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rail | power PzS batteries

Operating and assembly instructions

Version overview

Revision	date	Status	Name	Chapter	Reason for change
00	2024-11-07	Created	W. Pickart	-	New creation
	2024-11-08	Tested	M. Stump		
	2024-11-08	Released	Dr D. Mahl		

Foreword

Dear customer,

Thank you for choosing a product from our company.

Read this documentation carefully before working on the battery system or its components. It contains important information on the safe and correct unpacking, storage, installation, commissioning, operation and maintenance of rail | power PzS batteries.

We reserve the right to make changes to the content of this documentation. Our products are constantly being further developed. Therefore, there may be differences between the illustrations in this documentation and the product you have purchased. These installation instructions are not subject to change.

Please note that the version of the battery manual was up to date at the time of delivery, but the latest version of the manual should still be downloaded from the Hoppecke homepage at: https://www.hoppecke.com/de. This is the only way to ensure that the technical information is up to date. This applies in particular if the battery system is modified, adapted or extended.

Keep this documentation in such a way that it is immediately available to all persons who have to carry out activities in connection with the battery system or its components.

HOPPECKE Business Unit Rail

Hoppecke Battery Systems GmbH
P.O. Box 11 80, D-59914 Brilon
Bontkirchener Str.1, D-59929 Brilon

Phone: +49 (0) 29 63 61 1412
Fax: +49 (0) 29 63 61 1452

Internet: www.HOPPECKE.com
Email: hbs@hoppecke.com

Service hotline:
+49 (0) 2963 61 591
Email:
service@hoppecke.com

Table of contents

1. About these instructions

These operating and installation instructions are intended to help you optimise the operation, installation and maintenance of the HOPPECKE rail | power PzS cells used. This is the only way to achieve maximum service life.

Contact your local contract partner,

- If you have any questions about this documentation,
- If there are local rules and regulations that are not covered by this documentation or that contradict it.

1.1. Target group of this document

All work on the battery and the rail | power PzS cells may only be carried out by trained, fully qualified, authorised personnel (ideally by qualified electricians):

- Personnel authorised by the train manufacturer's safety officer
- Personnel authorised by the train operator's safety officer
- Personnel, authorised by HOPPECKE
- HOPPECKE specialists

Untrained personnel must not carry out any work on rail | power PzS cells.

1.2. Means of presentation

1.2.1. Symbols and signal words

The following symbols and signal words are used in these operating and maintenance instructions:

DANGER!

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING!

Indicates a potential hazard with medium risk that can result in death or serious injury if not avoided.

CAUTION!

Indicates a low-risk hazard that could result in minor or moderate bodily injury if not avoided.

Hint

Indicates information that is important for optimum use of the product.

1.2.2. Graphic symbols / pictograms on the battery system

The following graphic symbols are used in these operating and maintenance instructions and on the product:

EN ISO 7010 - W012
Warning of electrical voltage

EN ISO 7010 - W026
Warning of danger from charging batteries

EN ISO 7010 - W023
Warning of corrosive substances

EN ISO 7010 - W002
Warning of explosive substances

EN ISO 7010 - P003
No naked flames; fire, naked sources of ignition and smoking prohibited

EN ISO 7010 - M002
Follow the instructions for use

EN ISO 7010 - M004
Use eye protection

EN ISO 7010 - M009
Use hand protection

EN ISO 7010 - M010
Use protective clothing

1.3. Notation of nominal data

In these operating and maintenance instructions, nominal battery data is used in accordance with the following notation:

Notation	Meaning	Explanation
Un	Nominal voltage	Defined value for each cell chemistry; corresponds to the average voltage during discharge
U_E	Final discharge voltage	Voltage at which the battery is defined as discharged. This also depends on the discharge current.
U_0	Open terminal voltage	Voltage at the battery terminals in idle state (no charging or discharging)
C_n	Nominal capacity	Electrical charge of the battery in Ah when discharging with nominal current up to the final discharge voltage at nominal temperature
$I_n = I_5$	Rated current	Fixed charge/discharge current (serves as reference value)
C-rate	C-rate	Discharge current of the battery based on its nominal capacity Example: Discharging at 0.2 C for a 100 Ah battery means discharging at 20 A
IXX	Discharge current	Designated as I_{XX} based on rated capacity Example: I_5 for a 100 Ah battery = 100 Ah/5 h =20 A
T_n	Nominal temperature	Reference temperature for capacity
D	Tightening torque of pole screws	M10: 25 Nm ± 3 %

1.4. Abbreviations and definitions

The following table explains abbreviations and terms used in these operating and installation instructions:

Abbreviation/term	Explanation
Trickle charge	Refers to the charging of an accumulator to equalise its self-discharge with the aim of keeping the accumulator in a fully charged state.
Heavy load	Refers to charging an accumulator with increased voltage and a defined current in order to fully charge the accumulator as quickly as possible.
CAS number	The CAS number (also CAS registration number and CAS registry number, CAS = Chemical Abstracts Service) is an international labelling standard for chemical substances.
Electrolyte	HOPPECKE rail | power PzS cells are sealed lead-acid batteries with a liquid electrolyte consisting of diluted sulphuric acid.

1.5. Warranty, test reports Maintenance

This must be documented as proof that the maintenance has been carried out correctly. 13.2 Maintenance log on page 57 you will find table templates for this documentation.

The maintenance documentation must be kept together with the other documentation for the battery/battery system.

Note: When commissioning sealed batteries (VLA products), the acid density and voltage must also be documented from the start to the end of the commissioning process. This must be documented separately and is not included in the table template.

* This documentation must be submitted to the manufacturer as proof in the unlikely event of a warranty claim.

2. Safety instructions

Observe the safety instructions when handling the batteries and their components.

Hint

When handling batteries and their components, please also observe the information sheets of the ZVEI (German Electrical and Electronic Manufacturers' Association):

- Information on the safe handling of lead accumulators (lead batteries)
- Safety data sheet for battery acid

These documents are available at www.zvei.org.

2.1. Sources of danger

2.1.1. Explosive gas mixture

Water is decomposed each time the batteries are charged. This can result in the formation of a hydrogen-oxygen gas mixture (oxyhydrogen gas), which ignites even with a low energy supply.

There is danger from:

- Explosions
- Fires
- Pressure waves
- Flying hot or molten substances

These hazards can be caused by the following ignition sources:

- Short circuits
- Electrostatic charges and discharges
- Smoking
- Open flames / fire, embers and sparks near the batteries
- Electrical sparks from switches or fuses
- Hot surfaces with temperatures above 300 °C

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Measures to avert the danger:

- Work with voltage-insulated, non-sparking tools.
- Ensure adequate ventilation of the battery compartment in accordance with DIN EN IEC 62485-2 so that any explosive gas mixture that may arise is removed.
- Avoid electrostatic charging:
  - Do not wipe batteries with plastic housings with a dry cloth or a cloth made of synthetic material! - Only clean batteries with a cotton cloth moistened with water. Wiping with a cotton cloth moistened with water does not generate an electrical charge. - Wipe batteries with a damp cloth (with water) before removing or tearing off a label.
  - Wear shoes and clothing that prevent the build-up of electrostatic charges due to their special surface resistance (see 2.2 Personal protective equipment on page 16).
- Never clean batteries with feather dusters or dry cloths made of synthetic fibres.

- Use hand lamps with mains cable without switch (protection class II) or hand lamps with battery (protection class IP54).

2.1.2. Electrical voltage

Metal parts of the batteries are always live. High currents flow in the event of a short circuit.

There is danger from:
- Tensions
- Electric shocks

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Measures to avert the danger:
- Be very careful when working on the batteries.
- Never place tools or other metal objects on a battery.
- Remove watches and jewellery before working on the batteries.
- Do not touch any bare battery parts, connectors, terminals or poles.

2.1.3. Electrolyte

Rail | power PzS cells contain diluted sulphuric acid as the electrolyte. The closed lead-acid battery, available as a 2V single cell, is a tried and tested technology based on tubular and grid plate electrodes and liquid electrolytes. The electrodes are designed in lead-antimony technology.

- Electrolyte can leak out as a result of damage to the housing of a cell.
- Reverse polarity of the battery or individual cells can result in overheating and electrolyte leakage.
- Electrolyte is highly corrosive.
- Contact with the electrolyte is excluded during normal operation.
- If the housing is destroyed, the bound electrolyte released is just as corrosive as liquid electrolyte.
- The electrolyte can cause severe skin burns and serious eye damage.

There is a possible medium-risk hazard that could result in death or serious injury if not avoided.

Measures to avert the danger:
- Always wear safety goggles and protective gloves when working on batteries.
- Wash clothing contaminated with electrolyte with water.
- Check correct polarity before making connections.

