HOPPECKE

Commissioning

of stationary Nickel-Cadmium Batteries with FNC cells

It is assumed that only qualified personnel are engaged in assembly and installation of the components provided.

Qualified personnel are persons who, on the strength of their training, experience and instruction, together with their knowledge of the relevant standards, provisions, accident prevention regulations and operating conditions, have been authorised by those responsible for the safety of the components / installation, to carry out the relevant necessary work, with the ability to recognise and avoid possible hazards. Amongst other things, knowledge of First Aid and of local rescue equipment are also necessary.

Failure to observe the instructions on use, repair with non-original parts, unauthorised intervention, or use of additives to the electrolyte shall invalidate the warranty.

1. Safety instructions

The following safety measures relate to the handling of batteries and are to be observed in connection with all operating instructions contained in these instructions.

Observe assembly and installation instructions and display visibly at point of Installation. Work on batteries only after instruction by qualified staff. The operating instructions must always be accessible to personnel responsible for dealing with batteries.

Wear eye protection and protective clothing when working with batteries. Observe accident prevention regulations.

No smoking. No open flame, embers or sparks in the vicinity of the battery, to avoid risk of explosion and fire.

Explosion and fire risk, avoid short-circuits. Warning! Metal parts of the battery cells are always live. Never place foreign objects or tools on the battery. Ensure adequate ventilation of the battery room, so that explosive gases produced during charging are drawn off (see DIN EN 50272-2).

Have eye rinsing bottle to hand. If electrolyte splashes into the eyes or onto the skin, rinse with plenty of clear water and seek immediate medical advice. Clothing contaminated with electrolyte is to be washed thoroughly.

Electrolyte is highly corrosive. In normal operation there is no possibility of contact with the electrolyte. Electrolyte is released only if the cell housing is destroyed.

Do not tilt the battery. Use only approved lifting and conveying equipment e.g. lifting gear. Lifting hooks must not cause damage to cells, connectors or connection cables.

Dangerous electrical voltage. Use only suitable tools and measuring instruments.

NiCd batteries or cells belong to flammability class E (see DIN EN 2). If electrical fires occur, it is possible that the equipment may be live! Extinguishing water or foam are ideal conductors and electric shocks may occur. Electrical fires must be fought with extinguishing powder or carbon dioxide CO_2.

2. First Aid measures

Electrolyte in contact with the eyes:
- Rinse immediately with plenty of water for at least 10 minutes.
- If available, rinse the eyes 1% boric acid solution
- Immediately visit the eye clinic/eye casualty department.

Electrolyte in contact with the skin:
- Immediately remove clothing contaminated by electrolyte, and wash affected areas of skin with plenty of water. Visit doctor if any problems occur.
- Skin which has been in contact with electrolyte has a soapy consistency. Continue rinsing with water until normal skin condition has been restored.

If electrolyte is swallowed:
- Rinse out mouth immediately with plenty of water, and repeatedly drink large amounts of water.

Do not induce vomiting. Call emergency medical service immediately. Any liquid spillage must be analysed for acidity and alkalinity using litmus papers. If the liquid is alkali neutralise with 1% Boric acid solution using half a cupful of Boric acid to 2 gallons of water. Any liquid collected should be kept in a plastic container and disposed of by an Authorised Contractor. Never put it into the sewage system!

3. Transport and storage

Batteries must be packed, marked and conveyed in accordance with the applicable transport regulations (ADR, IMDG Code, IATA). The cells of the battery should be protected against short-circuiting, sliding, falling over or damage and are to be secured to pallets by suitable means. There should be no dangerous traces of lye on the outside of the packages. Any special national regulations are to be observed.

Following receipt and inspection of batteries, the battery cells should be replaced in their original packing. This provides the battery with good protection against damage while it is in storage prior to installation.

3.1 Tools

At all times insulated tools must be used to prevent the battery from direct short circuits at the cells.
Nickel Cadmium Battery electrolyte should never be allowed to come into contact with lead acid batteries and Sulphuric acid from lead acid batteries should not be used in nickel cadmium batteries. Tools and instructions should be dedicated to one battery or the other, not both. Cross contamination will destroy the batteries. Any liquid spillage from nickel cadmium batteries must immediately be neutralised using half cup of boric acid to 2 gallons of water (or 5% hydrochloric acid solution).
Hydrometers, thermometers and voltmeters for lead acid batteries must be kept separate.

