INSTALLATION & OPERATION MANUAL

OPzV

2V Cells

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SECTION 1 DELIVERY & STORAGE

Inspect for signs of damage or missing components. Store the battery in a dry, clean and preferably cool but frost-free location. Do not expose the cells to direct sunlight as damage to the container and cover may occur. As the batteries are supplied charged, storage time is limited. In order to easily charge the batteries after prolonged storage, it is advised not to store them more than 6 months at 20°C, 4 months at 30°C, 2 months at 40°C. A refreshing charge shall be performed after this period. Failure to observe these conditions may result in significantly reduced capacity and service life.
Alternatively, cells can be float charged at the recommended float voltage during storage.

SECTION 2 INSTALLATION

2.1 Handling

The electrical protective measures, the accommodation and ventilation of the battery installation must be in accordance with the applicable rules and regulations.

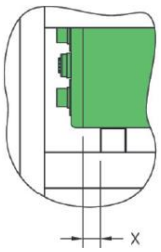
Particular attention must be paid to the following: the battery should be installed in a clean, dry area. Avoid placing the battery in a warm place or in direct sunlight. Lifting cells with weight above 25kg has to be made with special handling devices (lifting belts). Do not lift the cells by the terminals. The layout of the charging room must allow easy access to the batteries. Approved battery racks are recommended for proper installation. Place the cells or monoblocs on the rack and arrange the positive and the negative terminals for connection according to the wiring diagram. Battery cells are usually installed in series.

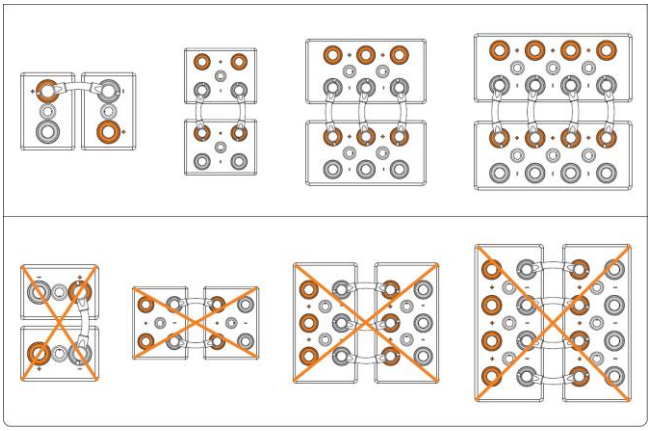
2.2 Cells in Parallel Strings

Valve-regulated cells and monoblocs may be connected in parallel to give higher current capability. In the case of parallel connected strings, use batteries of the same capacity, design and age only with a maximum of 4 parallel strings. If more than 4 strings are required, consult VALEN. The resistance of the cables in each string must be the same, e.g. same cross-section, same length. Connect the battery strings in parallel at the end terminals. Check that all contact surfaces are clean. If required, clean with a brass brush. Tighten the terminal screws, using the correct torque loading of 22Nm.

2.3 Horizontal Installation

The connection between the lid and container of the cell must not lie directly on the rack bar, as shown in the image. Ensure that the internal plates are vertical (positive and negative poles are oriented one above the other as shown in the picture).





SECTION 3 COMMISSIONING OF BATTERIES

Check the cells/blocs regarding their polarity. The open-circuit voltages of a battery's individual cells must not deviate from average more than +0.03V. Should greater deviations occur, consult VALEN.
Connect the battery to the DC power supply, with the charger switched off, battery fuses removed, and the load disconnected, ensuring that the polarity is correct: positive terminal of the battery to the positive terminal of the charger. Switch on the charger and charge. The first charge must be monitored to ensure that limits are not exceeded and that no unacceptable temperatures occur. When charging is finished switch off the charger or switch over to operating voltage.

SECTION 4 OPERATION

4.1 Discharging

Never discharge the batter below the specified final voltages.

Rate (h)	Current (A)	End Voltage (VPC)
10	I_{10}	1.80
8	I_8	1.75
5	I_5	1.70
3	I_3	1.70
1	I_1	1.60
0.25	$I_{0.25}$	1.60

No more than the specified capacities are to be discharged. Charge immediately after discharge as well as after partial discharge.

4.2 Charging

When commissioning a new battery (first charge), charging must only be carried out with direct current. Charging procedures with their limit values may be employed as follows:

- DIN 41 773: IU – characteristic
- DIN 41 776: I – characteristic

The limits for charging currents and the ripple currents (see 4.6) must not be exceeded.
The commissioning charging of a filled and charged battery has to be made as full charge. The fully charged state is reached when the cell voltages have not risen for a period of 2 hours. It can be made as mentioned below. Methods a and b are recommended.

a) Using chargers with IU characteristics at an increased voltage of 2.33-2.40V x number of cells with automatic switching to the float voltage, see 4.3a. The complete charging time will be a minimum of 24 hours.
b) Using chargers having a boost charging state with I characteristic, see 4.6 with the load switched off up to the final charging voltage of 2.60-2.75V x number of cells. The charging must be monitored and switched off when the fully charged state is reached or switched over to float charging as per 4.3a. The charging time is about 6-8 hours.
c) Using chargers with IU characteristics with float voltage (see 4.3a), after approximately 1-month, full charge state will be reached.