Take the following first aid measures if contact with the electrolyte has occurred:

Electrolyte on the skin or hair

- Dab off electrolyte with a cotton or paper towel, do not rub off.
- Remove contaminated clothing, avoiding contact with unaffected body parts.
- Rinse affected areas under running water for a longer period of time.

Acid in the eye

- Gently rinse the eye for a few minutes with an eye wash or under running water. Avoid excessive water pressure. If possible, remove any contact lenses and continue rinsing.
- See an ophthalmologist immediately.

Acid in the body

- Rinse out mouth. DO NOT induce vomiting.
- Consult a doctor or go to hospital immediately

2.1.4. Toxic substances

Rail | power PzS cells contain lead.

- Symbol: Pb
- CAS number: 7439-92-1

There is a low-risk hazard that could result in minor or moderate bodily injury if not avoided.

Measures to avert the danger:

- Avoid contact with toxic substances.
- Wear personal protective equipment (see 2.2 Personal protective equipment on page 16).

Hint

REACH

(Registration, Evaluation, Authorisation and Restriction of Chemicals
)

In accordance with the REACH regulation, we would like to point out that HOPPECKE rail | power PzS cells contain the SVHC substance lead metal (CAS.No. 7439-92-1) with more than 0.1 % by weight (SVHC = Substance of Very High Concern).

A material safety data sheet (MSDS) is available from your account manager.

Further information on REACH can be found at https://echa.europa.eu.

2.1.5. Fire

In the event of a fire, there is a risk of:

- Hot or molten substances
- Short circuits
- Open flames / fire, embers and sparks
- Hot surfaces with temperatures above 300 °C

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Measures to avert the danger:

- Wear personal protective equipment against acids (see 2.2 Personal protective equipment on page 16), also use respiratory protection with self-contained breathing air supply for large battery systems. Contact with water can lead to reactions with the electrolyte (acid) and consequently to violent splashing.
- Disconnect the battery electrically.
- Extinguish incipient fires with CO2.
- When extinguishing electrical fires with water in low-voltage systems (up to 1 kV), maintain a spray jet distance of 1 m and a full jet distance of 5 m.
- Delete at short intervals. Otherwise there is a risk of explosion due to possible static charge on the battery housing.

2.1.6. Improper transport

The batteries can be damaged if transported incorrectly. Falling batteries can result in personal injury.

If the batteries are transported incorrectly, there is a risk of:

- Suspended loads
- Falling batteries or parts of batteries
- Leaking electrolyte

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Measures to avert the danger:

- Use safety shoes and safety goggles.
- Do not tilt the batteries.
- Always lift batteries by the handles or lifting points provided for lifting equipment and never carry them by the poles of the battery or the cells.
- Only use authorised lifting and transport equipment, e.g. lifting slings. Lifting hooks must not cause any damage to cells, connectors or connection cables.
- Always set the batteries down carefully to avoid damaging them.
- Use suitable transport equipment.
- Carefully secure the charge during transport to prevent damage to the battery housing.

2.1.7. Notes on disassembly

If the connecting cables have not been disconnected before replacing the batteries, there is a risk of electric shock.

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Measures to avert the danger:

- Before starting to remove the batteries to be replaced, disconnect the supply lines (fuses).

Due to the lead and acid content, rail | power PzS batteries must not be disposed of with the waste or deposited in a landfill at the end of their service life, see . 12 Waste disposal on page 54.

2.2. Personal protective equipment

Always wear protective clothing when working on the batteries and their components:

- Safety goggles
- Protective gloves
- Protective clothing, preferably made of cotton to avoid electrostatic charging of clothing and body
- Safety shoes

In the event of an accident, you can prevent injuries or at least minimise the consequences of injuries.

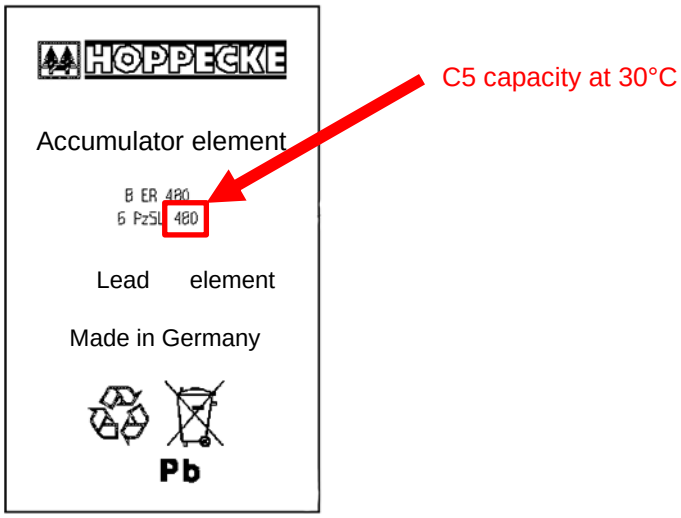
The conductivity of textiles and shoes must have the following properties to prevent electrostatic charging:

- an insulation resistance ≥ ^{105} Ω
- a surface resistance < ^{108} Ω

2.3. Labelling on the product

The type plate of a battery is attached to the container for the battery cells (container, trough, carrier). On the type plate you will find the serial number, date of manufacture, type, nominal voltage, number of battery cells and nominal capacity ($C_5 = C_n$) of the battery.

There is also a type plate on the individual rail | power PzS cells, which indicates the C5 capacity of the cell (reference temperature 30°C).



3. Use of the product

3.1. Intended use

The rail | power PzS cells of the battery are used to store and release electrical energy in rail vehicles.

Use only in rail vehicles for:

- Buffering and supply of the low-voltage on-board electrical system
- Provision of energy in emergencies
- Provision of energy for vehicle maintenance and upgrades
- Starting the vehicle drive motors

The intended use includes the following requirements:

- Only operate the batteries when they are in perfect condition
- No deactivation or dismantling of safety devices
- Compliance with all instructions in these operating and assembly instructions

3.2. Non-intended use

DANGER!

Improper use of the batteries can lead to personal injury and damage to property.

HOPPECKE Batterie Systeme GmbH accepts no responsibility or liability for personal injury or damage to property resulting directly or indirectly from handling the batteries if they are not used as intended. The risks associated with improper use are borne solely by the operator.

Any use other than that described under "Intended use" is not in accordance with the intended use and is therefore not permitted.

Non-intended use of the product includes in particular

- Operation in potentially explosive atmospheres
- Operation in safety-relevant applications, unless these applications are expressly specified or permitted in the product documentation
- Operation without permanent/insufficient fastening
- Operation outside the technical data
- Operation or storage outside the specified environmental conditions
- The electrical connection does not correspond to the documentation supplied with the battery.
- Operation with unauthorised changes or modifications to the product

4. Directives, laws and standards

Please observe the latest editions of the following regulations:

- Accident prevention regulations
- DIN EN ISO 20345 ("Personal protective equipment - Safety footwear")
- DIN VDE 0105 ("Operation of electrical installations"), regulates in particular the quality and qualification requirements for work on electrical installations (DIN VDE 0105-100) and on railway electrical installations (DIN VDE 0105-103).
- DIN VDE 100/IEC 60364 ("Erection of low-voltage installations")
- DIN EN 50110/VDE 0105 ("Operation of electrical installations")
- DIN EN IEC 62485-2 ("Safety requirements for batteries and battery systems"), particularly applicable for calculating the necessary ventilation of battery rooms (in DIN EN IEC 62485-2).
- DIN EN 50547:2013 Batteries for on-board power supply systems
- DIN EN 60077-1 ("Railway applications - Electrical equipment on railway vehicles")
- DIN EN 60896-11: Stationary lead-acid accumulators, Part 11: Closed types, test methods
- DIN VDE 0119-206-4: Condition of railway vehicles - Electrical and traction systems; traction electrics - Part 206-4: Batteries
- ADR/RID: European Agreement concerning the International Carriage of Dangerous Goods by Road / Regulations concerning the International Carriage of Dangerous Goods by Rail
- IATA-DGR: Dangerous Goods Regulations - International Air Transport Association
- IMDG Code: International Maritime Code for Dangerous Goods, German: Dangerous goods labelling for dangerous goods in maritime transport
- Waste and Residual Substances Monitoring Ordinance (Federal Law Gazette 1996)

Observe any additional applicable territorial, operational and project-specific regulations.

5. Function and structure

5.1. Battery

Batteries are interconnected from rail | power PzS cells and used in rail vehicles.