3.2 Transport

For transport the cells are provided with yellow transport plugs before departure from the factory.

In the case of used cells, the standard vent plugs (hinged lid plugs) or AquaGen® plugs are replaced by the yellow transport plugs. The standard vent plugs (hinged lid plugs) or AquaGen® plugs should be kept for possible subsequent use.
- The cells should be transported in an upright position, secured against sliding, tipping over or damage.
- It is essential that the relevant national or international regulations for the transport of dangerous goods are observed.

3.3 Storage

Basically, batteries must be stored on pallets in a dry area, if possible under a dustproof cover.
The recommended storage temperature is 20°C.
- The storage area should satisfy the following requirements:
- The storage space must be dry
- The storage space must be frost-free
- The temperature of the storage area may not exceed 30°C
- The battery must not be subject to any major fluctuations in temperature
- The battery cells may not be stacked
- The battery cells should not be exposed to direct sunlight
- Suitable binding material, a container, and a brush and shovel should be available to deal with any spilt electrolyte.

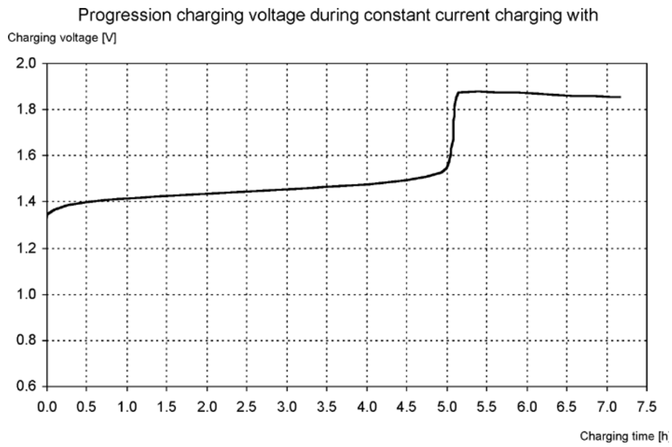
4. General instructions on commissioning of the battery

Both during and after charging, the battery produces explosive detonating gas (a mixture of oxygen and hydrogen). Adequate ventilation must therefore be provided, as specified in DIN EN 50272-2. No electrical connections has to be connect or disconnect up to 1 hour after charging. No naked flame, glowing matter, electrical equipment or carriers of static electricity which could generate sparks are to be allowed in the vicinity of the battery.

Metal parts of the battery can conduct voltage. Use insulated tools and wear suitable clothing! Do not wear rings, watches or metal objects while working on battery installations. The load must be disconnected from the battery. The battery must be connected to the direct current supply with correct polarity (positive terminal to positive terminal connector), with the battery charger switched off and the load disconnected.

4.1 I and Ia charging

Charging with constant current is used particularly for NiCd and NiMH batteries. An advantage is that the amount charged can be determined directly from charging time. With a higher charging current, the charging time may be reduced accordingly. If a charging method without a cut-off value (I charging) is used then, on reaching a state of full charge, the battery will be overcharged. The entire charging current then goes into secondary reactions. The diagram below shows the charge voltage depending on time during charge with constant current I_5.



In principle, HOPPECKE recommend commissioning at constant current I_5 for all NiCd cells, but commissioning with constant voltage is also possible. The state of full charge of an alkaline battery is clearly recognisable from a rise in voltage. During initial charging with constant current, cell voltages up to 1.9 V may occur. The charging method used in commissioning must allow for this and, where necessary, the battery should be split for this purpose.
If the charging method does not allow the individual cells to be supplied with at least 1.9 V, then the charging time should be suitably extended. When charged and filled cells are supplied, a certain amount of self-discharge occurs, which is swiftly compensated for after commissioning. Since in this case the negative electrode is at a high state of charge, even commissioning at a limited voltage of at least 1.65 V per cell will lead to an evenly charged battery.