4.3 Standby Operation/Buffer Operation

In this case, the load, DC power supply and the battery are connected permanently in parallel. Thereby the charging voltage is the operational voltage of the battery and also the system voltage.

a) During standby operation (float) the DC power supply is always able to provide the maximum load current and the battery charging current. The battery only supplies current if the DC power supply fails. The charge voltage at 20°C must be set for OPzV at 2.25V x number of cells ± 1% measured at the batteries' terminals.
b) During buffer operation the DC power supply is not always able to provide the maximum load current. The load current temporarily exceeds the rated current of the DC power supply. During this time the battery supplies current. The battery is not always fully charged. Depending on the load, the charge voltage should be set at 2.25-2.30V x number of cells.

4.4 Recharging

After a discharge, the battery can be recharged at the operating voltage, see 4.3a. To reduce the charging time, the recharging can be carried out at 2.33-2.40V x number of cells with automatic reduction to the voltage under 4.3a. The recharging times are dependent on the charging procedure selected and, on the charging current available; as a rule, they run to 12-24 hours at charging currents between $2 \cdot I_{10}$-$0.5 \cdot I_{10}$.

4.5 Equalising Charge

After deep discharge or after inadequate recharging float charge voltages in single cells may deviate more than +0.2V or -0.1V. Then equalising charge is necessary. This can be carried out as follows:

a) At an increased voltage of 2.33-2.40V x number of cells for 24 up to a maximum of 48 hours.
b) At currents according to the I characteristic (see 4.6).

As it is possible to exceed the permitted load voltages, appropriate measures must be taken, e.g. switch off the load. On exceeding the maximum temperature of 45°C, charging must either be stopped or proceed with reduced current of be switched to float charge to allow the temperature to drop. The equalising charge

is completed when the single cell voltages not longer increase within 2 hours.

4.6 Charging Currents

Charging current is not limited as long as the battery voltage is below the gassing voltage of 2.40V x number of cells. Thereafter the charging current has to be limited:

Charging Process	Charging Current per 100Ah	Cell Voltage
I-Characteristic	1.5A	2.60-2.75VPC

During recharging up to 2.40VPC the effective value of the AC ripple current may reach temporarily maximum 20A/100Ah nominal capacity. After recharging and at float charge in standby operation or buffer operation the effective value of the AC ripple current must not exceed 5A/100Ah nominal capacity.

4.7 Battery Temperature

All technical data apply for the nominal temperature of 20°C. The ideal operating temperature range is 20°C ± 5K. The recommended operating temperature range is 10°C to 30°C. Higher temperatures reduce the working life, whilst lower temperatures reduce the available capacity. A maximum temperature of 45°C must not be exceeded. At very low temperatures (below 0°C) there is a risk of battery freezing and container split (especially for deep discharges) because the acid in the electrolyte may reach a density where it freezes (between -6°C and -13°C for a fully discharged battery).

4.8 Temperature-rated Charging Voltage

A temperature-related adjustment of the charging voltage within monthly averaged battery temperatures of 10°C to 45°C should not be made. Below 10°C in the monthly average, the charging voltage should be increased (-0.003V/K per cell) for a faster recharging.

Operating Temperature (°C)	Float Voltage (VPC)
-30	2.40
-25	2.39
-22.5	2.38
-17.5	2.36
-15	2.36
-10	2.34
-5	2.33
0	2.31
+10	2.28

4.9 Electrolyte

Electrolyte is diluted sulphuric acid fixed as Gel.

4.10 Light Cyclic Applications

Discharges have to be restricted to 80% DOD. At regular discharges up to 0.5°C_{10} within 24 hours, use a charging voltage of 2.35V to 2.40VPC for at least 15 hours. After having discharged 3 times at C_{10}, the battery has to be charged to 100%, by 12 hours boost charge.

SECTION 5 BATTERY MAINTENANCE

To avoid leakage currents and the associated risk of fire, keep the battery dry and clean. Cleaning with clear water, no solvents, no detergents as it can cause permanent damage to container and lid.
Avoid electrostatic charges.
To be charged and listed every 6 months:

- Battery voltage
- The voltage of some cells/bloc batteries (pilot cells)
- The temperature of the container in some cells/bloc batteries (pilot cells)

Check and list every 12 months:

- The voltages and temperatures in all cells/blocs must be measured and listed
- Connectors, racks, and the ventilation must be checked

After the first 6 months of operation, should the float charge voltage in single cells deviate more than +0.2V or -0.1V from the average value, perform an equalising charge (4.5). If the voltages are still out of the limits, contact VALEN.