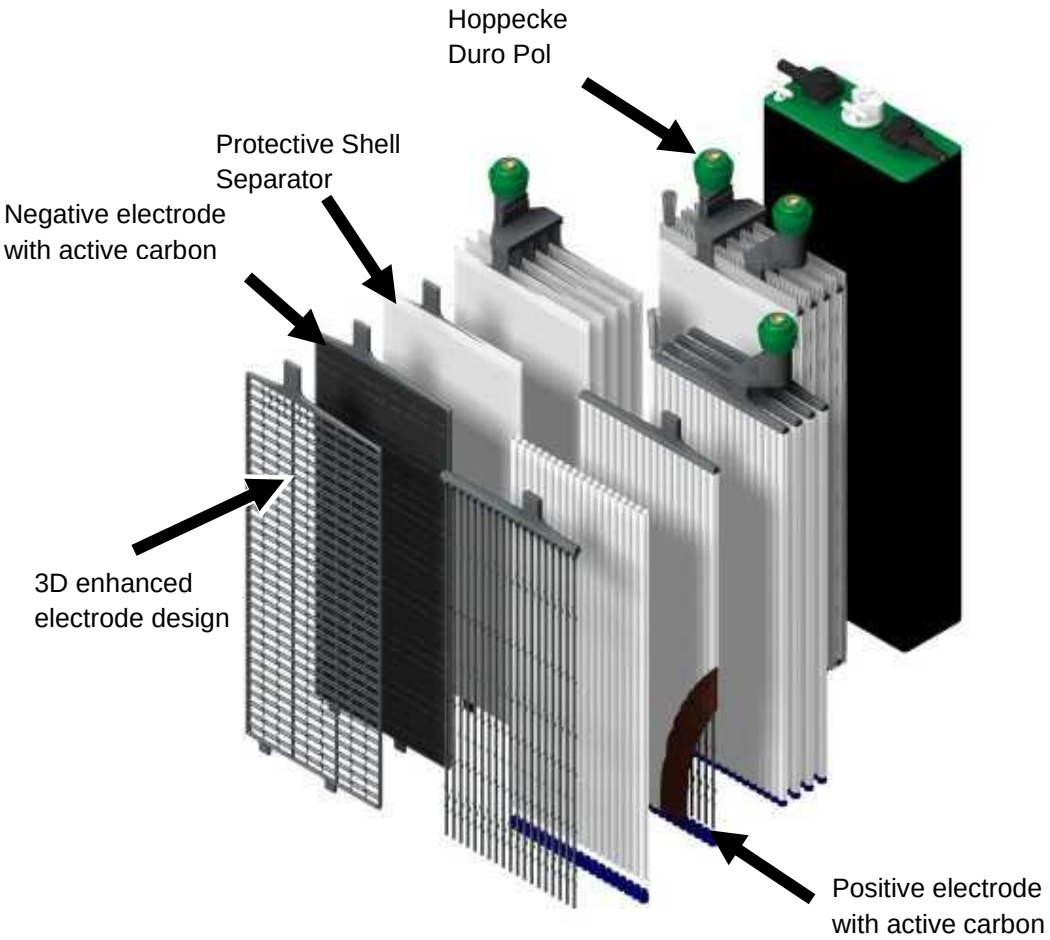
Here they fulfil one or more of the following functions:

- Buffering and supply of the low-voltage on-board electrical system
- Provision of energy in emergencies
- Provision of energy for vehicle maintenance and upgrades
- Starting the vehicle drive motors

5.2. rail | power PzS cells

HOPPECKE rail | power PzS cells are sealed lead-acid batteries with liquid electrolyte. It is a long-proven technology based on tubular and grid plate electrodes. rail | power PzS batteries are available as single cells (2 V).

The following picture shows an example of the structure of a HOPPECKE rail | power PzS cell:



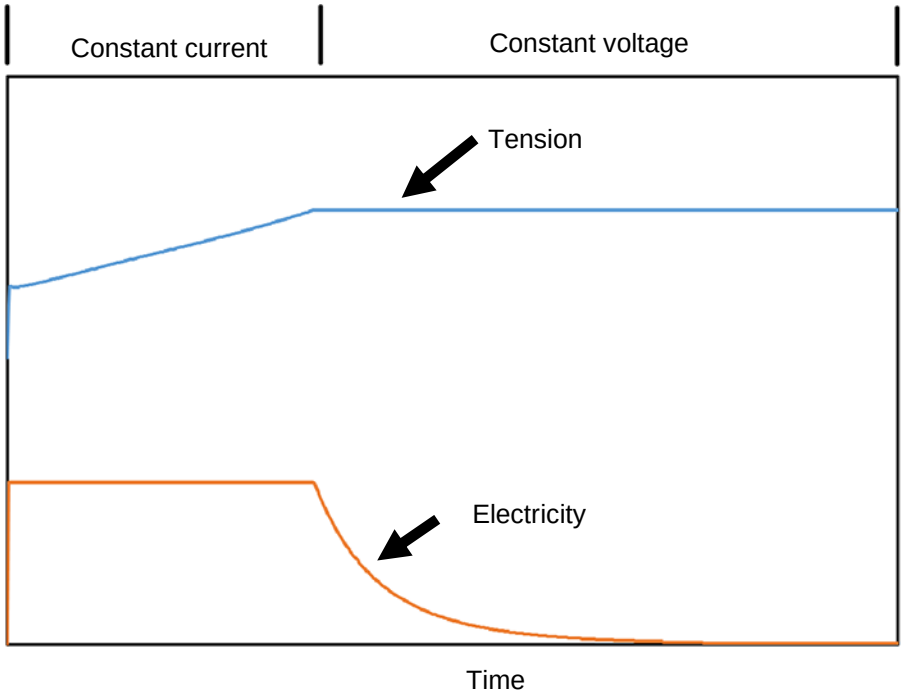
Active Carbon ensures improved fast-charging capability.

The Protective Shell Separator effectively prevents short circuits caused by mossing.

5.3. Charging method for rail | power PzS cells

5.3.1. Single-stage charging with constant current, constant voltage (IU)

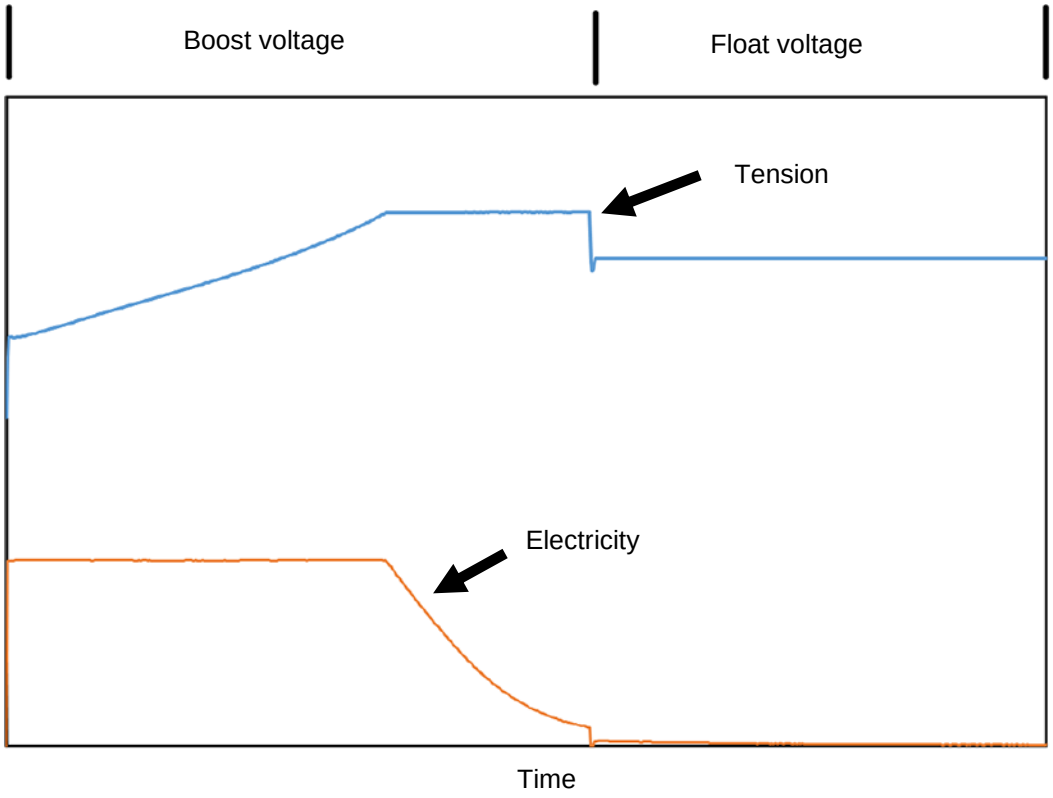
In this charging process, both the current (I) and the voltage (U) are limited. At the start of charging, the charging current is limited and the charging voltage rises slowly. When a defined voltage is reached, this is kept constant by the charger. The current then drops automatically to a low value.



The charging voltage setting always represents a compromise between charging time and ageing. As the current decreases when the voltage limit is reached due to the natural behaviour of the battery, the charging process is slowed down. Although a higher voltage extends the constant current phase and shortens the charging time, ageing is also accelerated.