4.2 U and IU charging

Charging with constant voltage leads to a falling current. This is due to the rise in the open-circuit voltage and the internal resistance as the state of charge increases. The high charging current at the start of charging may be a problem. For this reason, charging methods involving only U charging are not used. The IU charging procedure is used, in which the current is limited to a maximum value.

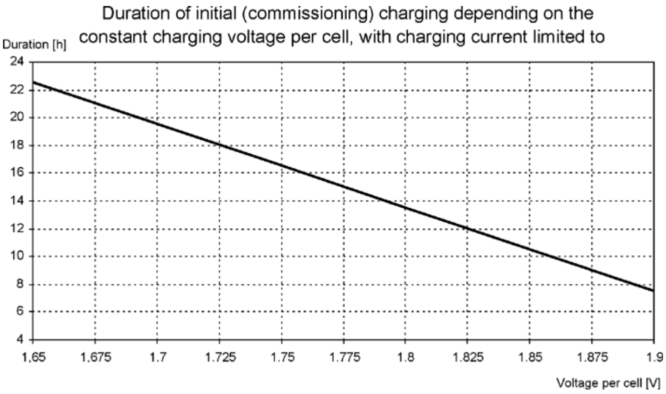
An advantage of IU charging is that batteries may be connected in parallel with no problems (parallel charging), and that overcharging is minimal (if the correct charging voltage is chosen). Against this is the fact that a much longer charging time is required to reach a state of full charge.

Under charging with constant current, the current must be limited to the five-hour discharge current I_5 (e.g. for a 100 Ah battery the current I_5 = 20 A). In the case of initial charging at a constant limited voltage of 1.65 V per cell and a current limited to I_5, the charging time must be extended. Full charge of the negative electrode, which normally limits the charging process, may be recognised from a voltage rise accompanied by a simultaneously fall in the current. Since, however, the current does not fall to zero, a further equalising charge off the positive electrode occurs. Only when the positive electrode is also fully charged does the user have the full capacity of the cell at their disposal.

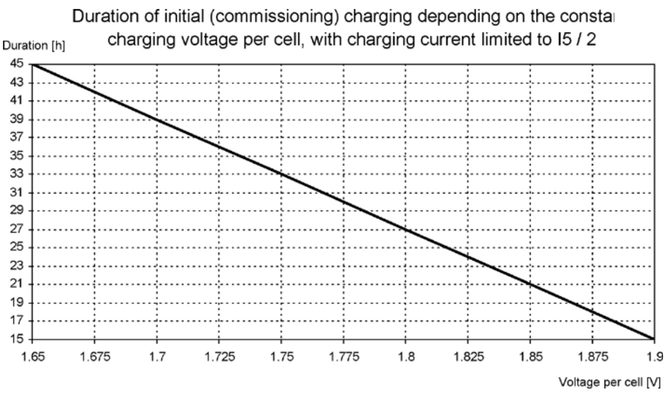
The following table shows the specified charging time for initial charging with limitation of charging voltage:

Voltage [V]	Time [h]	Current [A]	Capa-city [Ah]	Descpription
1.9/cell	7.5	I_5	1.5 * Cn	Recommended method: the product of current and time with a cell voltage of 1.9 V should correspond to 1.5 * Cn. Example 100 Ah cell 1.9 V cell voltage: I = 20 A T = (100 Ah / 20 A) * 1.5 = 7.5 h
1,85/cell 1,8/cell 1,75/cell 1,7/cell 1,65/cell	10.5 13.5 16.5 19.5 22.5	I_5	1.5 * Cn	In limiting the charging voltage an additional factor must be introduced. If starting from 1.9 V per cell the voltage is reduced by 0.5 V, then charging time must be increased by 3 hours in each case. Charging voltages of less than 1.65 V per cell are not allowed.

If charging voltage is limited, then charging time must be altered accordingly. The following diagram shows the duration of initial charging at constant voltage at a charging current limited to I_5.



