ATTACHMENTS:

CEL-40

Customer: RAZEL – BEC SAS

Project: Nîmes Water Tunnel / France

Quote Ref.: 9098/05

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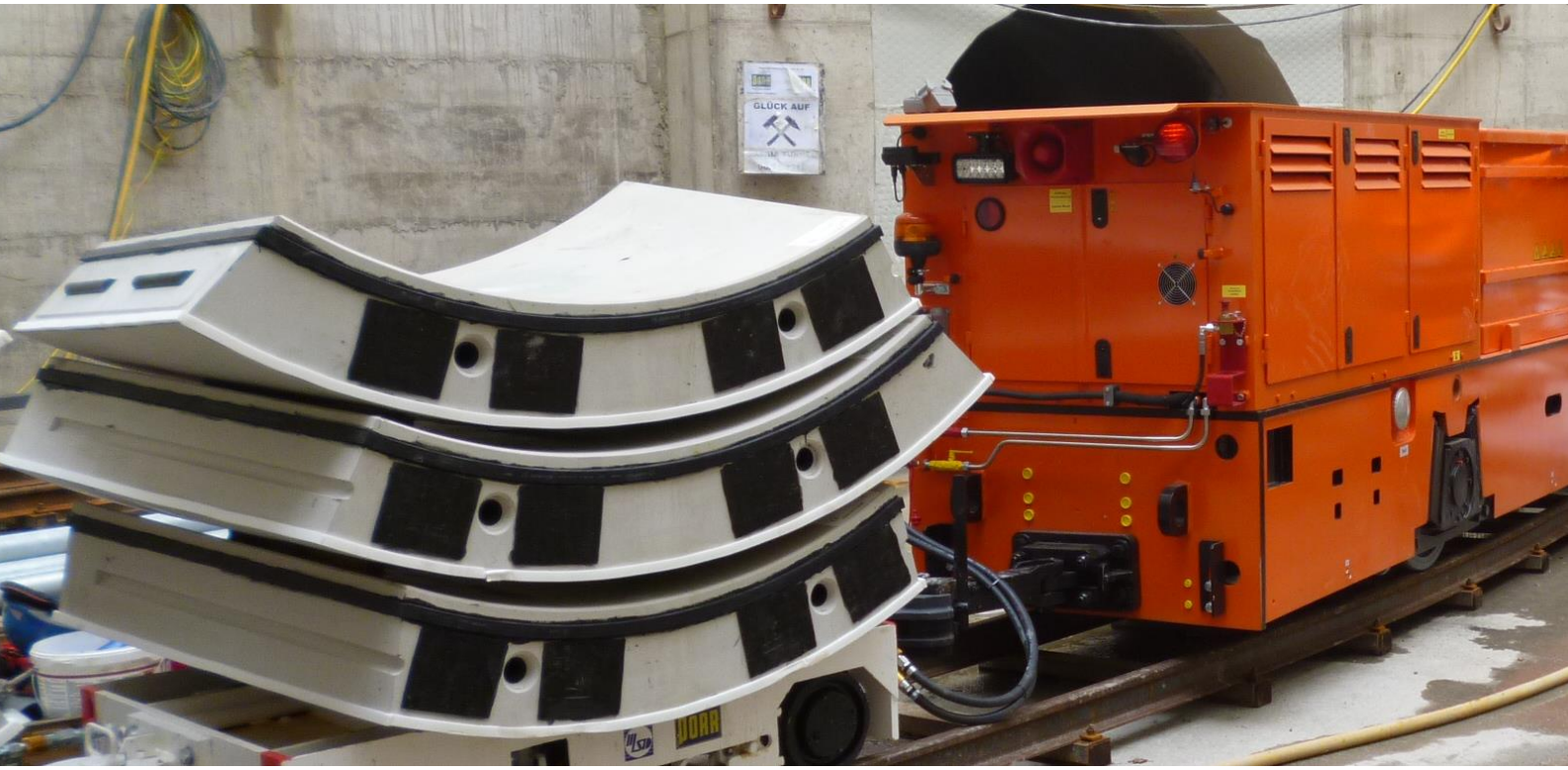
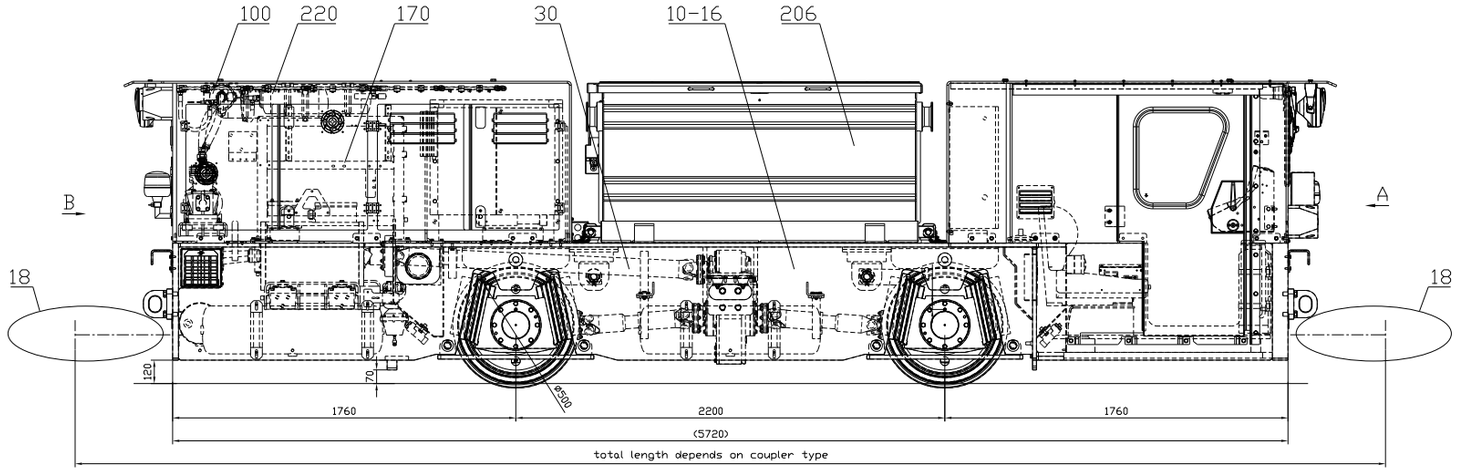
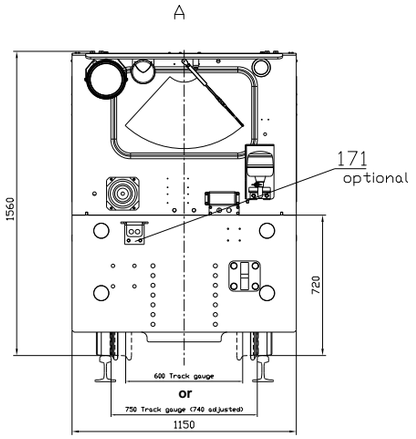
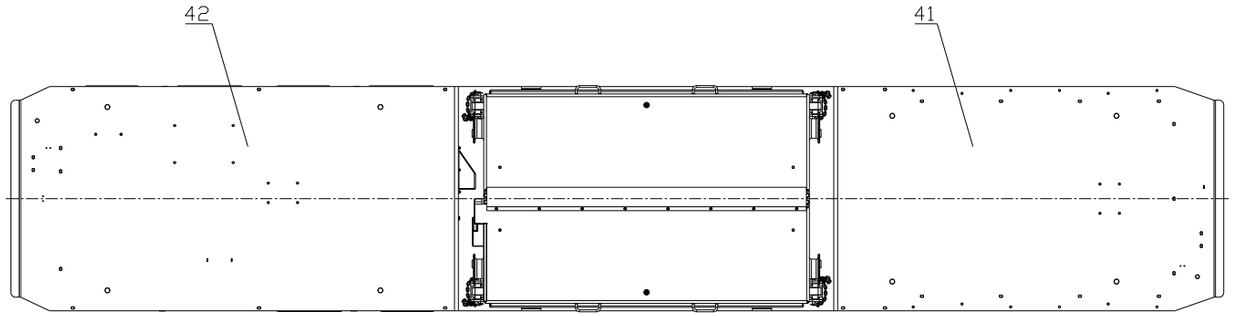
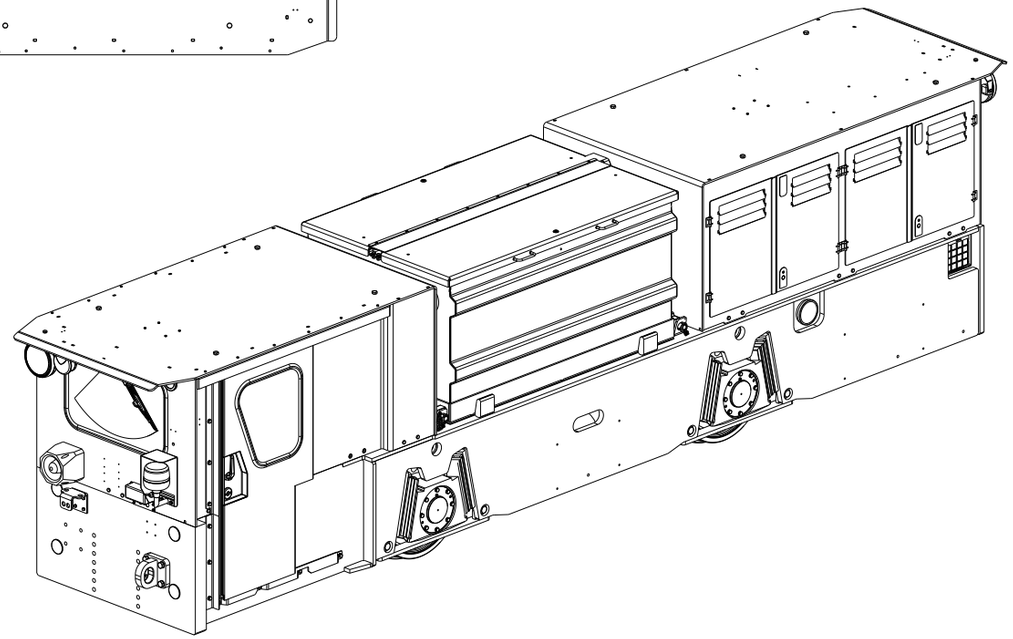


DRAWING









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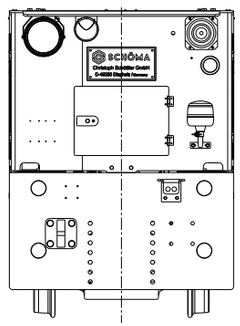
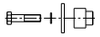




Hebezapfen nur zum Anheben, Umsetzen oder Verladen der Lok, während des Betriebes Teile demontieren.