5.3.2. Two-stage charging with constant current, constant voltage (IU0U)

The two-stage charging process (IU0U) initially works according to the same principle as single-stage charging. First the current is limited, then the voltage is kept constant once a certain value has been reached. This first voltage threshold is referred to as the "boost voltage" (also known as the strong charge voltage). Once the boost voltage has been reached, the charging current decreases. When a certain charging current is reached (usually $I_{50} = C_{n/50h}$), the voltage is reduced to a lower value. This voltage value is referred to as the "float voltage" (also known as the float charge voltage).



The advantage is that the boost voltage can be selected higher than with a single-stage charge. This extends the constant current phase, resulting in a better state of charge in a shorter time.

After reaching the current threshold (I_{50}), which indicates that the battery has been sufficiently charged, the voltage is switched to the float voltage. This is significantly lower than the voltage for single-stage charging.

5.4. Technical data

An overview of the available rail | power PzS cells is available on the Hoppecke website (www.hoppecke.com).

5.4.1. Technical details etails

Construction / Design	• Cells according to EN 60254 - 2 • HOPPECKE rail | power PzS cells are sealed lead-acid batteries with a liquid electrolyte consisting of diluted sulphuric acid. • Battery fulfils the requirements of EN 61373 (shock and vibration)
Battery designation	rail | power PzS <rated voltage> V <rated capacity> Ah
Nominal temperature	20°C
Nominal capacity	C_5 at 20 °C Removable capacity when discharging with I_5 (see rating plate) up to 1.6 V per cell at nominal temperature
Rated current	$I_5 = C_5 / 5$ h (see rating plate)
Nominal voltage cell	2.0 V / cell
Self-discharge	Approx. 3% per month at 20 °C
Electrolyte	Diluted sulphuric acid

5.4.2. Ambient conditions for rail | power PzS cells

Ambient conditions according to EN 50125-1	**Description of the**
Temperature class T3	• Ambient temperatures -25°C ... +45°C • Internal temperatures -25°C ... +55°C • Fulfilled for functionality and only for short-term operation at high temperatures above +45°C up to a maximum of +60°C. • Not fulfilled for class T3 as power temperature range for the battery with the emergency loads (see temperatures in the respective design files for the battery)
Height class AX	More than 1400 m

5.4.3. Battery charging characteristics

Like all chemical reactions, the charging/discharging processes in the cell are subject to a temperature effect. In general, chemical reactions are faster when the temperature rises and slower when the temperature falls. For this reason, temperature compensation is used for the charging voltage.

This compensation is applied equally for the single-stage (IU) and the two-stage (IU0U) charging process.

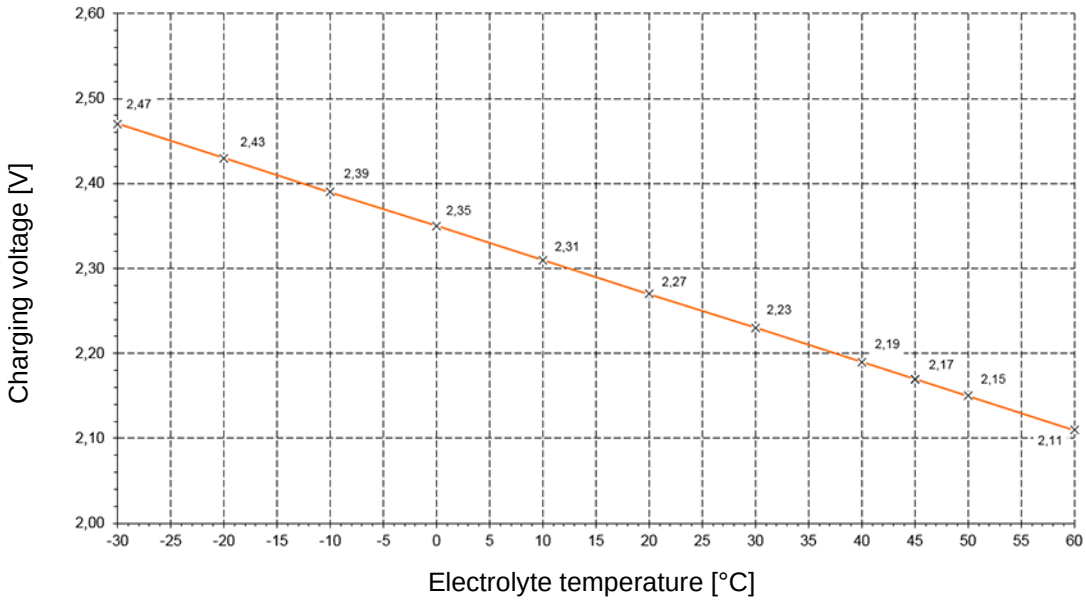
Hint

Depending on the specific operating mode of a vehicle and the resulting special requirements for the load, individual values may deviate from those listed below.

5.4.3.1. Single-stage, temperature-compensated charging (IU charging)

A temperature-compensated charging characteristic is required for rail | power PzS batteries in order to avoid excessive currents at high ambient temperatures and to fully charge the batteries at low temperatures. Based on the charging parameters at the design temperature, the charging voltage is increased or decreased depending on the measured battery temperature.

The following figure shows the charging voltage per cell as a function of the battery temperature monitored by the charger. It shows the temperature-compensated charge with -4 mV/°C per cell based on 20 °C for rail | power PzS batteries in relation to a single-stage constant voltage charge with current limitation.



The recommended maximum charging current is 1.0 x I_5.

Charging voltages at 20 °C: 2.27 V per cell

Hint

The charging curve describes a wide temperature range (based on EN50547) in order to ensure a safe energy supply to the vehicle by the charger at all times. The specified temperature range is permissible for a few days, but should not be understood as a permanent operating temperature for the battery. At higher battery temperatures, accelerated ageing occurs, which can considerably shorten the service life. The service life and maintenance intervals specified in this manual only apply at an average temperature of no more than 20°C (or another average temperature specific to the project).

Hint

If the battery temperature is ≥ 60 °C, the charging process must be interrupted to prevent damage to the cells. Select a control that only continues the charging process when the battery temperature has dropped to ≤ 55 °C.

Hint

You can assume that the temperature sensor is defective if temperatures above +80 °C or below -50 °C are measured by the battery charger.

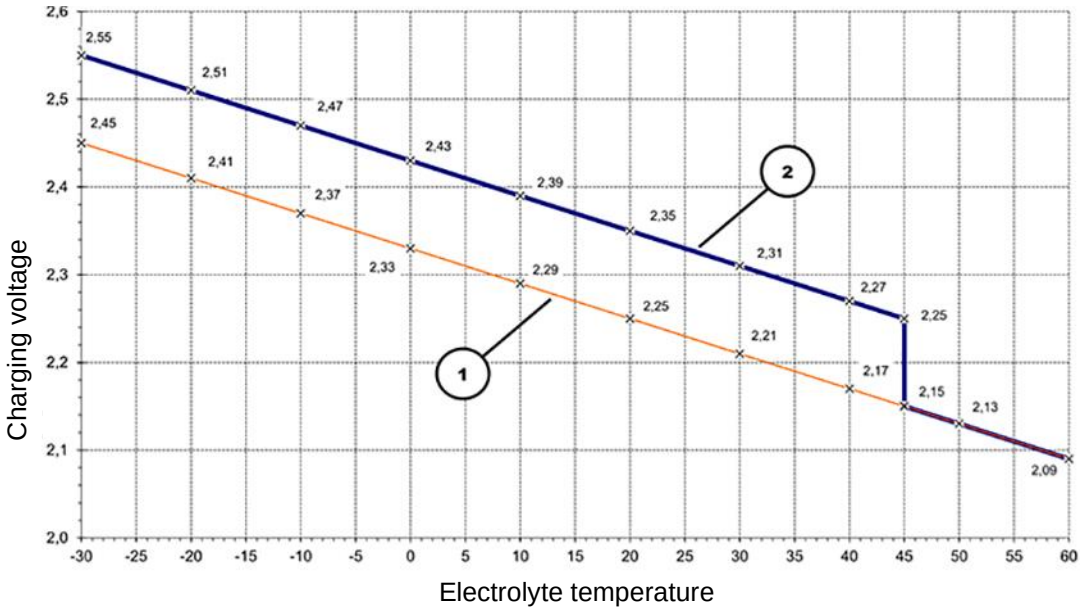
In this case, set the battery charger so that the charging voltage is limited to 2.11 V/cell (trickle charge at 60 °C).

The battery charger should generate a SERVICE message and the defective temperature sensor should be replaced within a few days.