If now the current is also limited, then charging time must be further extended. For a battery charged with a limitation of cell voltage to 1.8 V per cell and a current of I_5, then 13.5 hours will be required to obtain a good result. If the current is halved, then the charging time must be doubled.



The charging voltage for initial charging should lie between 1.65 and 1.9 V. Acceptable values for current are between $I_5/2$ and I_5.
Satisfactory results will not be obtained with values lying outside these ranges.

The duration of initial charging may be calculated as follows:
Assumption: 100 Ah FNC cell
I_5 = Cn / 5h
100 Ah / 5h = 20 A

$T_{opt.}$ = (1.5 * Cn) / I_5 at 1.9 V/cell
(1.5 * 100 Ah) / 20 A = 7.5 h

Ia Initial charging
Optimal commissioning charge: constant current = 20 A over 7.5 h with limited cell voltage = 1.9 V

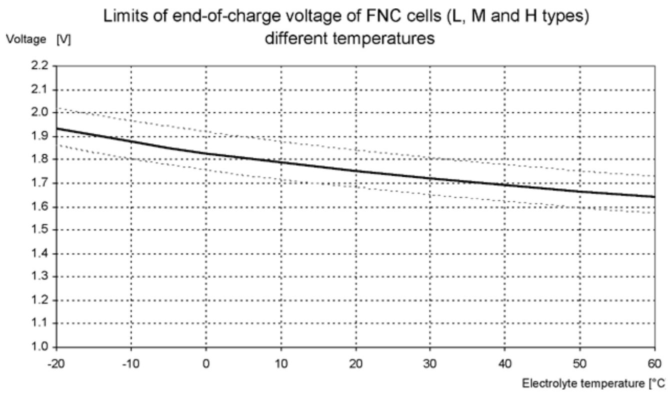
Assumption: a constant voltage of 1.7 V is available
$T_{IBL} = T_{opt.}$ + (1.9 V – 1.7 V) * (3 h / 0.5 V)
7.5 h + 12 h = 19.5 h

IU Initial charging
Possible commissioning charge: constant cell voltage = 1.7 V over 19.5 h with limited current = 20 A

Assumption: In addition the battery charger can only supply 15 A
$T_{IBL1} = T_{IBL} * (I_5 / I_{actual})$
19.5 h * (20 A / 15 A) = 26 h

IU Initial charging
Possible commissioning charge: constant cell voltage = 1.7 V over 26 h with limited current = 15 A

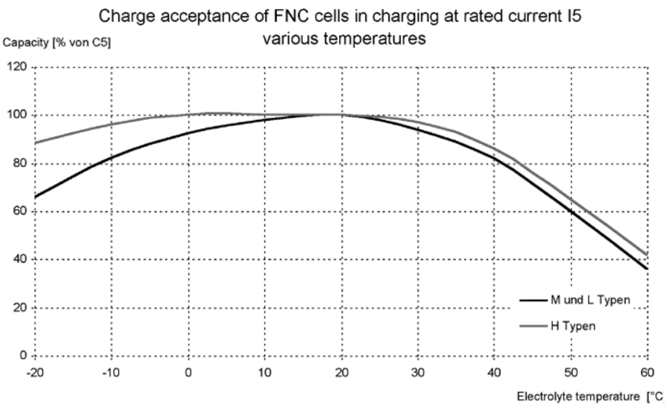
If charging takes place at a constant rated current I5 and without voltage limitation over a period of more than 5 h, then the individual cells will reach a voltage which will not increase further even with additional charging. This is the so-called end-of-charge voltage, which depends on the electrolyte temperature. This relationship is shown in the following diagram:



The end-of-charge voltage shown on this graph may vary by ± 5% between individual cells.

If an electrolyte temperature of +45°C is exceeded, then charging should be interrupted and the battery allowed to cool down.

The capacity charged to and withdrawn from a battery also depends on the electrolyte temperature. This relationship is shown in the following diagram:



If batteries with cells of type L are correctly charged at an electrolyte temperature of -20°C, then only 66% of the rated C_n can be fed into the battery. These cells also display the same behaviour at higher temperatures: at 45°C the battery can be charged to only 70% of rated capacity C_n.