Lifting point for lift, load or displace the loco, during operation parts must be detached

Maße ohne Toleranzangaben nach DIN ISO 2768m	Oberflächen nach DIN ISO 1302	SCHÖMA Postfach 1309 49345 Diepholz/Germany		Blatt / Blätter 1/1	
Schweißnahtvorbereitung nach DIN EN ISO 9692-1	Schweißen nach DIN EN ISO 13920-BF			Maßstab 1:10	
Brennschnitt nach DIN EN ISO 9013-332		Verwendungsbereich	Benennung General view CEL-40 Typ 2		
			Datum	Name	Zeichnungsnummer
Für diese Zeichnung behalten wir uns alle Rechte nach DIN ISO 16016 vor.		Bearb.	23.07.2021	S.Thöttke	01.004.171-00
		Gepr.	23.07.2021	N.Thöttke	

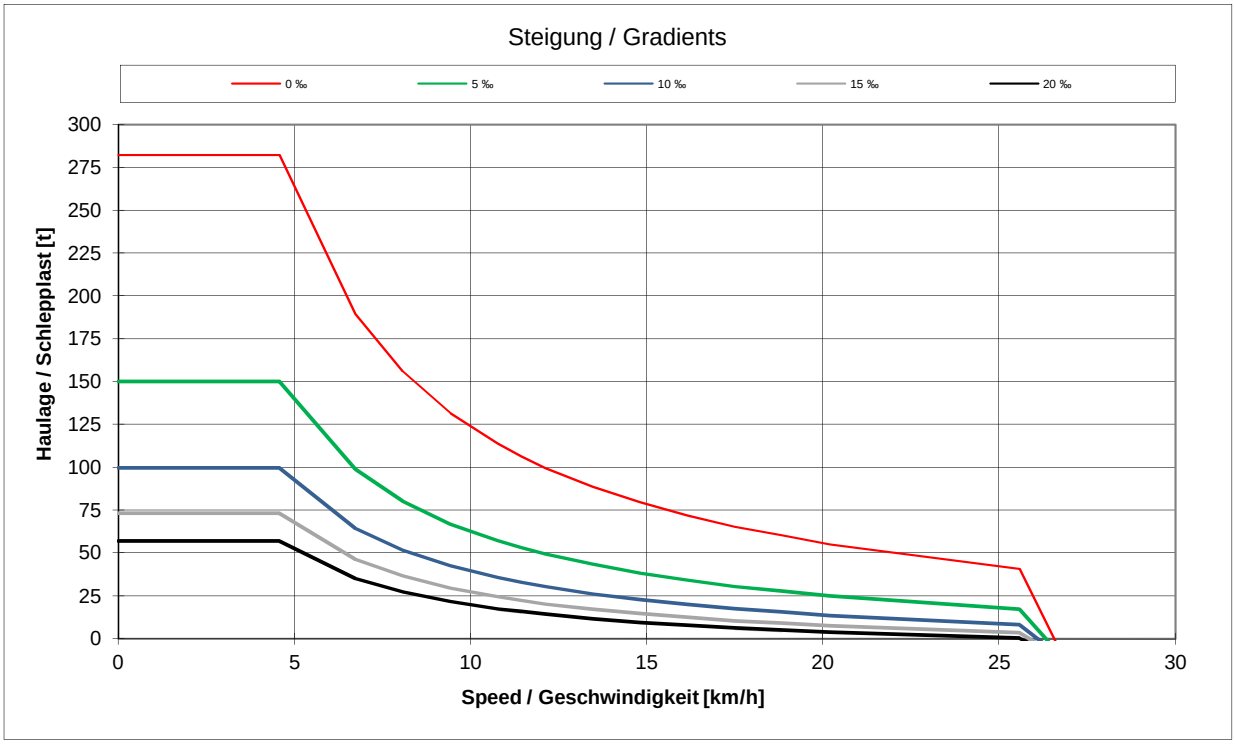
LOCOMOTIVE PERFORMANCE

Battery Electric Tunnel Locomotive CEL-40
Performance

Max. Motorleistung / Max. power:	**38**	[KW]	
Traktionsgewicht / Traction weight:	**12**	[t]	
Max. Zugkraft / Max. traction force:	**22,9**	[KN]	Antrieb / Traction System

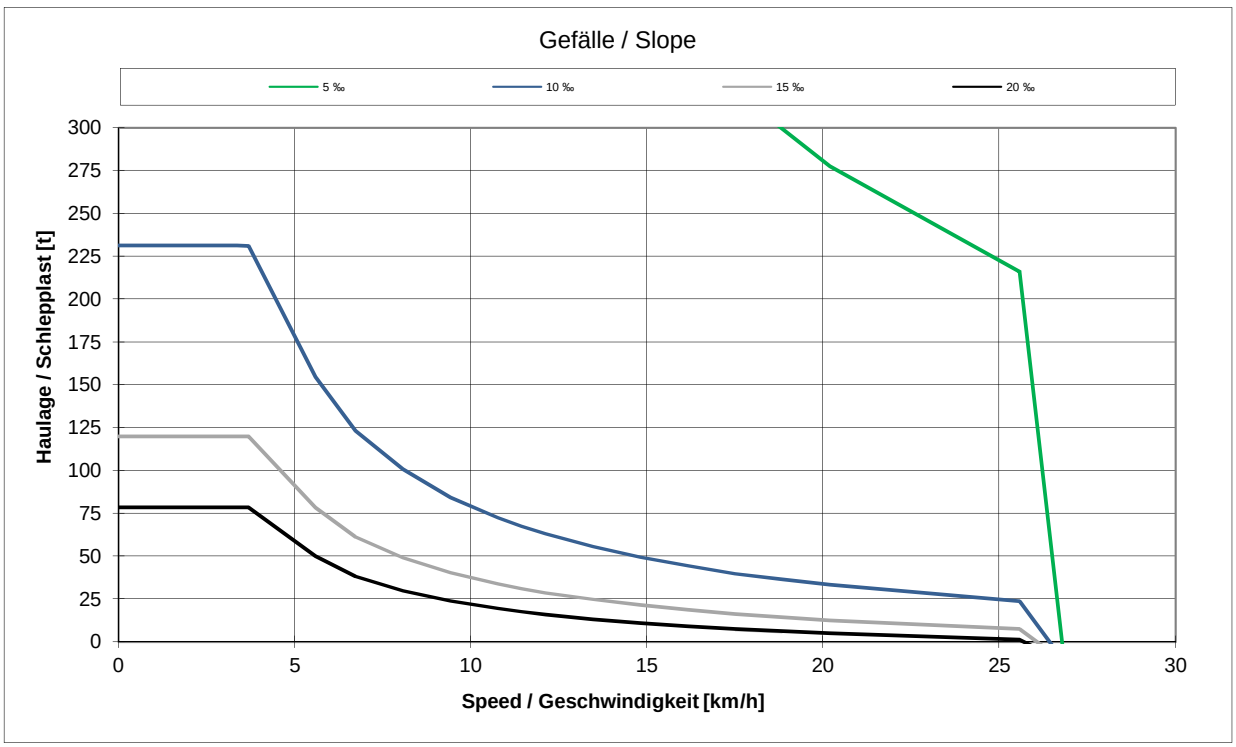
Schleppleistung / Traction Power

Max. Zugkraft / Max. traction force: **17,7** [KN] @ Reibwert / Friction factor: **0,15**



Verschleißfreie Bremsleistung / Wear Free Brake Power

Max. Bremskraft / Max. brake force: **14,1** [KN] @ Reibwert / Friction factor: **0,12**



BATTERY CAPACITY CALCULATION

Battery Sizing

Locomotive model: **CEL-40** **Project: NIMES, France**

Locomotive specification:

Locomotive weight	12	tonnes
Locomotive quantity	1	
Total Traction weight	12	tonnes
Battery capacity	1550	Ah
Battery voltage	80	V
Batteries per loco	1	
Max. battery discharge	75	%
Usable battery energy	93	kWh

Working condition:

Temperature	max. 40	°C	
Humidity	max. 95	%	
Altitude	max. 1000	m	
Rolling resistance	60	N/to	
Max. haulage	33	to	**in**
	55	to	**out**