SECTION 6 FAULTS

Should faults be detected in the battery of the charging device, contact VALEN immediately. Measured data as in section 5, simplify fault detection and elimination.

SECTION 7 TESTING

Tests must be conducted according IEC 60 896-21. Check that the battery is fully charged. Before testing new batteries, it must be ensured that a sufficient commissioning charge has been applied and the battery is fully charged.

SECTION 8 STORAGE & TAKING OUT OF OPERATION

If filled lead-acid accumulators are to be taken out of operation for a long period of time, they must be placed fully charged in a dry, frost-free room. To avoid damage periodically equalising charging's (see 4.5 interval) or permanent float charging has to be made.

SECTION 9 TRANSPORT

OPzV cells/blocs are protected against short-circuit. If properly packed, batteries are not considered as dangerous goods according to the international regulations for dangerous goods on road and on rail (ADR and RID).

HORIZONTAL INSTALLATION

SECTION 1 REQUIREMENTS FOR THE HORIZONTAL INSTALLATION OF OPZV CELLS

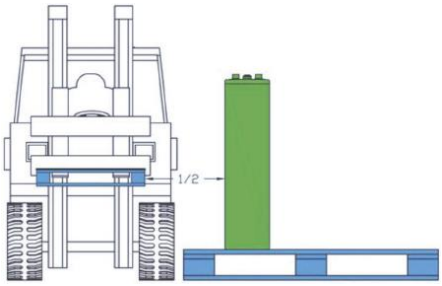
Only OPzV cells or blocs ordered specifically for horizontal installation may be installed this way. These types of cells or blocs are going through different activation treatment against the ones that are produced for vertical installation. During the horizontal installation of heavy and large cells, personnel accidents or cell damages are highly likely to occur. Therefore, installation of OPzV cells larger or equal to 1500Ah, must be performed only under supervision of VALEN trained personnel.
The following equipment must be ensured before installation:

- Assembling pallet specifically designed for Oz horizontal installation. Assembling pallets for OPzV horizontal installation are available from VALEN.
- Forklift truck with appropriate lifting power.
- Grease as a sliding agent.

Also, these workers are needed for the complete process.

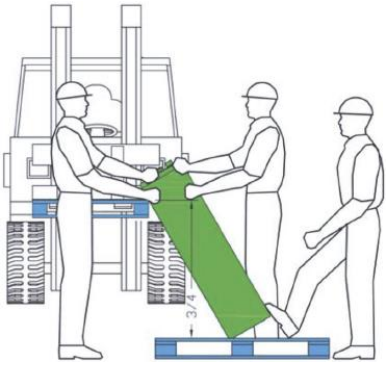
SECTION 2 PREPARATIONS

The assembling pallet is loaded to the forks of the truck as shown. The goal is to prevent the pallet from tilting and sliding while loading the cell on it.
The forklift must be placed in a way that the horizontal distance from the side of the assembling pallet to the cell's side is ½ of the cell's height.

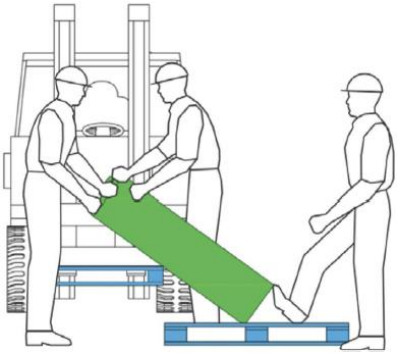


Any shorter distance can cause tilting of the cell having as a result the possible injuring of the personnel and/or damage of the cell. Move the forklift forward or backwards to centre the cell to the assembling pallet.

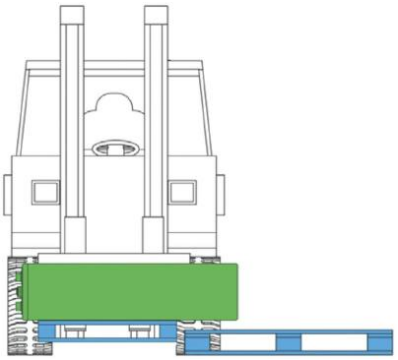
SECTION 3 TILTING OF THE CELL



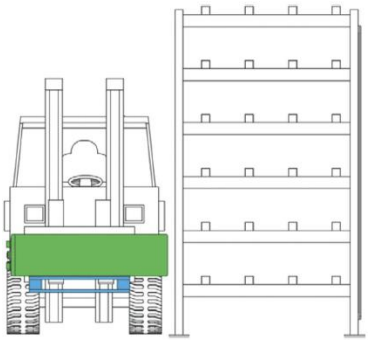
The pallet must be lifted to the 'Y' of the cell's height. By grabbing the cell from the side and the valves, it is gently tilted till it contacts the pallet. The cell is blocked by personnel's foot to avoid sliding on the transport pallet.