During storage, batteries undergo temperature-related self-discharge. This means that the greater the difference between actual and recommended storage temperature, the greater the self-discharge as storage time progresses. If no initial charge is given, then less than the full battery charge will be available at the start of operation.

The age of the cells of a battery may be determined by the date of manufacture, which is stamped into the cell cover in code form. Commissioning will follow a different course depending on the condition and age of the cells supplied.

Cell cover stamp on HOPPECKE FNC cells (FNC 411 L as example):

L11	21	02

- 02 – Year of manufacture, in this case 2002
- 21 – Week of manufacture in the year, here calendar week 21
- L11 – Type of cell, here 11 plate pairs of performance type L

4.3 Commissioning of the battery after a short period of storage or transport

Before charging, remove any yellow transport plugs still in place. This is necessary to avoid any build-up of pressure in the cells, as result of water decomposing during charging. In principle, care is to be taken that no contaminants of any kind gain access to the opened cells. During any waiting period, the cells should be closed by a plug (standard vent plug or transport plug). During charging these plugs are to be removed since during initial charging, entrained electrolyte droplets contaminate both the hinged lid plugs and also the Aqua-Gen® vent plugs. No other work of any kind should be carried out in the battery room during bringing into operation of the battery.

⚠ In principle, before the start of commissioning, check the recommended settings for the battery charger and ensure that it is functioning properly.

4.3.1 Battery comprised of unfilled and uncharged cells

- Ensure that you have the electrolyte specified for the particular type of cell. The electrolyte is different for each of the performance types (H, M and L types).
- Only remove the yellow transport plugs fitted by the manufacturer just before (maximum 10 minutes) filling the cells with electrolyte.
- The transport plugs should be kept for subsequent use.
- The cells are filled with the specified electrolyte (aqueous potassium hydroxide solution with an addition of lithium hydroxide) up to the min. mark + 1 cm. Slight heating may occur during filling. Any splashes of lye should be removed with a damp cloth.
- Close the cells with a vent plug.
- After the cells have been filled, initial charging may commence only after a waiting time of 12 hours.
- The plugs used for the waiting period must be removed.

- Initial charging is given at a constant rated current I5 over a period of 7.5 h, i.e. the battery is charged at a charge factor of 1.5. If a lower current is used, then the charging time should be extended accordingly. At least 50% of the rated current I5 should be charged during the initial charging. If charging has to be interrupted (e.g. electrolyte temperature > 45°C) it must be ensured that a charge factor of 1.5 is reached.
- After a waiting period of at least 2 hours, top up with electrolyte to the maximum mark.
- The cells are sealed using the standard vent plugs (hinged lid plugs) or AquaGen® vent plugs supplied
- The cells should be cleaned.

ℹ These cells may be brought into operation only with constant current in accordance with the Ia charging characteristic. A commissioning charge based on U or IU charging is not permissible.

4.3.2 Battery comprised of filled and charged cells

- Before charging, remove any yellow transport plugs still in place.
- The transport plugs should be kept for subsequent use.
- Initial charging is given at a constant rated current I_5 over a period of 7.5 h, i.e. the battery is charged at a charge factor of 1.5. If a lower current is used, then the charging time should be extended accordingly. At least 50% of the rated current I_5 should be charged during the initial charging. If charging has to be interrupted (e.g. electrolyte temperature > 45°C) it must be ensured that a charge factor of 1.5 is reached. If charging voltage or charging current are limited, then the charging time must be extended accordingly. The charging voltage may not be limited to less than 1.65 V per cell.
- After a waiting period of at least 2 hours, top up the electrolyte with distilled or de-ionised water (no water containing acid!) to the maximum mark.
- The cells are sealed using the standard vent plugs (hinged lid plugs) or AquaGen® vent plugs supplied.
- The cells should be cleaned.

4.4 Commissioning of the battery after storage for over 12 months

⚠ Before commissioning, cells which have been stored for a long time should be checked for any damage, and also to confirm that all accessories are present (in particular standard or AquaGen® vent plugs).

For the correct commissioning of batteries after a lengthy period of storage, it is necessary to use a suitable charge/discharge unit.