Track section 1

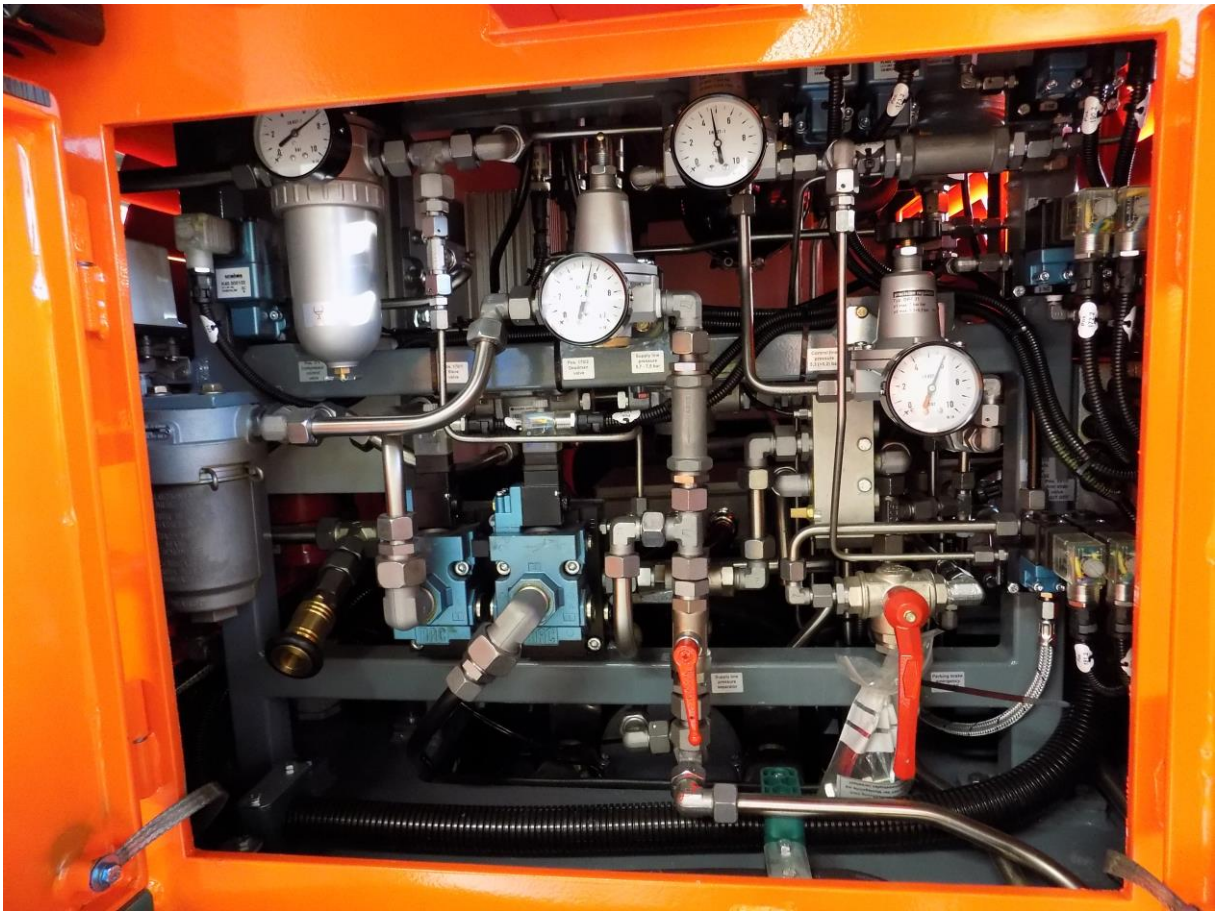
Track length	1	km	
Gradient	1,00	%	**in**
	-1,00	%	**out**
Consumption per ride	3,76	kWh	**in + out**

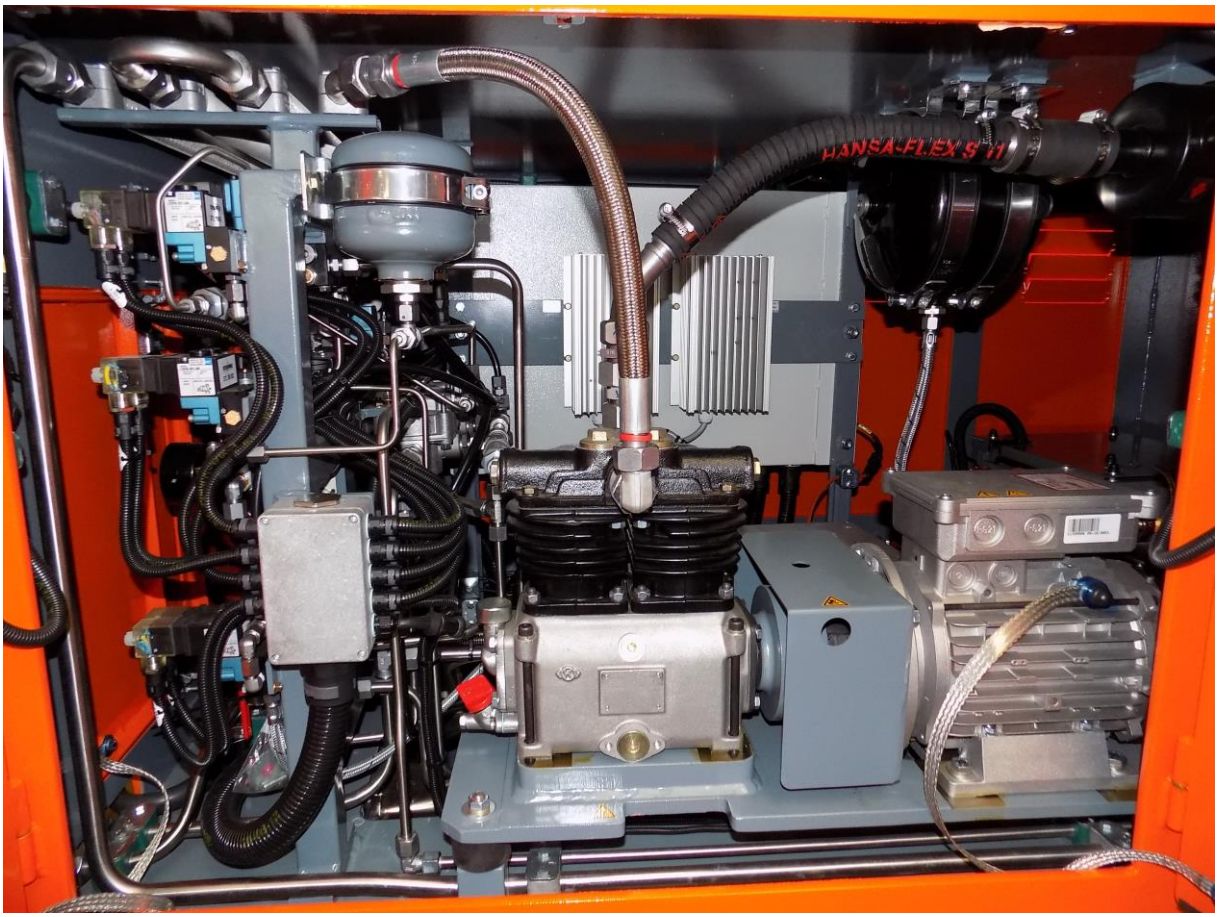
Total Consumption per ride @ max. length	**3,8**	**kWh**	**in + out** **incl. all auxiliary consumers**
Possible driving cycles	**24,8**	**@ max. length**	