5.4.3.2. Two-stage, temperature-compensated charging (IU0U charging)

A two-stage charge (constant current / constant voltage) is recommended for rail | power PzS batteries. In addition, a temperature-compensated charging characteristic is required to avoid excessive currents at high ambient temperatures and to fully charge the batteries at low temperatures. Based on the charging parameters at the design temperature, the charging voltage is increased or decreased depending on the measured battery temperature.

The following figure shows the charging voltage per cell as a function of the battery temperature monitored by the charger. It shows the temperature-compensated charge with -4 mV/°C per cell based on 20 °C for rail | power PzS batteries in relation to a two-stage constant voltage charge with current limitation.



1 = Float charge 2 = Heavy charge

Hint

The charging curve describes a wide temperature range (based on EN50547) in order to ensure a safe energy supply to the vehicle by the charger at all times. The specified temperature range is permissible for a few days, but should not be understood as a permanent operating temperature for the battery. At higher battery temperatures, accelerated ageing occurs, which can considerably shorten the service life. The service life and maintenance intervals specified in this manual only apply at an average temperature of no more than 20°C (or another average temperature specific to the project).

The switchover from the low voltage level (trickle charge) to the higher voltage level (boost charge) takes place when the charging current I_{50} is exceeded.

The switchover from the higher voltage level (high charge) to the lower voltage (trickle charge) takes place when the charge current I_{50} falls below the same level.

To prevent battery damage, it is necessary to switch from heavy charging to trickle charging at battery temperatures ≥ 45 °C. The hysteresis must be selected so that the switch back to trickle charging only takes place at a temperature ≤ 40 °C.

The recommended maximum charging current is 1.0 x I_5.

Charging voltages at 20 °C:
- Float charge = 2.25 V per cell
- Heavy charge = 2.40 V per cell

Hint

If the battery temperature is ≥ 60 °C, the charging process must be interrupted to prevent damage to the cells. Select a control that only continues the charging process when the battery temperature has dropped to ≤ 55 °C.

Hint

You can assume that the temperature sensor is defective if temperatures above +80 °C or below -50 °C are measured by the battery charger.

In this case, set the battery charger so that the charging voltage is limited to 2.09 V/cell (trickle charge at 60 °C).

The battery charger should generate a SERVICE message and the defective temperature sensor should be replaced within a few days.

6. Instructions for transport

Observe the regulations for the transport of batteries specified in the following sections.

Hint

Observe the safety instructions, see 2 Safety on page 11.

6.1. Transport of undamaged battery n

Filled batteries are not treated as dangerous goods if all of the following points apply:

- Undamaged
- Tight
- Secured against falling over and slipping on a pallet
- No short circuit present
- No dangerous traces (e.g. acid) on the outside of the package

The sender, packer, shipper must provide the following packaging:

- A stable pallet must be used to transport the battery.
- The battery must be covered with cardboard to prevent short circuits.
- The battery must then be tensioned horizontally and vertically with plastic tape.
- An additional clean bonnet over the package is recommended.
- Each package must be labelled: "Attention filled batteries".
- Each package must be labelled "Transport upright".
- The following text must be written in the transport document: -
  new battery: "Carriage in accordance with RN 2801 a para. 4a" -
  Used battery: "Carriage according to RN 2801 a para. 4 b"

6.2. Transport of damaged battery n

Filled batteries are treated as dangerous goods if one of the following points applies:

- Damaged
- Leaking
- Contaminated by acid

The battery must be packed and transported in a container made of stainless steel or solid plastic. No type approval is required for containers < 1 $^{m3.}$

The container must be labelled with the hazard label no. 8 and UN NR 2794.

An accident leaflet for batteries (HO3) must be provided with the vehicle for transport and the driver must be made aware of the dangerous goods.

The following information must be entered in the accompanying document:

- Gross weight without pallet
- Batteries, wet, filled with acid, dangerous goods ADR KL. 8 2801 item 81 c UN 2794. Dangerous goods packed, labelled and approved for transport according to ADR.

7. Notes on storage

The service life of the batteries begins with delivery ex works HOPPECKE. The storage times are to be fully counted towards the service life period.

Hint

Observe the safety instructions, see 2 Safety on page 11.

Unpack, install and commission the batteries as soon as possible after delivery, see 8 Assembly / commissioning on page 33.

If this is not possible:

- Store batteries in a clean, dry and frost-free room.
- Protect batteries against mechanical damage and soiling.
- Do not expose batteries to direct sunlight.
- Do not stack batteries on top of each other. Observe any project-specific regulations that may apply.

Either charge filled batteries permanently with trickle charge during storage or recharge them regularly, see:

- 7.2 Storage with permanent float charge on page 32
- 7.3 Storage with regular recharging on page 32

If you follow the instructions for charging during storage, the battery will always be ready for use.

Hint

Too high a storage temperature leads to faster self-discharge and premature ageing of the battery.

The storage temperature must be in the range 0 °C ... +40 °C.

The optimum storage temperature is in the range +10 °C ... +20 °C.

7.1. Storage period

Hint

- If rail | power PzS cells are to be stored for a longer period of time, they must be kept fully charged in a dry, frost-free room.
- Avoid direct sunlight. To avoid damage, recharging must be carried out during a storage period, see 7.3 Storage with regular recharging on page 32.
- Towards the end of the maximum storage period, charge acceptance may become more difficult during recharging.
- Failure to observe this can lead to sulphation of the plates, resulting in a loss of performance and shortened service life of the battery.
- The battery should be recharged a maximum of twice during the storage period. The battery should then be operated in constant charge retention mode.
- The service life of the battery(ies) begins with the delivery of the filled and charged batteries ex works HOPPECKE. Storage times are to be fully counted towards the service life.
- A storage period of 24 months must not be exceeded.
- If the storage period is likely to extend over several months, you will need to organise a suitable charger in good time

7.2. Storage with permanent float charge

The following applies to trickle charging: Charge permanently with current limitation to $I_{5=}$ Cn/5 h with 2.25 V per cell at 20°C ± 5°C.

7.3. Storage with regular recharging

The following applies for regular recharging: Charge the battery for 24 hours at a constant voltage with current limitation to $I_{5=}$ Cn/5 h at 2.40 V per cell.

The following intervals must be observed:

- Every 6 months if the average storage temperature is ≤ + 20 °C
- Every 3 months, if the average storage temperature is in the range + 20 ... + 30 °C
- Every 6 weeks if the average storage temperature is > + 30 °C

Note the respective charging processes in a log.

7.4. Storage with built-in battery

Hint

Ideally, you should store the battery separately from the vehicle in a clean, dry and ideally frost-free room.

If it is not possible to disconnect the battery from the vehicle and the vehicle is parked, make sure that the battery is not deeply discharged.

Disconnect the battery electrically from the vehicle's electrical system to prevent permanent loads from discharging the battery.

Parking is to be regarded as normal operation with regard to maintenance. Carry out the regular maintenance intervals and work, see 9 Maintenance on page 38.

Hint

Carry out regular recharging during the parking period, see 7.3 Storage with regular recharging on page 32.

8. Assembly / commissioning

Objective: The battery is connected for use in the vehicle.

Hint

Observe the safety instructions, see 2 Safety on page 11.

DANGER!

Danger due to a short circuit between the positive and negative terminals of a battery.

If the positive and negative terminals of a battery are short-circuited, there is a risk of overheating and explosion.

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Never short-circuit the positive and negative terminals of a battery.

DANGER!

Danger when connecting a battery to the load.

Reversing the polarity of batteries can cause overheating and acid leakage.

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Always check the correct polarity before making connections.

Ensure that all consumers in the vehicle and the charger are switched off.

Hint

If the terminals of a battery are damaged, the battery can no longer be used.

Do not damage the battery terminals.

Hint

- Provide stable, secure surfaces for carriers/troughs/battery cells.
- Ensure that all consumers in the vehicle and the charger are switched off.

Hint

Observe the project-specific electrical circuit diagram.

8.1. Checking the delivery

HOPPECKE Batterie Systeme GmbH packs your delivery with the greatest possible care to ensure that it arrives undamaged.

- Check the delivery immediately:
- Completeness (comparison with the delivery note)
- Transport damage
- Document:
  - Damage to the outer packaging
  - Visible stains or moisture that would indicate electrolyte leakage.

If the delivery is incomplete or there is transport damage:

- Write a short defect report on the delivery note before you sign it.
- Ask the forwarding agent for an inspection and note the name of the inspector.
- Draw up a defect report and send it to HOPPECKE Batterie Systeme GmbH and the carrier within 14 days.

Check goods for defects:

- The notes in chapter 2 Safety must be observed.
- Unpack the batteries after delivery and check for defects by carrying out a visual and functional check.
- Document any defects and send them to Hoppecke Batterie Systeme GmbH in text form within 14 days.

Hint

If you notify the freight forwarder of defects or incompleteness too late, this may result in the loss of your claims.