4.4.1 Battery comprised of unfilled and uncharged cells

Unfilled and uncharged cells have a virtually unlimited shelf life. These batteries are commissioned in accordance with the instructions above for “Commissioning of the battery after a short period of storage or transport” for batteries comprised of unfilled and uncharged cells.

4.4.2 Battery comprised of filled and charged cells

In principle, batteries made up of cells which have been in store for a longer period of time are brought into operation in the same way as batteries comprising cells stored for short periods of time.

- These batteries are commissioned in accordance with the instructions above for “Commissioning of the battery after a short period of storage or transport” for batteries comprised of filled and charged cells.

The battery should then be additionally charged and discharged (a maximum of 3 charge/discharge cycles).

- Discharge is at the rated current I_5 down to a voltage of 1.0 V per cell on an arithmetical average.
- The cell plugs are removed.
- Initial charging is given at a constant rated current I_5 over a period of 7.5 h, i.e. the battery is charged at a charge factor of 1.5. If a lower current is used, then the charging time should be extended accordingly. At least 50% of the rated current I5 should be charged during the initial charging. If charging has to be interrupted (e.g. electrolyte temperature > 45°C) it must be ensured that a charge factor of 1.5 is reached. The charging voltage may not be limited to less than 1.65 V per cell.
- A pause of 30 minutes should be made between each instance of charging and discharge, so that the gases formed by the decomposition of water may bubble up.

On completion of final charging and after a waiting time of at least 2 hours, the electrolyte level is topped up to the maximum mark with distilled or de-ionised water (no water containing acid!).

- The cells are then sealed using the standard vent plugs (hinged lid plugs) or AquaGen® vent plugs supplied.
- The cells should be cleaned.

5. Capacity testing of batteries in accordance with DIN IEC 623

The battery should be given a capacity test every 3-5 years. This is especially important after the commissioning of batteries after a long period of storage, so that the end of battery life may be forecast accurately.

In accordance with international standard DIN IEC 623, charging takes place at constant rated current I_5 over a period of 7 to 8 hours. After charging the battery should be stored for a minimum of 1 h but for no more than 4 h at an ambient temperature of (20 ± 5)°C. Discharge is effected at rated current I5 down to a voltage of 1.0 V per cell as an arithmetical average. To obtain a capacity of 100%, the minimum discharge time should be 5 h.
The capacity obtained during this test may be calculated as follows: Capacity (%) = (discharge time (h) / 5 h) * 100

If after five charge/discharge cycles the capacity required for this test has not been reached, then the battery should be replaced.

To carry out a capacity test on the battery, proceed as follows:

1. Discharge at rated current I_5 down to a voltage of 1.0 V per cell on an arithmetical average.
2. Pause for at least 8 hours. During this waiting period, the cells must be sealed by vent plugs (transport, standard or AquaGen® vent plugs).
3. Charge at constant rated current I_5 over a period of 7.5 h, with vent plugs (standard or AquaGen® vent plugs) removed.
4. 2-hour pause, during which the cells must be sealed by vent plugs (transport or standard vent plugs).
5. Discharge at rated current I_5 down to a voltage of 1.0 V per cell on an arithmetical average. This discharge completes the capacity test as specified in DIN IEC 623.

If insufficient capacity is determined in the capacity test under point 5 above, then points 2 to 5 should be repeated until capacity no longer rises.

After this capacity test, the following work is necessary for correct operation of the battery:

- Pause for at least 8 hours. During this waiting period, the cells must be sealed by vent plugs (transport, standard or AquaGen® vent plugs).
- Charge at constant rated current I_5 over a period of 7.5 h, with vent plugs (standard or AquaGen® vent plugs) removed.
- On completion of charging, the cells are sealed using the standard vent plugs (hinged lid plugs) or AquaGenh vent plugs supplied
- After a waiting period of at least 2 hours, top up the electrolyte with distilled or de-ionised water (no water containing acid!) to the maximum mark.
- The cells should be cleaned.