Max. travel distance	**50**	**km**	

PHOTOGRAPHS

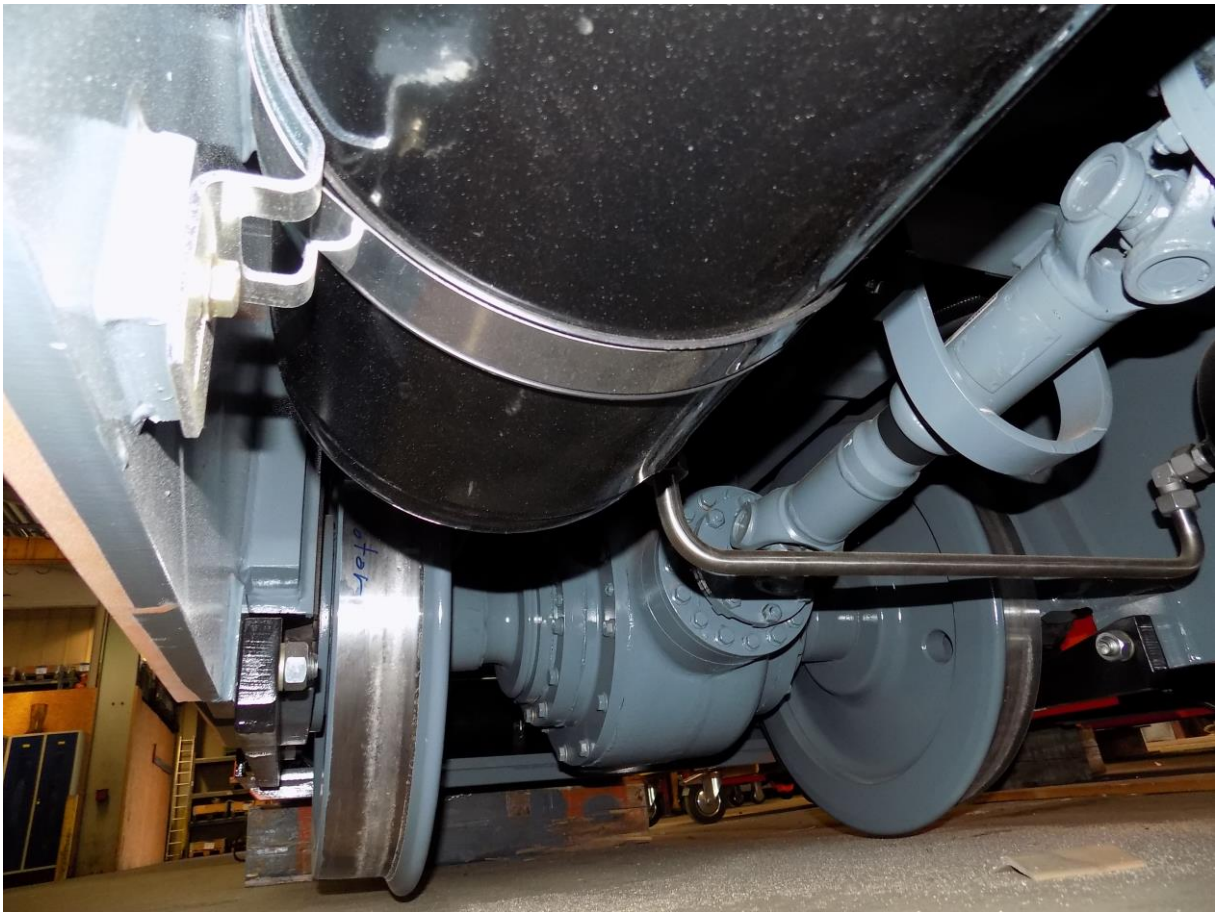
Photographs of a CEL-40



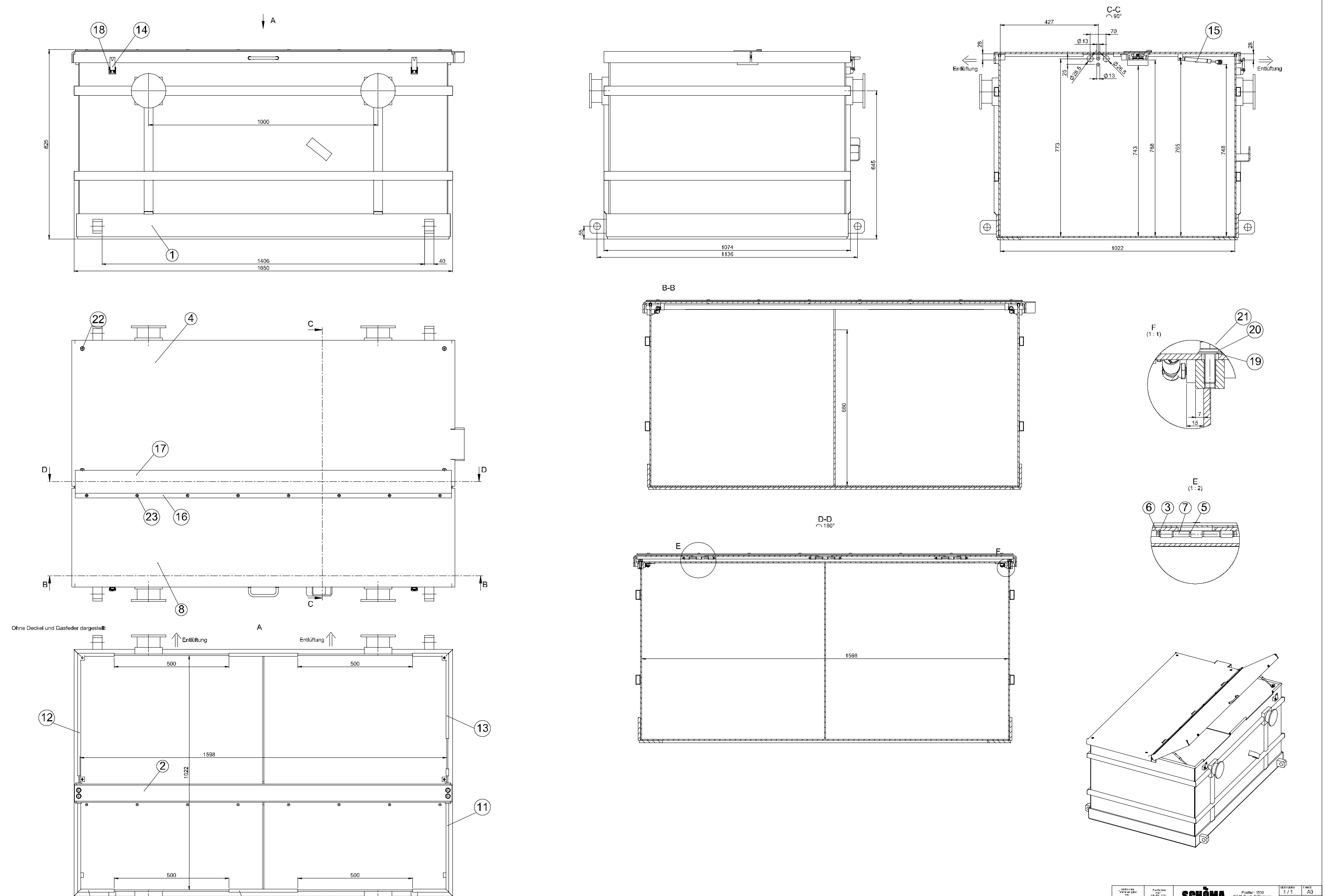

HANSA-FLEX S 11


On-board supply
1232E - Invert
HIGH VOLTAGE!
WABCO


THIS SIDE UP
GRAF-SYTECO
Maximum speed 25 kph
Attention!
Never throw sand in slipping wheels!



DATA SHEET: BATTERY SYSTEM

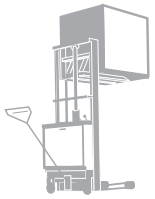


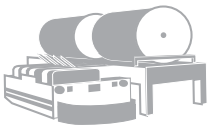
Maße ohne Toleranzangaben nach DIN ISO 2768m	Oberflächen nach DIN ISO 1302	SCHÖMA LOKOMOTIVEN	Postfach 1509 49345 Diepholz/Germany Tel.: ++49 5441 / 997-0	Blatt / Blätter 1 / 1 — Format A0 — Maßstab 1:5
Schweißnahtvorbereitung nach DIN EN 29692	Schweißen nach DIN EN ISO 13920-BF	Verwendungsbereich:	Benennung: Batteriekasten Kompl.	
Brennschnitt nach DIN EN ISO 9013-332				
Für diese Zeichnung behalten wir uns alle Rechte nach DIN ISO 16016 vor.		Datum / Name — Bearb. / Gepr. / Norm	Zeichnungsnummer: 3030074263	Zeichnungsindex: G

Battery System

Typical system as described below, however different suppliers are chosen

Traction batteries
Hawker perfect plus





EnerSys®
Power/Full Solutions

Superior efficiency and reliability – Increased capacities

HAWKER
perfect plus

The Hawker perfect plus motive power batteries provide a high level of power and reliability for all industrial truck applications, from simple applications with a low capacity loading up to heavy duty multi-shift applications.

Why "plus" ?

Compared to the former perfect range, the Hawker perfect plus cells provide higher efficiency in discharge achieved by advanced components used in the construction of the positive plates. The sizing of the positive and negative plates has been optimised according to the volume available in the cell boxes. The process of filling the positive plates has been improved. All these technical enhancements have enabled an increase in the cell capacities while keeping the same exterior dimensions. The Hawker perfect plus range is at the highest technology level and has a very high efficiency. This improvement integrates the european harmonisation of the DIN and BS ranges. This range meets the dimensions of standards DIN/EN 60254 and IEC 254-2.

Cell construction

All Hawker perfect plus cells use the robust tubular vented technology (PzS). The positive electrodes are diecast tubular plates (PzS) and advanced components used in their manufacture provide increased efficiency. The negative plates are flat pasted plates. The separator is of the microporous type. The cell box and lid are made from high impact, temperature resistant polypropylene and are heat-seal welded to prevent electrolyte leakage.

Terminals

The special design of the terminals ensures that no electrolyte can leak from the cells.

Cell connectors

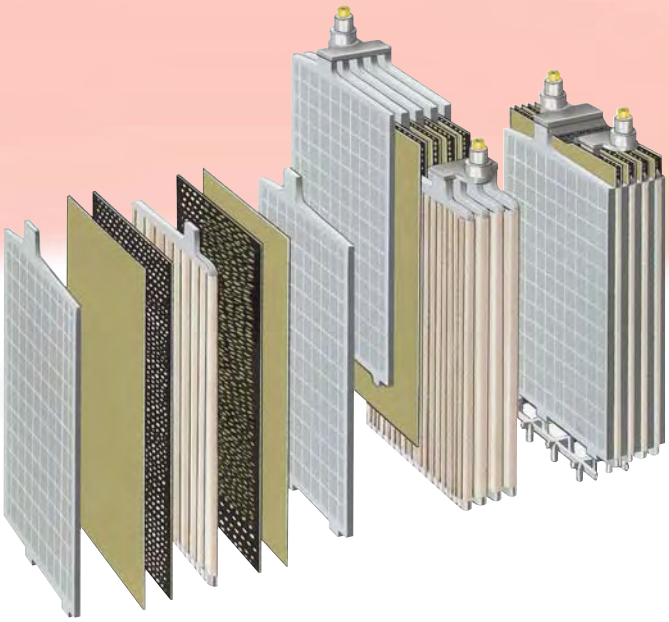
The cells are joined by fully insulated flexible and halogen free connectors. The bolt-on connectors allow cells to be replaced or moved without excessive work.