8.2. Installation and connection

Objective: The battery is connected for use in the vehicle.

DANGER!

Danger due to a short circuit between the positive and negative terminals of a battery.

If the positive and negative terminals of a battery are short-circuited, there is a risk of overheating and explosion.

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Never short-circuit the positive and negative terminals of a battery.

DANGER!

Danger when connecting a battery to the load.

Reversing the polarity of batteries can cause overheating and acid leakage.

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Always check the correct polarity before making connections.

Ensure that all consumers in the vehicle and the charger are disconnected or switched off.

Hint

If the terminals of a battery are damaged, the battery can no longer be used.

Do not damage the battery terminals.

Hint

- Provide stable, secure surfaces for carriers/troughs/battery cells.
- Ensure that all consumers in the vehicle and the charger are switched off.

Hint

Observe the project-specific electrical circuit diagram.

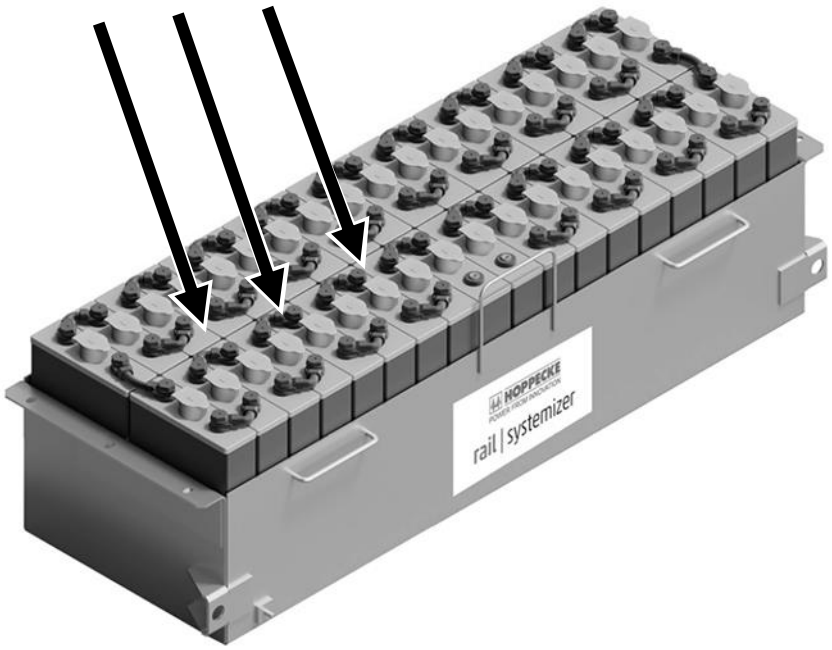
For delivery of so-called battery kits (cells, connectors, terminal screws):

- Install the cells in the battery compartment of the vehicle according to your customer's installation drawing.
- Install the connector.
- Connect end poles.

Hint

Cells and ribbed panels are always installed from the outside inwards (and as specified in the construction drawing). Any gap corrections and unevenness on the outer walls are levelled out with ribbed plates depending on the gap. This ensures a form-fit installation of the cells in the battery trays.

Insert ribbed panels into all gaps



Hint

The cells must be installed on a flat surface (trough floor). The maximum flatness tolerance is 3 mm in relation to the total area of the trough.

Hint

When installing cells in containers or carriers, the cells must not be "driven in". They must be inserted without applying excessive force, as otherwise the box/lid weld seam will be overloaded and leaks will occur.

Hint

When making the screw connections, observe the tightening torque of 25 Nm for the M10 terminal screws.

1. Connect the positive terminal of the battery to the positive terminal of the vehicle electrical system or charger.
2. Connect the negative terminal of the battery to the negative terminal of the vehicle electrical system or charger.
3. Connect any existing control lines (e.g. temperature sensors, medium-voltage taps, etc.).
4. Check the battery connection, for example by checking the charging voltage and the control signals.

Result: The battery is connected for use in the vehicle.

9. Maintenance

9.1. Preventive maintenance

Hint

Follow the instructions in chapter 2 Safety on page 11.

Have the batteries serviced regularly and properly by HOPPECKE specialist personnel or personnel authorised by HOPPECKE Batterie Systeme GmbH.

To ensure that the battery is in optimum condition, follow the maintenance schedule:

Activity	Interval	Description of the
Visual inspection of the battery	3 months	9.1.1 Visual inspection of the battery on page 39
Check electrolyte level	3 months	9.1.2 Check electrolyte level on page 40
Measuring the charging voltage	1 year	9.1.3 Measuring the charging voltage on page 41
Cleaning the battery		9.1.4 Clean battery on page 42
Measuring the insulation resistance		9.1.5 Measuring the insulation resistance on page 43
Refill with deionised / distilled water	6 months	9.1.6 Refill with deionised / distilled water on page 45
Replacing the battery (cells, connectors)	7 years *)	11 Disassembly on page 52

*) Interval may vary depending on the project and/or the ambient temperature.

Hint

To provide evidence in the event of a warranty claim, enter the activities and the measured values in the maintenance log, see 13.2 Maintenance log on page 57.

9.1.1. Visual inspection of the battery

Objective: The visual inspection of the battery is carried out.

1. Check the battery with regard to the following criteria:

Test object	Test criterion / test	Remedy
Battery / cells, screws, connectors and cable lugs	Check the battery/cells for dirt, especially in the area of the connections.	Thoroughly remove dirt from battery cells, screws, connectors and cable lugs with a clean, damp cloth.
Ventilation openings	Check ventilation openings for free passage.	Clear the ventilation openings.
Battery and container	Check the battery and container for mechanical damage.	In the event of mechanical damage: Contact the depot manager or HOPPECKE Service.
Connectors, screws, cables	Connectors, screws and cables must not be loose.	Tighten screws on cables or connectors.
Temperature sensor	Check the temperature sensor, if present, for proper attachment.	Attach the temperature sensor.
Cells / batteries Valve plugs Contamination	Check for electrolyte contamination. Plugs must be tight (no stains from electrolyte on the plugs or on the cells).	Check plug for tight fit, correct if necessary.
Seals	The container seals, if present, must not exhibit any mechanical damage.	Replace damaged seals.

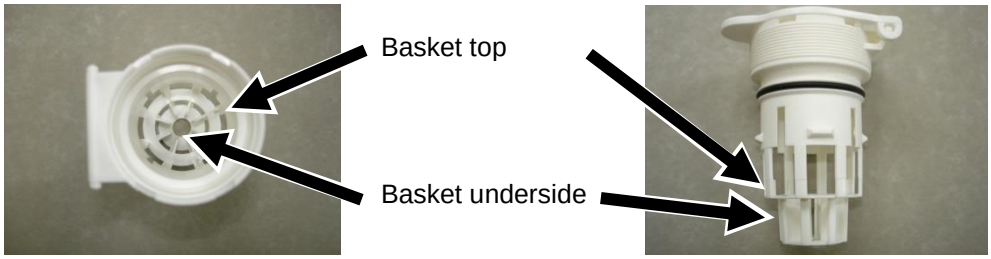
2. Enter activities in the maintenance log, see 13.2 Maintenance log on page 57.

Result: The visual inspection was carried out.

9.1.2. Check electrolyte level

Objective: The electrolyte level of the battery cells is checked.

1. Disconnect the battery from the vehicle electrical system.
2. Open the hinged lid plugs.
3. Check the electrolyte level. (The markings for the minimum and maximum fill level can be seen on the inside of the hinged lid plugs, where the upper and lower electrolyte levels are indicated by a dotted line)



4. If necessary, top up with distilled / deionised water up to the maximum mark, see 9.1.6 Refill with deionised / distilled water on page 45.
5. Close all hinged lid plugs.
6. Reconnect the battery to the vehicle electrical system.

Result: The electrolyte level of the battery cells was checked.

9.1.3. Measuring the charging voltage

Objective: The charging voltage of the battery is measured and checked.

The measurement of the voltages is used for fault detection. Logging the measured voltages helps with this.

DANGER!

When establishing access to the battery system, contact with sharp edges and/or live components may occur due to the design.

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Measures to avert the danger:

- Be very careful when working on the batteries.
- Wear personal protective equipment, see 2.2 Personal protective equipment on page 16.

Prerequisite

The battery system is connected to the vehicle's onboard charger and is being charged.

Tools required:

- Digital multimeter
- Current clamp
- Contact thermometer

1. Measure the charging voltage of the battery system with a suitable multimeter.
2. Measure the charging current of the battery system with a suitable current clamp.
3. Measure the temperature of the battery with a suitable contact thermometer.
4. Check the measured value using the charging characteristics, see 5.4.3 Battery charging characteristics on page 24.