By slowly lowering the forks of the truck the cell will be tilted until it reaches the horizontal position. During lowering, the cell must be grabbed only by its valves and its side. Hand's placement underneath the cell may cause serious injury.



When the cell reaches the horizontal position, it must be pushed onto the assembling pallet as shown.

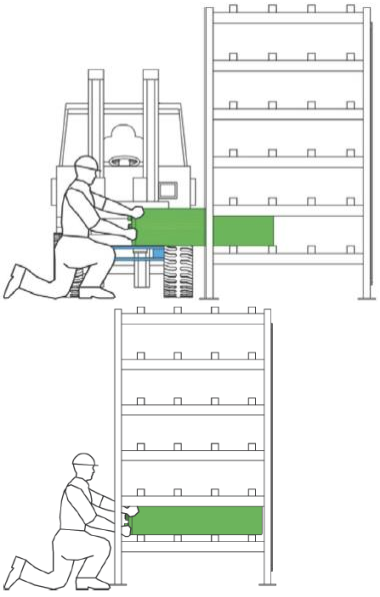


The cell on the assembling pallet is now transferred to the rack compartment where it should be inserted.

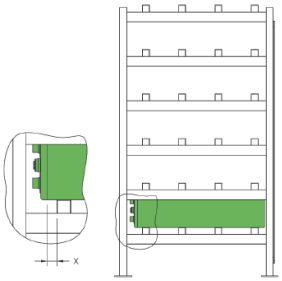
WARNING! Drive smoothly and do not turn fast! Cell rests on a slippery surface!

SECTION 4 CELL PLACEMENT TO BATTERY RACK

Rack bars must be greased prior to cell placement on the rack. The cell on the assembling pallet must be placed 1cm higher than the relative rack bar. From this position the cell should be slowly moved as far as possible into the compartment. The pallet will then be lowered until the cell sits horizontal and could be moved completely into the rack.



The connection between the lift and container of the cell must not lie directly on the rack bar as shown.



SECTION 5 INSTALLATION AND COMMISSIONING

The next steps of battery installation and battery commissioning are described above.

SECTION 6 DISMANTLING

To dismantle cells installed in horizontal position the described procedure must be followed in reverse:

- The assembling pallet is placed on the same height of the rack bars and the cell is pulled slowly and transferred onto the assembling pallet. For pulling the cell, a belt laid around the cell's bottom may be used.
- The cell placed on the assembling pallet is transferred carefully and lowered beside a transport pallet. The horizontal distance between the cell and the edge of the transport pallet must be equal to ½ of cell's height.

- The cell is smoothly slid onto the transport pallet until it comes into contact with it. While blocking the cell by foot, the truck's forks are elevated to a height equal to 'Y' of cell's height.
- Handling the cell by its valves and side, it is manually pulled to vertical position.
- The process is repeated until all battery cells are dismantled.

SECTION 10 BATTERY REPORT

VALEN OPzV BATTERY REPORT

Installed by:_____ Representative:_____
Operating Company:_____ Date:_____ Time:_____

Battery Information

Type of Battery:_____ No. of Cells/String:_____ String Float Voltage:_____
Installation Date:_____ No. of Strings/Battery:_____
Battery Charge Current:_____ Battery Code:_____ Float Current:_____
Charging Equipment:_____ Ambient Temp.:_____ Bloc Temp.:_____

Battery Charger Information

Make:_____ Type:_____ Current Rating:_____
Model:_____ Year of Manufacture:_____ Charging Voltage:_____

INDIVIDUAL CELL READINGS

Cell No.	Cell ID	Float Volts	Cell No.	Cell ID	Float Volts	Cell No.	Cell ID	Float Volts	Cell No.	Cell ID	Float Volts	Cell No.	Cell ID	Float Volts
1			26			51			76			101		
2			27			52			77			102		
3			28			53			78			103		
4			29			54			79			104		
5			30			55			80			105		
6			31			56			81			106		
7			32			57			82			107		
8			33			58			83			108		
9			34			59			84			109		
10			35			60			85			110		
11			36			61			86			111		
12			37			62			87			112		
13			38			63			88			113		
14			39			64			89			114		
15			40			65			90			115		
16			41			66			91			116		
17			42			67			92			117		
18			43			68			93			118		
19			44			69			94			119		
20			45			70			95			120		
21			46			71			96			121		
22			47			72			97			122		
23			48			73			98			123		
24			49			74			99			124		
25			50			75			100			125		

Remarks and Recommendations:_____

Signed:_____

VALEN OPzV BATTERY MAINTENANCE REGISTER

Date	Maintenance Description

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