Flip top plugs

Flip top plugs with electrolyte level markings are fitted. These allow adequate escape of charging gasses and provide a safe anti-surge baffle for the electrolyte during operation.

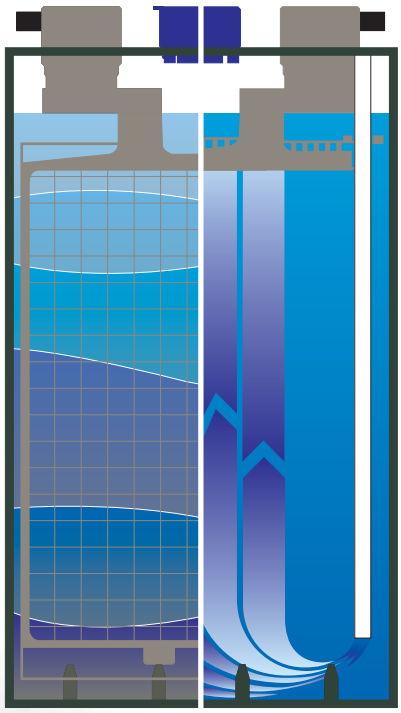
Lid

The lid is equipped with holes for installation of electrolyte circulation system, these can also be used for temperature sensor tests.



Hawker aquamatic

The aquamatic water refill system makes it possible to top up all the cells from one central point through an integrated system. The aquamatic vent plugs automatically ensure the optimum filling level and also allow the measurement of electrolyte specific gravity. The aquamatic kit can be expertly fitted at the factory and on site.



Stratification of the electrolyte at different specific gravity levels

Electrolyte circulation

Electrolyte circulation

The Hawker electrolyte circulation system, using the AirLift principle, consists of a pipe system which is fitted in the cells. A diaphragm pump sends a low rate airflow into the cell which creates a circulating air stream inside the cell box. This system prevents electrolyte stratification and the battery charging is optimised.

Benefits

Hawker perfect plus

- increased capacities in same dimensions
- higher running time and battery availability
- european harmonisation of capacities and sizes in DIN and BS ranges

Hawker perfect plus with electrolyte circulation

- no electrolyte and temperature stratification during partial or complete charging process
- optimal charge acceptance by positive and negative electrodes and therefore uniform plate stressing
- charging time shorter by up to 30 % and energy savings of up to 20 % compared with conventional charging processes
- minimised gassing phase, reduced sludging and water consumption reduced by up to 70 %
- temperature rise during charging is up to 10 °C lower, allowing use in warm ambient conditions
- more rapid battery availability for the same nominal charging current due to shorter charging time and therefore higher battery utilisation rate in multiple shift operation
- higher performance and longer battery service life in heavy operation particularly with opportunity charging
- longer maintenance intervals, lower maintenance costs

Definition of application fields

1. Low duty
single shift with light operation and discharge lower than 60 % C_5.
electrolyte T °C about 30 °C

2. Normal duty
single shift with discharge up to 80 % C_5.
electrolyte T °C 30 °C

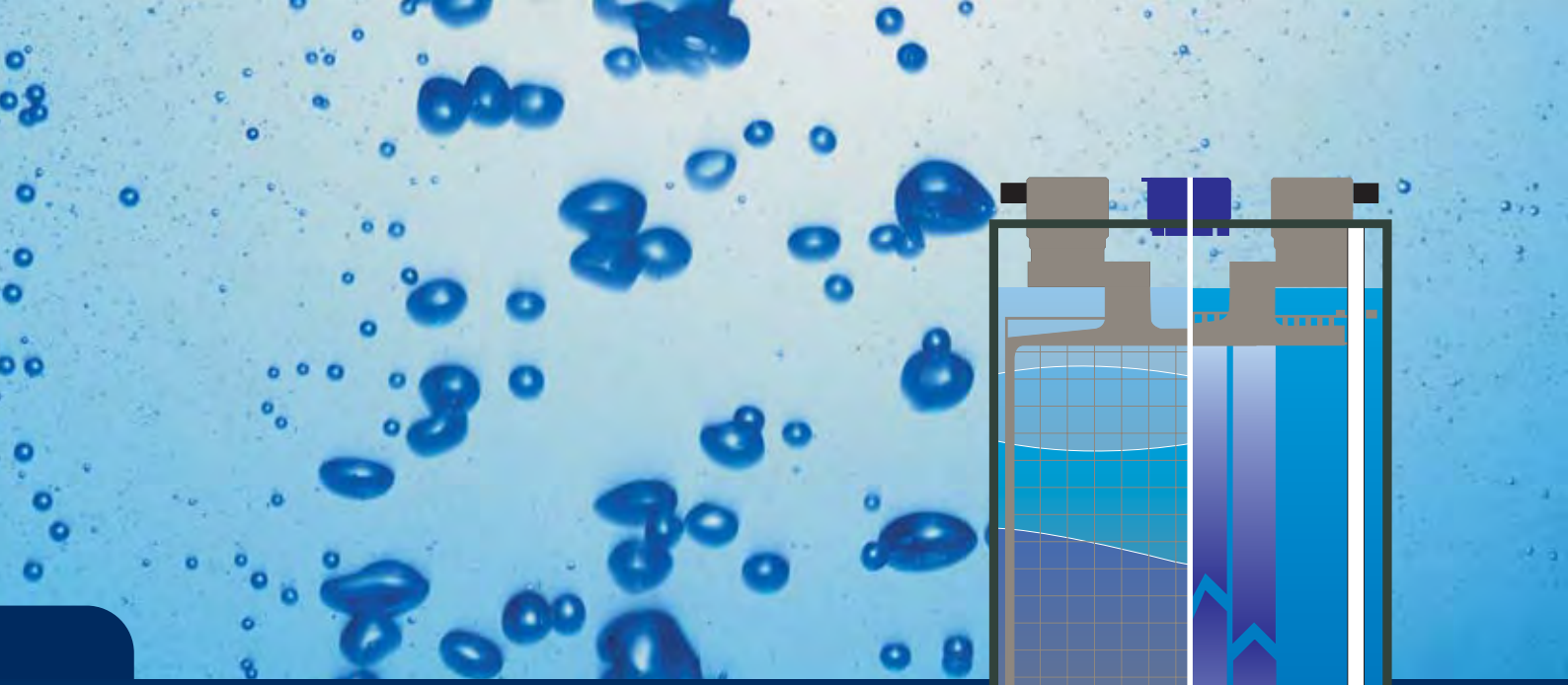
3. Heavy duty

- single shift with discharges of 80 % C_5 and high discharging currents
- opportunity charging to augment the useable capacity
- multi-shift operation with or without battery changes
- high ambient temperature

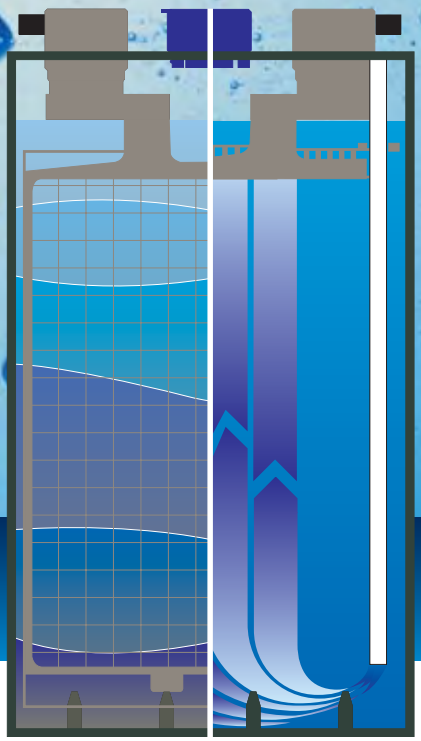
	1. Low duty	2. Normal duty	3. Heavy duty
Hawker perfect plus	■	■	■
Hawker perfect plus with electrolyte circulation	■	■	■
Hawker Water Less®	■	■	
Hawker Water Less® with electrolyte circulation	■	■	■
Hawker wf200 plus	■	■	
Hawker evolution	■		

HAWKER

EC Hawker Electrolyte Circulation System



Perfect High Performance



Electrolyte stratification at different specific gravities

Electrolyte circulation using the AirLift principle

HAWKER

Hawker Electrolyte Circulation System

The advantages of Hawker vented batteries with electrolyte circulation system and the customer benefit derived from it led to increased use of this series. Particularly in applications where high performance, short charging times and high temperatures are anticipated the Hawker vented battery with electrolyte circulation is the preferred traction battery.