It applies:

	Measured current (I)	Measured voltage (U)
Battery	< I_{50}	Trickle charge
	Higher than I_{50} but lower than I_5	Heavy load
	≥ I_5	I phase; no statement possible. Wait until U is constant, i.e. until either trickle charge or boost charge is present.

Example of a rail | power PzS cell:

A cell voltage of 2.40 V at 20°C must be measured for heavy charging.

5. Note the measured values in the maintenance log, see 13.2 Maintenance log on page 57.

Result: The charging voltage of the battery is measured and checked.

9.1.4. Clean battery

Objective: The battery is cleaned.

A clean battery is essential to prevent accidents and material damage as well as a reduced service life and availability.

Cleaning the rail | power PzS cells is necessary to maintain the required insulation of the cells against each other, against earth or against external conductive parts. It also prevents damage caused by corrosion and leakage currents.

Cleaning the battery is not only necessary to ensure high availability, but is also an essential part of the accident prevention regulations.

Hint

Improper cleaning can damage the batteries.

Avoid damaging the battery:

- Do not use solvents or wire brushes for cleaning.
- Prevent the ingress of cleaning water and dirt particles. The cell plugs must be sealed.

1. Clean the battery with clean cleaning cloths and water without adding any cleaning agents.
2. Allow the surfaces of the battery to dry after cleaning.

Hint

Remove any liquid that has got into the battery compartment. Dispose of in accordance with the waste/residual materials monitoring regulations.

3. Enter activities in the maintenance log, see 13.2 Maintenance log on page 57.

Result: The battery is cleaned.

9.1.5. Measuring the insulation resistance

Aim: The insulation resistance of the battery is measured.

The insulation resistance of a battery in a rail vehicle is a measure of its conductivity. This results from moisture and soiling of the battery between the battery terminals and the vehicle chassis. Ideally, there is no electrical conduction here if the insulation resistance of the battery is infinitely high.

When commissioning a new battery, the insulation resistance must be > 1 MΩ. It decreases with the operating time (due to aerosols from the batteries, condensation, dust) and must not fall below the following values depending on the nominal battery voltage:

Nominal battery voltage	Standard	Insulation resistance
Below 100V	DIN VDE 0119-206-4	10 kΩ
Between 100 and 120V	DIN EN IEC 62485-2	100 Ω per volt nominal voltage
Over 120V	DIN EN 62485-3 09/2015	Number of cells x 2V Nominal voltage cell x 500 Ω/V

If the value falls below this minimum value, any insulation monitor that may be present may respond, resulting in an undesirable increased discharge and loss of battery performance.

Hint

Use an insulation tester with a test voltage of 500 V for rail | power PzS batteries.

Suitable measuring device, e.g. Fluke 1507 (HOPPECKE mat. no.: 4141201237), with the settings 500 V/DC.

CAUTION!

Risk of damage to the vehicle's electrical system.

An insulation test voltage of 500 V can damage other components connected to the battery.

Disconnect all poles of the battery from the vehicle's electrical system when measuring the insulation resistance.

WARNING!

There is a risk of electric shock when carrying out measurements with an insulation measuring device.

There is a possible medium-risk hazard that could result in death or serious injury if not avoided.

Observe the safety precautions described in the documentation for the insulation measuring device.

Tools required:

- Insulation tester (e.g. Fluke 1507)

1. Check the function of the insulation measuring device by measuring any metal part of the battery tray / battery container against any metal part of the vehicle chassis. The measured resistance must be 0 Ω.
2. Measure the insulation resistance between the positive terminal of the battery and a metal part of the vehicle chassis (battery compartment or central earthing point).
3. Measure the insulation resistance between the negative terminal of the battery and a metal part of the vehicle chassis.
4. Check the function of the insulation measuring device by measuring any metal part of the battery tray / battery container against any metal part of the vehicle chassis. The measured resistance must be 0 Ω.
5. Clean the battery if the measurements fall below the minimum value (see 9.1.4 Clean battery on page 42).
6. Measure the insulation resistances again according to steps 2 and 3.

Hint

If the insulation test fails again, contact HOPPECKE Service.

7. Enter activities in the maintenance log, see 13.2 Maintenance log on page 57.

Result: The insulation resistance of the battery has now been measured.

9.1.6. Refill with deionised / distilled water

Objective: The battery is topped up with deionised / distilled water.

WARNING!

Contact with the electrolyte may occur when checking the electrolyte level.

There is a possible medium-risk hazard that could result in death or serious injury if not avoided.

The electrolyte can cause severe skin burns and serious eye damage.

Wear safety goggles and protective gloves (five-finger gloves made of latex or PVC) when working on the batteries.

Hint

Always check the electrolyte level before this maintenance step, see 9.1.2 Check electrolyte level on page 40.

Hint

- Tap water is not permitted and will impair your battery performance.
- Only use deionised / distilled water in accordance with EN 60993 or DIN 43530-4 for refilling.

Prerequisite

You have access to the battery system.

Tools required:

- Measuring glass tube
- Funnel or pipette for filling the deionised / distilled water into the cells

1. Open all hinged lid plugs.
2. Fill each rail | power PzS with deionised / distilled water to the maximum level.
3. Close the hinged lid plug.
4. Clean the battery system if necessary, see 9.1.4 Clean battery on page 42.
5. Enter activities in a maintenance log, see 13.2 Maintenance log on page 57.

Result: The electrolyte levels of the battery are topped up with deionised / distilled water.

9.2. Corrective maintenance

Hint

Follow the instructions in chapter 2 Safety on page 11.

9.2.1. rail | power PzS cell n replace

Target: rail | power PzS cells are replaced.

DANGER!

When establishing access to the battery system, contact with sharp edges and/or live components may occur due to the design.

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Measures to avert the danger:

- Be very careful when working on the batteries.
- Wear personal protective equipment, see 2.2 Personal protective equipment on page 16.

DANGER!

Loose connections on the pole screws can become very hot and cause ignition or explosions.

Only use each screw and washer once.

- Initially tighten the pole screws by hand only.
- Align the batteries and connectors again if necessary.
- Then tighten the pole screws to the specified torque.

Hint

- Switch off all consumers and chargers from the battery system before starting maintenance work.
- A battery always has a voltage at the terminals.
- A battery must not be earthed or short-circuited.
- Batteries/troughs are very heavy. Carry battery trays with a sufficient number of people or use suitable lifting gear and means of transport.

Hint

If rail | power PzS cells are defective, a maximum of 10% of the cells in the entire battery can be replaced. If more cells are defective, all cells must be replaced.

Tools required:

- Torque spanner with suitable spanner sizes for M10 screws

1. Remove the connectors to the neighbouring cells.
2. Lift the rail | power PzS cells to be replaced out of the trough/container.

Hint

It is recommended to use a suitable suction lifting device for removing and installing the cells.

3. Lift new rail | power PzS cells into the trough.
4. Establish electrical connections to the neighbouring cells.

Prerequisite

The replacement cells must be in a charged state. Stored cells must be 7 Notes on storage on page 30 can be reloaded.

Hint

Replace the M10 pole screws with plastic heads with new ones, as the screw connection is secured with a micro-encapsulated adhesive.

When making the screw connections, observe the tightening torque of 25 Nm for the M10 terminal screws.

Result: The rail | power PzS cells are replaced.

9.2.2. Replace connector

Objective: A defective connector is replaced.

Tools required:

- Torque spanner with suitable spanner sizes for M8 screws

1. Loosen the terminal screws of the connector to be replaced.
2. Remove the defective connector.
3. Install the new connector and fit the pole screws.

Hint

Replace the M10 pole screws with plastic heads with new ones, as the screw connection is secured with a micro-encapsulated adhesive.

When making the screw connections, observe the tightening torque of 25 Nm for the M10 terminal screws.

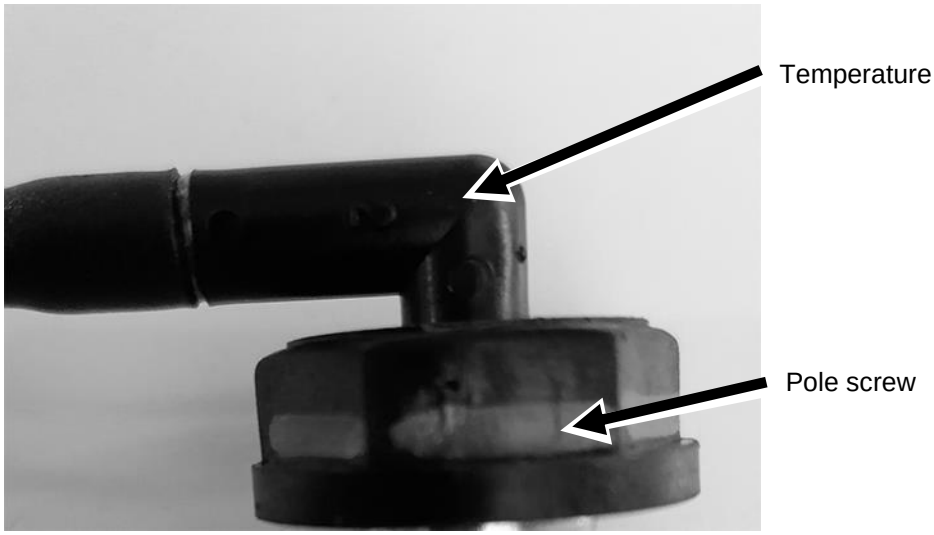
Result: The defective connector has been replaced.