6. Cleaning of the battery

A clean battery is essential, not only for the sake of external appearance, but more importantly to avoid accidents and material damage, together with any reduction in the life expectancy and availability of the battery. It is necessary to clean the cells, racks and insulators in order to maintain the required insulation of the cells from earth or from external conductive parts. This will also avoid damage due to corrosion and leakage currents. Regular cleaning of the battery is necessary not only to secure its high availability, but as an important element in the observance of accident prevention regulations.

Dangerous contact voltages are possible. Observe the notes on safety in these operating instructions.

During initial charging and in operation, the evaporation of entrained electrolyte droplets during water decomposition may lead to the deposition of white electrolyte residues on the cells. These residues should be removed without the use of cleaning agents, with the standard vent plugs (hinged lid plugs) removed. We recommend the use of a damp cloth.

- Plastic parts of the battery, in particular cell containers, may only be cleaned with water with added rinsing agent. With the transport plugs fitted, the battery may be cleaned using a high-pressure cleaner. The pressure must be set so that the plastic parts are not damaged (cleaning temperature should not exceed 60°C with a max. operating pressure of 50 bar).
- Standard vent plugs (hinged lid vent plugs) may be cleaned in a bucket with rinsing agent. The plugs should then be dried thoroughly.
- Avoid electrostatic charging (do not use dry cloths for cleaning!).

7. Electrolyte

As the charge exchange medium, the electrolyte is of critical importance, ensuring optimal performance of the battery when kept at the correct concentration and filling level. There will be a loss of performance if electrolyte levels are too low. Special attention should therefore be given during maintenance to ensuring that electrolyte levels are correct. The electrolyte is comprised of aqueous potassium hydroxide solution (KOH) with an addition of lithium hydroxide (LiOH), and is designed for use in temperatures ranging from -25 to +45°C. DIN IEC 993 applies to the production of the electrolyte. When the cells have been in use for some time the density of the electrolyte is usually 1.19 kg/l-1 ± 0.01 kg/l-1 at the reference temperature of 20° Celsius (on delivery the electrolyte density may be higher). The electrolyte density is temperature-dependent and may be adjusted using the correction factor 0.0005 kg/l-1 K-1. The lithium hydroxide (LiOH) content varies for each of the different load types L, M and H. The electrolyte retains its effectiveness throughout the entire life of the battery and does not need to be replaced. In nickel-cadmium cells, electrolyte density does not give an indication of the state of charge.

For the majority of FNC products HOPPECKE will provide on request a special electrolyte allowing operation even in the temperature range down to -45ºC.

8. Documentation

A record should be made during commissioning of the battery. A form for such a commissioning record is appended to these instructions. If your battery has more cells than provided for on the form, please ask HOPPECKE Batterie Systeme for a suitable form for your purposes.

9. Taking the battery out of service

- Discharge at rated current I5 down to a voltage of 1.0 V per cell.
- Replace the standard vent plugs (hinged lid vent plugs) or AquaGen® vent plugs by the yellow transport plugs. This is important to avoid atmospheric oxygen coming into contact with the electrodes.
- Clean the battery including all cells
- Store on pallets in a dry, frost-free room. The complete battery or the individual cells should be provided with a cover.

In principle, when taking the battery out of service, the standard vent plugs (hinged lid vent plugs) or AquaGen® vent plugs on the individual cells should be replaced by the yellow transport plugs. The standard vent plugs (hinged lid vent plugs) or AquaGen® vent plugs should be kept for subsequent use.

Depending on the length of storage after being taken out of service, the battery should be brought back into service again in accordance with these instructions.

9.1 Disposal

Disassembly and disposal of the battery should be carried out only by trained personnel. EC Directives 91156 (EEC) and 9386 (EEC) must be observed. Your local HOPPECKE representative will be pleased to give you a quotation for proper disassembly and disposal of your battery. To take back all no longer used batteries, is the long term target of the HOPPECKE collection and recycling concept.

We have entered into a cooperation contract with two companies to use there logistic network of collection points for Europe. Both recycler separate the cadmium content of the batteries by distillation. This cadmium will be used for the production of cadmium oxide for new batteries. This is the great advantage of these method. In this way we have a "Closed Loop System" for the cadmium content of the recycled batteries.