Construction

When batteries are being charged, the acid components in the electrodes find their way into the free space taken up by the electrolyte. Due to their higher specific weight they sink to the bottom of the cell and are concentrated there. Maximum utilization of the active compound requires a uniform specific gravity of the electrolyte over the height of the plate. In conventional charging processes this would be ensured by a specified overcharge following a full charge. This overcharge would cause heavy gassing, and this would result in a more uniform specific gravity of the electrolyte. It would also entail longer charging times and an increase in heat generated and thus an increase in energy costs and a reduction in battery life. With electrolyte circulation the electrolyte is induced to flow around the cell by the introduction of atmospheric air. The air is supplied by an aeration pump and motor unit fitted in the charger, on the battery or in the vehicle, depending on the application.

Electrolyte Circulation

Hawker electrolyte circulation using the AirLift principle comprises a system of tubes built into the cell. A diaphragm pump conducts a weak current of air into the cell, setting up circulation inside the cell container. This prevents electrolyte and temperature stratification and optimizes charging.

Advantages

- Saving of up to 30% in charging time
- Saving of up to 20% electricity consumption per charge
- Reduction of electrolyte temperature by up to 10°C per charge
- Avoidance of electrolyte and temperature stratification
- up to 75% less water consumption
- water top-up intervals are up to 4 times as long
- even more economical charging equipment possible (reduced current rating)

Efficiency calculation

Example: Battery 80 V 620 Ah

- Charger: Type Hawker WoWa 50 Hz, 80 V / 125 A
- Energy saving per charge: 10 kWh
- Charging time reduced by 25%, from 8 hrs to about 6 hrs
- Savings of about 1 litre of water per charge
- Temperature rise during charging reduced by about 10°C

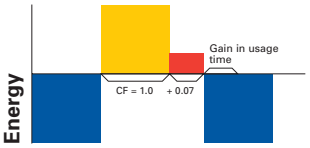
Charging

Discharging stage Main charging stage After-charging stage

Normal

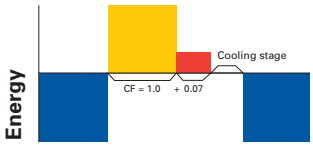
Normal charging with charging factor (CF) = 1.2

With EC - Variant 2



With charging factor (CF) of 1.07:
1-way temperature reduction effect due to lower charging factor of 1.07 combined with gain in usage time
- Savings of up to 30% in charging time, giving greater battery availability for even more economical usage

With EC - Variant 1

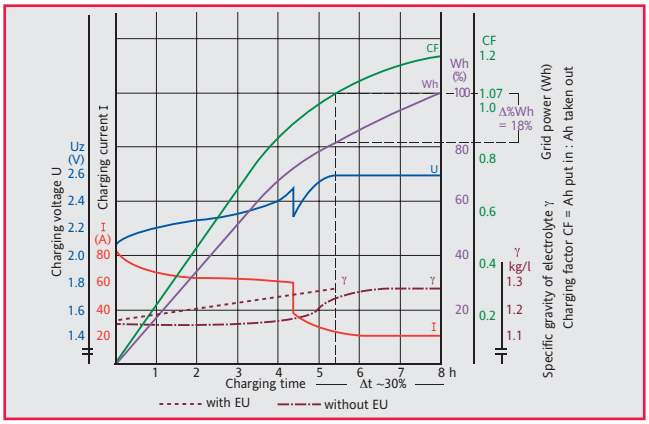


With charging factor (CF) of 1.07:
2-way temperature reduction effect due to lower charging factor of 1.07 and cooling stage
- Longer working life due to lower heat generation and careful charging

With EC - Variant 3

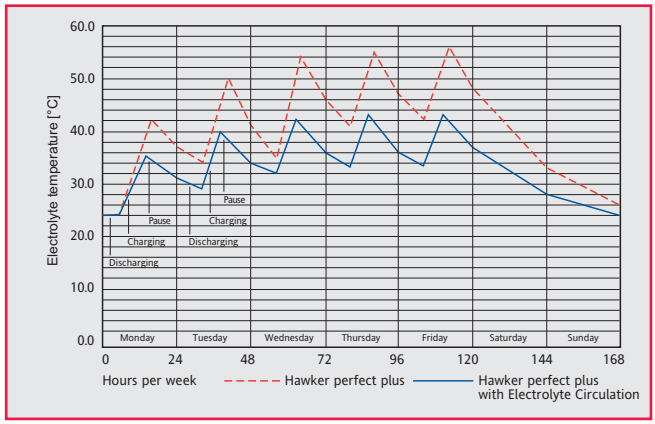
With charging factor (CF) of 1.07:
2-way temperature reduction effect due to use of a charger with a lower current rating and a charging factor of 1.07
- Lower investment costs due to more economical design of charging equipment

WOWa charging graph



The fully charged state is achieved when the final specific gravity of the electrolyte γ has been reached. The graph shows that with the use of the electrolyte circulation (EC) system this state has been reached after only 5.5 hours with a charging factor (CF) of 1.07. This represents a saving in charging time of up to 30% (Δt), compared with a full charge with a charging factor (CF) of 1.2.

Temperature



Temperature changes over one week with normal charging and with charging with electrolyte circulation. Usage over one week.

Example: Battery: 80 V 6 PzS 930

- Charging current = 1.1 x I_5*
- Mean discharge current = 0.5 x I_5*
- Ambient temperature = 20 °C

* Current I_5 = rated 5 hr capacity

HF charger and electrolyte mixing

The Hawker Lifeplus, Powertech & Lifetech (from 24V 50A) are ideally suited for use with Hawker electrolyte mixing. In addition to operating at a low CF 1.07, these chargers adapt automatically to:

- Capacity of the battery
- Voltage of the battery (Lifeplus)
- Depth of discharge of the battery.

These factors plus high energy efficiency, very high and constant power factor, reduced overcharge factor and delayed start of charge available on Hawker Lifeplus and Powertech ranges deliver significant energy cost reductions.

powertron vario

industrie automation

The highly flexible HF charging system

- ▶Quick charge from 4,5h with AEM
- ▶Ideal for charging of big batteries – charger up to 300A
- ▶Charging technology for flooded and Li-Ion (*liflex*) batteries

Charger type	Battery type	Charging time (h)
powertron vario	**Standard PzS**	**7 – 14h**
powertron vario	**Standard PzS with AEM**	**4,5 – 13h**

Your benefits

- ▶**Compact and modular construction**
  -Reduced need of space due to integration of two different chargers in one rack
  -Combination of two chargers freely selectable:
  Voltage: 24V, 48V, 80V
  Charger current: 85A – 300A (see type table)
- ▶**Ideal for charging of big batteries in multi shift** – charger up to 300A
- ▶**Quick charge**
  -Special charging programme for quick charge from 4.5 hours with AEM
  -No spare battery and battery change
- ▶**High availability due to** unique ventilation system with forced ventilation through a separate air duct, resulting in lower sensitivity to dust
- ▶**Clear information about state of charge through** large coloured text-display

Standard features

- Pulse charge characteristic
- Soft start
- Coloured text-display with info about state of charge
- Data check via menu button
- IrComm-interface and data memory
- PFC-Filter
- Automatic equalising charge
- Automatic maintenance charge
- Delay of start

Options

- Charger plug
- Air circulation (AEM)
- Control for automatic water refill
- External ON / OFF
- Remote display
- Temperature driven recharge
- Special charging characteristics
- External signalling
- Battery controller-capability
- AGV-application

powertron vario

industrie automation

Type table

Voltage	Charging time **4,5 - 13h** PzS with AEM	Charging time **7,0 - 14h** PzS with Puls	Charger typ V / A	case
24V	280 – 1050 Ah	500 – 1125 Ah	E 24V / 85A	G40 (G50)
	500 – 1925 Ah	875 – 1950 Ah	D 24V / 150A	
	665 – 2300 Ah	1130 – 2450 Ah	D 24V / 200A	
	775 – 2800 Ah	1400 – 2900 Ah	D 24V / 240A	
	1000 – 3500 Ah	1700 – 3700 Ah	D 24V / 300A	
48V	280 – 1050 Ah	500 – 1125 Ah	D 48V / 85A	G40 (G50)
	400 – 1500 Ah	700 – 1550Ah	D 48V / 120A	
	500 – 1925 Ah	875 – 1950 Ah	D 48V / 150A	
	665 – 2300 Ah	1130 – 2450 Ah	D 48V / 200A	
	775 – 2800 Ah	1400 – 2900 Ah	D 48V / 240A	
	1000 – 3500 Ah	1700 – 3700 Ah	D 48V / 300A	
80V	280 – 1050 Ah	500 – 1125 Ah	D 80V / 85A	G40 (G50)
	400 – 1500 Ah	700 – 1550Ah	D 80V / 120A	
	560 – 2100 Ah	975 – 2200 Ah	D 80V / 170A	
	775 – 2800 Ah	1400 – 2900 Ah	D 80V / 240A	
	1000 – 3500 Ah	1700 – 3700 Ah	D 80V / 300A	G50