9.2.3. Replace temperature sensor

The temperature sensor is installed as an L-piece in a special pole screw.

Objective: A defective temperature sensor is replaced.

1. Disconnect the Cannon plug.
2. Remove the defective temperature sensor by pulling it out of the special pole screw.



3. Install the new temperature sensor by inserting it into the special pole screw provided.
4. Reconnect the Cannon plug.
5. Check the charging voltage, see 9.1.3 Measuring the charging voltage on page 41.

Result. The defective temperature sensor has been replaced.

10. Error sources

Hint

Observe the safety instructions, see 2 Safety on page 11.

10.1. Capacity too low

If the battery capacity is too low, proceed as follows:

Possible cause	Remedy
Loosened or oxidised poles	Check all connections, replace connectors if necessary (the spring washers must be replaced)
Temperature sensor is defective - resulting in incorrect charging parameters	Check temperature sensor if present

10.2. Insulation resistance too low

When commissioning a new battery, the insulation resistance must be > 1 MΩ. It decreases with operating time (due to aerosols from the batteries, condensation, dust) and must not fall below the following values depending on the nominal battery voltage:

Nominal battery voltage	Standard	Insulation resistance
Under 100 V	DIN VDE 0119-206-4	10 kΩ
Between 100 V and 120 V	DIN EN 50272 Part 2	100 Ω per volt nominal voltage
Above 120 V, i. e. from 100 cells	DIN EN 62485-3 09/2015	Number of cells x 1.2V nominal voltage x 500 Ω /V

If the value falls below this minimum value, any insulation monitor in the vehicle may respond, resulting in an undesirable increased discharge and loss of battery performance.

If the insulation resistance is too low, leakage currents can reduce the available capacity. This can also lead to different voltages between the cells. Regular cleaning prevents these leakage currents.

Possible cause	Remedy
Pollution	Cleaning
Leaking cells	Eliminate the cause of the leak, replace the cell if necessary

10.3. No battery voltage

If you cannot measure any voltage at the battery, proceed as follows:

Possible cause	Remedy
Battery plug not plugged in	Insert battery plug
Battery plug defective	Replace battery plug
Cable break	Replace cable
Cell connector defective	Replace the cell connector (the spring washers must be replaced)

10.4. Malfunction of the temperature sensor

If the temperature sensor does not provide plausible temperature values in the range below -50 °C or above 80 °C, proceed as follows:

Possible cause	Remedy
Temperature sensor defective	Replace temperature sensor
Plug defective	Replace plug
Plug not plugged in	Insert plug
Cable break	Replace cable

11. Disassembly / assembly of rail | power PzS cells and accessories

Objective: The rail | power PzS cells are replaced.

DANGER!

When establishing access to the battery system, contact with sharp edges and/or live components may occur due to the design.

There is an imminent danger with a high risk that will result in death or serious injury if it is not avoided.

Measures to avert the danger:

- Be very careful when working on the batteries.
- Wear personal protective equipment, see 2.2 Personal protective equipment on page 16.

DANGER!

Loose connections on the pole screws can become very hot and cause ignition or explosions.

Only use each screw and washer once.

- Initially tighten the pole screws by hand only.
- Align the batteries and connectors again if necessary.
- Then tighten the pole screws to the specified torque.

Hint

Observe the instructions for disassembly, see 2.1.7 Notes on disassembly on page 16.

Hint

- Switch off all consumers and chargers from the battery system before starting maintenance work.
- A battery always has a voltage at the terminals.
- A battery must not be earthed or short-circuited.
- Batteries/troughs are very heavy. Carry battery trays with a sufficient number of people or use suitable lifting gear and means of transport.

Prerequisite

You have established access to the battery system.

Hint

In the following description, the disassembly / assembly of rail | power PzS cells is explained using a special battery tray as an example. In practice, the valid, project-specific design drawings must be used.

Tools required:

- Torque spanner with suitable spanner sizes

1. Switch off all chargers and consumers on the vehicle. If present, disconnect the battery from the vehicle electrical system and charger using the corresponding isolator switch.
2. Loosen the screws that connect the trough to the container.
3. Lift the trough out of the vehicle and place it on a safe surface.
4. Loosen and remove the cell connector/cable.
5. If present, remove the temperature sensor.
6. Pull out the cells.
7. Dispose of the individual parts separately.
8. Clean the trough or container.
9. Install new cells in the trough/container using the appropriate replacement kit.
10. Refit the cell connector / cable.

Hint

Replace the M10 pole screws with plastic heads with new ones, as the screw connection is secured with a micro-encapsulated adhesive.

When making the screw connections, observe the tightening torque of 25 Nm for the M10 terminal screws.

11. If present , refit the temperature sensor.
12. Lift the trough back into the vehicle, paying attention to the guide pins.

13. Tighten the screws of the trough again.

14. Check the function of the battery according to the test specification in the separate document: PVE 10-20-General-00_Battery_Tray_rev<version number>.pdf

15. Reassemble the battery system.

16. Switch the chargers and loads back on. If present, switch the isolating switch back on.

Result: The rail | power PzS cells have been replaced.

12. Waste disposal

Hint

Observe the safety instructions, see 2 Safety on page 11.

Note

Used batteries with this symbol are recyclable economic goods and must be returned to the recycling process.

Use the HOPPECKE recycling system. Used batteries are collected and recycled. Contact HOPPECKE Service for further information.

Note

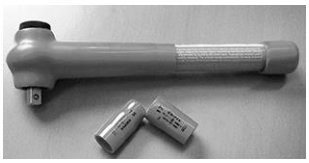
Dispose of lead batteries that are not recycled as hazardous waste in compliance with all regulations.

13. Appendix

13.1. Additional tools

Additional tools for maintenance and service are listed below:

Tool	Description of the
	Voltmeter/multimeter (Picture shows an example)
	Current clamp DC (Picture shows an example)
	Insulation tester: Fluke 1507 (HOPPECKE mat.no.: 4141201237)
	Charger/discharger (Picture shows an example)
	Contact thermometer (Picture shows an example)

	Fully insulated torque spanner (HOPPECKE mat. no. 4142500121)

13.2. Maintenance log

Hint

Enter the activities and the measured values in the maintenance log as proof in the event of a warranty claim.

Seriennummer des Batteriesystems
:_____

Number of the train: _____

Date of commissioning: _____

13.2.1. Quarterly maintenance interval

13.2.1.1. Maintenance - visual inspection of the entire battery system

Interval (years)	Visual inspection - Done (tick the appropriate box)	date	Auditor (name)
0,25			
0,5			
0,75			
1			
1,25			
1,5			
1,75			
2			
2,25			
2,5			
2,75			
3			
3,25			
3,5			
3,75			
4			
4,25			
4,5			
4,75			
5			
5,25			
5,5			
5,75			
6			
6,25			
6,5			
6,75			

13.2.1.2. Maintenance - Check electrolyte level

Interval (years)	Electrolyte level checked (tick)	date	Auditor (name)
0,25			
0,5			
0,75			
1			
1,25			
1,5			
1,75			
2			
2,25			
2,5			
2,75			
3			
3,25			
3,5			
3,75			
4			
4,25			
4,5			
4,75			
5			
5,25			
5,5			
5,75			
6			
6,25			
6,5			
6,75			

13.2.2. Half-yearly maintenance interval

13.2.2.1. Maintenance - Refilling deionised / distilled water

Interval (years)	Top up with water - Done (tick the appropriate box)	date	Auditor (name)
0,5			
1			
1,5			
2			
2,5			
3			
3,5			
4			
4,5			
5			
5,5			
6			
6,5			

13.2.3. Annual maintenance interval

13.2.3.1. Maintenance - Measuring the charging voltage

Interval (years)	Voltage [V]	Current [A]	Temperature [°C]	date	Auditor (name)
1					
2					
3					
4					
5					
6					

13.2.3.2. Maintenance - Cleaning

Interval (years)	Cleaning - Done (tick the appropriate box)	date	Auditor (name)
1			
2			
3			
4			
5			
6			

13.2.3.3. Maintenance - Measuring the insulation resistance

Interval (years)	Insulation resistance [Ω]	date	Auditor (name)
1			
2			
3			
4			
5			
6			