Further action, in particular the operation and maintenance of the battery, is described in the instructions "Operation and maintenance of stationary nickel-cadmium batteries with FNC cells". It is essential that these instructions, which are supplied with the battery, are followed.

Cd

Used batteries with this symbol are recyclable goods and must be sent for recycling. Used batteries which are not sent for recycling are to be disposed of as special waste under the appropriate regulations. Hoppecke have a "closed loop" recycling system for NiCd batteries. Your local HOPPECKE representative will be pleased to give you a quotation for disposal of your battery.

10. Commissioning record for HOPPECKE FNC NiCd batteries

Customer: ______________________ Order No.: ______________________

Where installed: ______________________

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Supplier: ______________________

Battery No.: ______________________

Cell type: ______________________ No. of cells: ______________________

Capacity [Ah]: ______________________

Charging method:

❍ Constant voltage (U- or IU characteristic) Constant voltage [V]: __________ Maximum current [A]: __________	❍ Constant current (I or Ia characteristic) Constant current [A]: __________ Maximum voltage [V]: __________

Battery voltages:

Charging voltage [V] Start of charging: ______________ end of charging: ______________

Open-circuit voltage [V] Start of charging: ______________ end of charging: ______________

Charging current:

Charger current [A] Start of charging: ______________ end of charging: ______________

Temperatures:

Ambient [°C] Start of charging: ______________ end of charging: ______________

Electrolyte [°C] Start of charging: ______________ end of charging: ______________

Pilot cell [°C] Cell-No.: ______________

Charging time:

Date from: __________ to: __________

Time from: __________ hours to: __________ hours

Commissioning carried out by: Date, signature ______________________

Acceptance (supplier) carried out by: Date, signature ______________________

Acceptance (customer) carried out by: Date, signature

Measurement of individual cell voltages 1-120:

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

1* = open terminal voltage · 2* = end-of-charge voltage 15 min before end of charging · 3* = cut-off voltage after 5 hours discharge

Measurement of individual cell voltages 121-240:

Cell No.	1* [V]	2* [V]	3* [V]	Cell No.	1* [V]	2* [V]	3* [V]	Cell No.	1* [V]	2* [V]	3* [V]
121				161				201			
122				162				202			
123				163				203			
124				164				204			
125				165				205			
126				166				206			
127				167				207			
128				168				208			
129				169				209			
130				170				210			
131				171				211			
132				172				212			
133				173				213			
134				174				214			
135				175				215			
136				176				216			
137				177				217			
138				178				218			
139				179				219			
140				180				220			
141				181				221			
142				182				222			
143				183				223			
144				184				224			
145				185				225			
16				186				226			
147				187				227			
148				188				228			
149				189				229			
150				190				230			
151				191				231			
152				192				232			
153				193				233			
154				194				234			
155				195				235			
156				196				236			
157				197				237			
158				198				238			
159				199				239			
160				200				240			

1* = open terminal voltage · 2* = end-of-charge voltage 15 min before end of charging · 3* = cut-off voltage after 5 hours discharge

Measurement of individual cell voltages 241-360:

Cell No.	1* [V]	2* [V]	3* [V]	Cell No.	1* [V]	2* [V]	3* [V]	Cell No.	1* [V]	2* [V]	3* [V]
241				281				321			
242				282				322			
243				283				323			
244				284				324			
245				285				325			
246				286				326			
247				287				327			
248				288				328			
249				289				329			
250				290				330			
251				291				331			
252				292				332			
253				293				333			
254				294				334			
255				295				335			
256				296				336			
257				297				337			
258				298				338			
259				299				339			
260				300				340			
261				301				341			
262				302				342			
263				303				343			
264				304				344			
265				305				345			
266				306				346			
267				307				347			
268				308				348			
269				309				349			
270				310				350			
271				311				351			
272				312				352			
273				313				353			
274				314				354			
275				315				355			
276				316				356			
277				317				357			
278				318				358			
279				319				359			
280				320				360			

1* = open terminal voltage · 2* = end-of-charge voltage 15 min before end of charging · 3* = cut-off voltage after 5 hours discharge

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