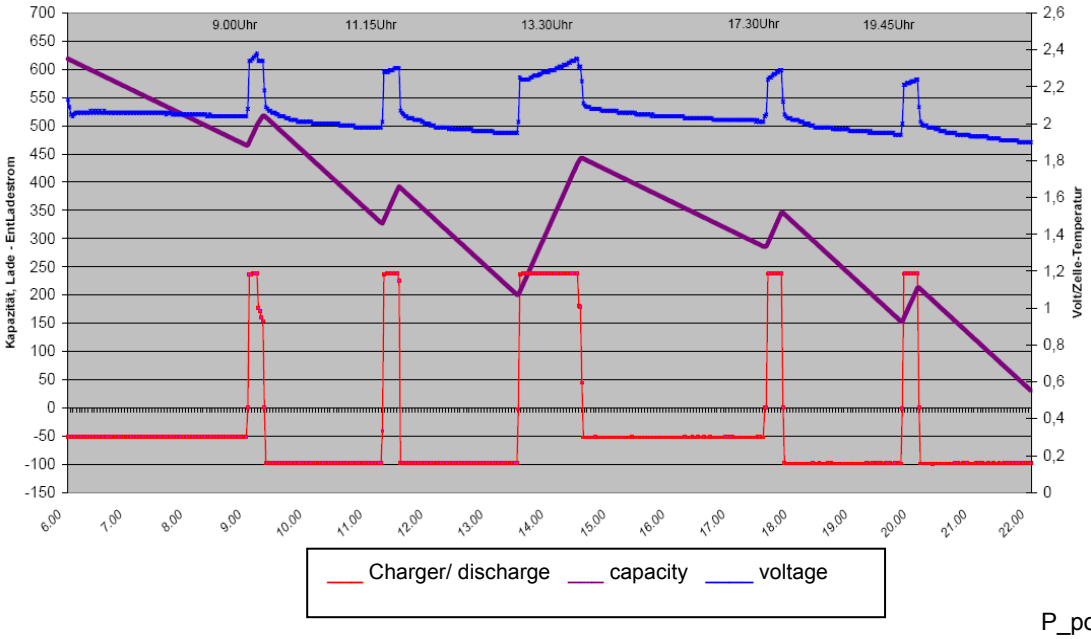
Dimensiona

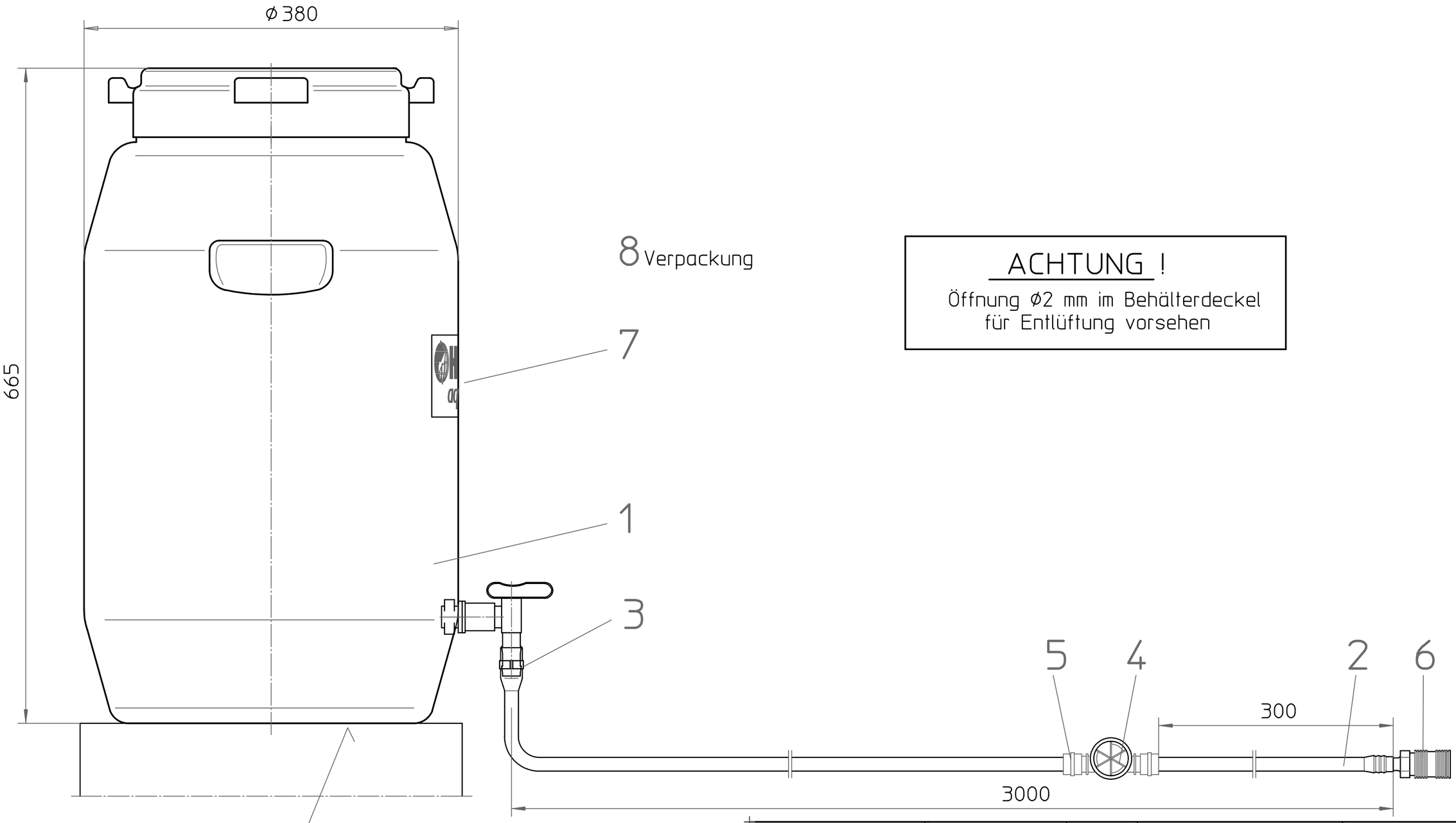
case	Width [mm]	Height [mm]	Depth [mm]
G40	575	660	570
G50	575	1200	570

Code letter E = Single phase 1x230V 50Hz

Code letter D = Three phase 3x400V 50Hz

Quick charge application





ACHTUNG !

Öffnung ø2 mm im Behälterdeckel
für Entlüftung vorsehen

Beachten !

Montagehöhe Behälter
ca 3000 mm

Allgemeintoleranzen für Schweißkonstruktionen (mm) A EN-ISO 13920

Längenmaße	
< 400	±1
> 400 - 1000	±2
>1000 - 2000	±3
>2000 - 4000	±4

Winkelmaße	
< 400	±20' bzw. ±6 mm/m
> 400 - 1000	±15' bzw. ±4.5 mm/m
>1000	±10' bzw. ±3.0 mm/m

Allgemeintoleranzen für Längen- und Winkelmaße (mm) DIN ISO 2768 Teil 1

Längenmaße	f	m	c	v
> 0.5 - 6	±0.1	±0.2	±0.4	±0.5
> 6 - 30	±0.2	±0.5	±1	±1
> 30 - 120	±0.3	±0.8	±1.5	±2
>120 - 400	±0.5	±1.2	±2.5	±4

Winkelmaße	f	m	c	v
< 10 - 50	±1°	±30'	±45'	±1°
> 50 - 120	±20'	±20'	±30'	±1°
>120 - 400	±10'	±10'	±15'	±30'
>400	±5'	±5'	±10'	±20'

Rund/Schräg	
> 0.5 - 3	±0.2
> 3 - 6	±0.5
> 6	±1

Allgemeintoleranzen für Längen- und Winkelmaße (mm) DIN ISO 2768 Teil 1

Längenmaße	f	m	c	v
> 400 - 1000	±0.8	±1.2	±2	±3
>1000 - 2000	±1.2	±2	±3	±4
>2000 - 4000	±2	±3	±4	±5

Verwendungsbereich:	Maße ohne Toleranzangabe nach	Abteilung	Maßstab: 1:4 im Original	Gew.: Kg.
BT Traktion		TT3 Hagen	Werkstoff:	Werkstoff-Kennzahl:

		Datum	Name
Bearb.		11.12.03	Djordjevic
Gepr.			
Freig.		17.12.03	
Geänd.			

HAWKER | CAD | Verteiler Z7

Zust.	Änderungs-Nr.	Ers.d. / Ers.f. / Urspr.:
		Ers.d.
00	52-2003	Ers.f. 300.0022.00551-02
		Urspr.:

Benennung:

