, on heavy haul installations, turnout life has outperformed CBT turnouts by at least 2 times.



## HENCON PROJECT MANAGEMENT

### Hencon Project Management offers clients:

- Coordination with the client on the type and quantity of equipment needed to maintain the planned production objectives;
- Basic engineering control, working closely with the client's project management team to ensure the equipment and mine infrastructure work seamlessly together;
- Equipment delivery control: we ensure delivery of all equipment to client's storage facility;
- Manufacturing of T-Track modules in locations logistically accessible from the client's worksite. For this project, the fabrication of modules took place within 20km of the worksite.
- Setup of equipment, supervision of the installation and installers, quality assurance and control including project management from module manufacturing and installation to final handover to the client;
- Practical and theoretical training of client's personnel;
- Organisation of maintenance area on-site.

## HENCON MAINTENANCE

### Hencon Maintenance offers clients:

- Highly qualified, responsible staff
- Modern and reliable equipment
- Astute work ethic
- Continuous monitoring of the execution of processes and work, starting with the delivery of equipment to the customer
- Long-term analysis and statistical performance indicators of the machine as a whole, as well as individual components and mechanisms
- To improve the quality and increase service life of equipment
- Planning an inventory of consumables and spare parts based on the amount of equipment supplied for maintenance, and considering all possible risks
- Independent planning of service and preventative work according to client's objectives (practically eliminating the risk of disruption to the production programme).
- Prompt response to customer requests
- Flexibility to solve all technical issues



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