Aquamaticstation Kpl. 60L

Set komplett vormontiert

Mat. Nr. 3147347 | Blatt 1

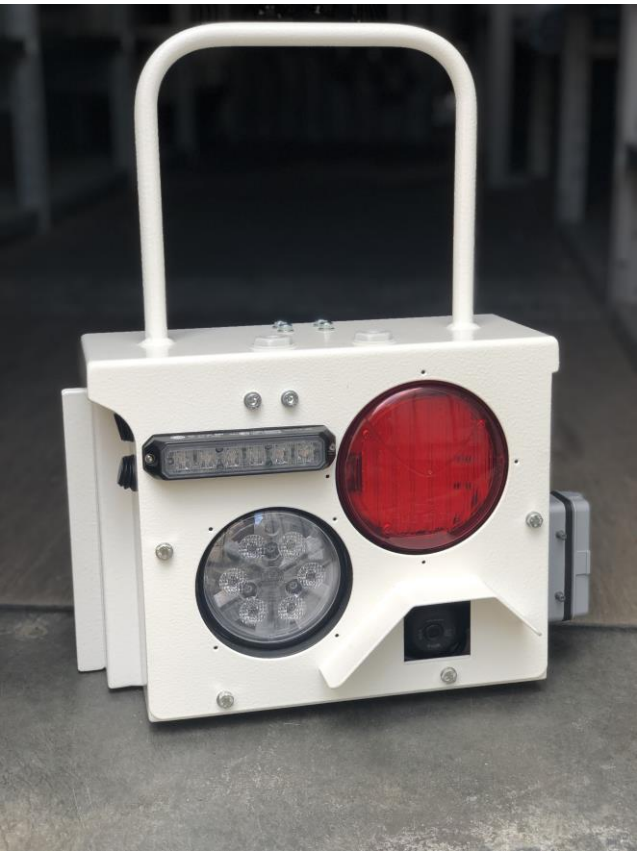
Zchg. Nr. 300.0022.00638

DESCRIPTION: HARD WIRED VIDEO SYSTEM

TECHNICAL DESCRIPTION
Hard Wired Video System

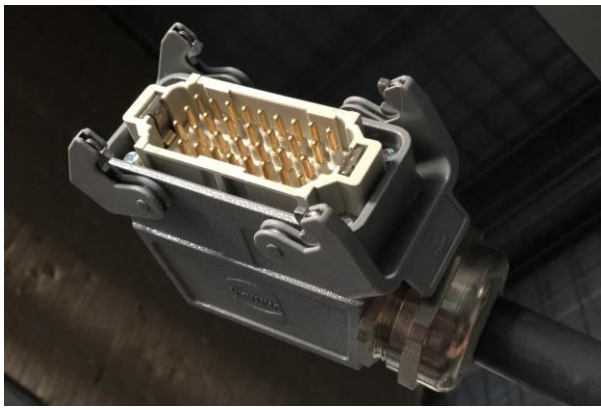
MONITOR

- 7" LED colour monitor
- Installed in locomotive driver's cabin
- Max. 3 cameras connectable
- **12" LED MONITOR AGAINST EXTRA COSTS AVAILABLE**



CAMERA BOX

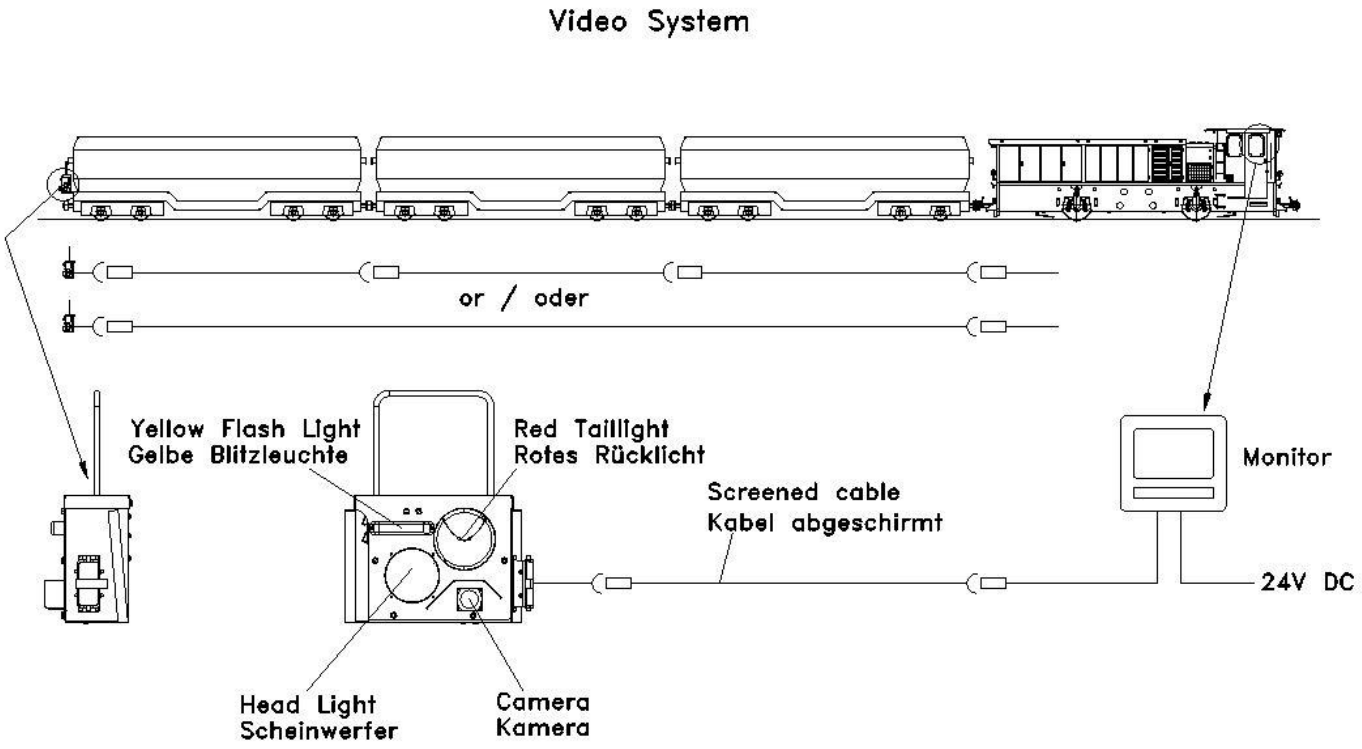
- High resolution colour camera
- High sensitivity to light
- Shock and vibration resistant
- Camera protection class IP 68
- Hardened and heated lens
- Light-weight protection box
- LED-Flash light
- LED head and tail light
- Electronic buzzer
- Robust waterproofed connectors, IP 68



CHARACTERISTICS

Signal transmission insensitive to sources of interference

SCHEMATIC


Video System
or / oder
Yellow Flash Light
Gelbe Blitzleuchte
Red Taillight
Rotes Rücklicht
Screened cable
Kabel abgeschirmt
Monitor
24V DC
Head Light
Scheinwerfer
Camera
Kamera

DESCRIPTION: LOCOMOTIVE CONTROL SYSTEM

TECHNICAL DESCRIPTION
ELECTRONIC LOCOMOTIVE CONTROL

Besides the conventional hard-wired relay control system all SCHÖMA locomotives can be equipped with a PLC (= programmable logical control) system, which provides certain benefits for the operation of the locomotive.

ADVANTAGES

- Only one operator handle is needed to accelerate and decelerate the locomotive.
- An ergonomically arranged display shows the relevant operating parameters and also warning and failure messages.
- The display text can be loaded for any language.
- Different driving modes can be selected.
- Optimum traction efficiency, which reduces the fuel consumption significantly.
- An additional brake handle for the train brake is installed on all hydrodynamic locomotives to give the driver the possibility to use the train brake independently.
- This is an additional safety device for using hydrodynamic locomotives on steeper slopes.
- Many functions can be specially adapted to the operation condition on site.

- Wheel slide detection system (anti-skid / anti-slip device) to optimize the traction and braking performance for hydrodynamic and –static drive systems
- Data logger with memory chip records driving parameters and fault reports over a period of min. 3 months.

MULTI TRACTION

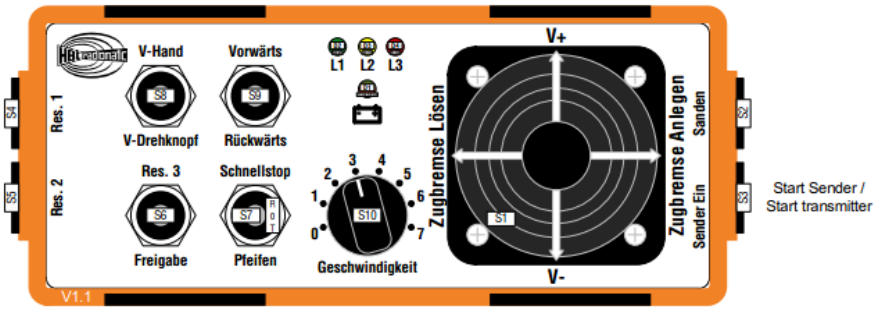
- Two or more locomotives can be operated in the train configuration, driven by one driver.
- The communication between the locomotives is by CAN-Bus via cable.
- The locomotives can be located anywhere in the train consist.
- The master locomotive communicates all driving and braking commands to the slave locomotives, including starting and stopping of the diesel engine.
- Error messages generated by the slave locomotives are communicated to the master locomotive.
- **OPTIONAL AGAINST EXTRA COSTS**

CONTROL PANEL

- To ensure direct view to the tracks at the opposite train end a control cabin can be mounted to the first car of the train consist to operate the locomotive.
- Alternatively a control panel corresponding with the arrangements on the locomotive can be mounted in a personnel car to operate the locomotive.
- The control cabin / panel and the locomotive are connected via cable and CAN-Bus.
- **OPTIONAL AGAINST EXTRA COSTS**

RADIO REMOTE SYSTEM

- To operate the locomotive from a remote location. The max. distance between the locomotive and the operator with the transmitter in his hands would be 50 m inside and 100 m outside the tunnel (with free vision).



- Especially recommended for shunting, loading and unloading sceneries in and outside the tunnel.
- **OPTIONAL AGAINST EXTRA COSTS**

BRAKING EFFORT DIAGRAMM

Braking Effort Diagram

Project: **Nîmes, France**

Locomotive:

Type:	**CEL-40**	
Weight:	12	[t]
Nos.:	1	

Train:

Weight without locomotive:	55	[t]
Weight percentage of the braked axles:	0	%
Weight percentage of the braked axles:	50	%
Weight percentage of the braked axles:	100	%

General:

Rolling Resistance:	40	[N/t]
Assumed Friction Factor (Wheel / Rail):	0,12	
Additional Safety Factor:	1	
Slope (up=+, down=-):	-1	%
Reaction time of the brake system:	3	[s]
Max. speed:	20	[km/h]