

OPERATION MANUAL

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Battery Charger /Analyzer

UL60

0.5 – 40VDC / 0.5 – 60A

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HISTORY OF REVISION

Date	Change	Version
	Time of charge NiCd initial start corrected; Emergency stop in case of mains failure improved; Reset TFT Display included; Text NKBN discharge corrected	1.34
	Time of charge lead-acid battery corrected; Capacity test lithium C1 to C10 included; Marathon initial start corrected	1.35
	Lithium cut-off voltage improved	1.36
	USB „Data clr“ after data save included	1.37
	USB can be switched off so that the stick can be reset (only effective for hardware from 20.7.2017)	1.38
	Dutch languages added	1.39
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	Eliminate of vibes running charging program	1.41
	Date failure during start in time corrected	1.42
06.08.2018	Date capacity test corrected; Discharging failure during Hawker short program corrected	1.43
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05.12.2018	Slovak language, corrected printout of page numbers in Russian, changed lead aviation start again	1.45
05.12.2018	New program for deep discharge NiCd	1.46
	Marathon manual 24-34-08, bugs corrected	1.47
	Optimization of routines for calibration	1.48
	Extended routines for external program editor	1.49
01.06.2019	SAFT Ultra Low Maintenance Batteries (ULM) added	1.50
	CAP=0 removed. Error display -1 fixed	1.51
11.12.2019	up to 22 cells 50 A	1.52
	Error fixed at “time start”	1.53
06.02.2020	Decreased waiting time at the end if no USB is plugged in	1,54
	Reset of the calibration values possible	1.55
	Delta U value extended for Program Editor	1.56
	Corrected Marathon switching for hand cell tester in reload	1.57
09.07.2020	Automatic cell tester averaging improved (median instead of mean value), since incorrect measurements sometimes occurred	1.58
	Error Program Editor fixed	1.60
	Error Program Editor fixed	1.61
	Error wireless manual cell measurement test fixed	1,62

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1 General information

1.1 Scope of application

The network-compatible battery charger /analyzer UL60 is a microprocessor controlled charging-, discharging- and maintenance device. All programs can be used for aircrafts, railways or stationary storage. Rechargeable lead acid- and Nickel Cadmium-batteries can be charged, discharged or optimally serviced with individually adjusted programs.

- rated voltages between 1.2 and 28.8 V
- capacities between 1 and 900 Ah
 - NiCd aircraft: max. 60 Ah with C₁
 - NiCd others: max. 230 Ah
 - Lead acid: max. 900 Ah (limit set by device settings)

All programs can be selected menu guided via console.

Main feature is the capacity test of lead acid- and Nickel Cadmium-batteries.

Focuses of the UL60 are process optimization and of aircraft batterie maintenance. Particularly the maintenance of the aircraft batteries is type specific and has to comply with manufacturer's maintenance manuals. The UL60 can fulfill these requirements.

Optional the UL60 cab be operated with an automatic cell tester. When using that the device can perform fully automated process cycles without any manual intervention. The only exception is the adjustment of the battery electrolyte level.

For measurement and recording of single cell-voltages the UL60 provides with a designated program.

The UL60 is network compatible via Ethernet with TCP/IP-protocol. Thus, it is possible to work with remote (multiple) display, data logging and connected network printers for recording of measurements.

Application field

The device with housing is constructed for for stationary and mobile use in closed rooms. Due to the robust construction, it can be used in 19" housing racks and cases as a multi-purpose tool.

Battery types - the software at present allows the use of the following battery types:

- | | |
|----|---|
| 00 | Other battery |
| 10 | Lead acid battery sealed MIL (with fixed electrolyte AGM or GEL) |
| 11 | Lead acid battery sealed commercial (with fixed electrolyte AGM or GEL) |
| 12 | Valve regulated lead acid aircraft battery |
| 16 | Lead acid battery vented commercial |
| 17 | Lead acid battery MIL P3-C Orion |
| 19 | Lead acid battery (free input) |
| 20 | NiCd battery (manufacturer independent) |
| 21 | NiCd battery HAWKER |
| 22 | NiCd battery Saft |
| 23 | NiCd battery NKBN |
| 24 | NiCd battery MARATHON |

The operator can coordinate each battery treatment with the respective battery type by typing in the battery parameter (nominal voltage, number of cells and nominal capacity). This procedure guarantees the best possible readiness (electrical performance) of the battery lifespan.

1.2 Application

The regular housing is designed for the use in spaces with roof, closed rooms which are comply with required ventilation facilities. This could be laboratories, work-/ battery shops, charging rooms and so on.

The completely functional plug-in unit can be used in the stationary 19" housing racks as well as on transport trolleys for mobile usage.

2 Maintenance and safety instructions

2.1 Safety instructions

Please read this manual carefully before commissioning and keep these in a safe place.

Every device is tested by the manufacturer in terms of functionality and safety before being shipped. When properly used, the device is safe in operation.

The battery charger / analyzer UL60 may only be operated in immaculate condition in compliance with this instruction manual. All safety and operating instructions has to be observed.

In case of maloperation or abuse danger can result for:

- the life and limb of the operator,
- the device and other properties of the operator,
- the functioning of the device.

All persons involved in the execution of installation, commissioning, operation, maintenance and servicing of the device must:

- be appropriately qualified,
- observe carefully these operating instructions and
- follow the applicable rules for occupational safety.

Unauthorized changes and modifications to the equipment are prohibited and will void the warranty. The local safety regulations have to be obeyed.

Working with the battery charger / analyzer UL 60:



CAUTION!

- Mains voltage (230V, 50Hz) in the battery charger / analyzer UL 60.
- Warning of hazardous electrical voltage.
- Disconnect from the mains power supply before opening the device.
- Hazards by charged capacitors with high capacity and performance.
- do not make any manipulations on the unit.

The battery charger / analyzer UL60 may only be opened and repaired by the manufacturer, enabled repair centers or in individual agreement with Nortec Electronics.

The operator has to check the functional safety and the condition of the device and cables before every use.

In the event of interruption of the power supply for > 1 second, the device returns to the initial state.

The charging cable must not be disconnected under load from the battery during operation.

The UL60 may only operate in the cases provided by the manufacturer housings or racks, otherwise the unprotected running fan may affect equipment damage or injury.

The battery charger / analyzer UL 60 complies with protection IP20. It should be kept clean and dry. Electrolyte contaminated tools and liquids must not be placed on the device.

The device is protected against polarity reversal or polarity reversal of the battery. In the event of reversed connection of the charging cable, the device signals "voltage <0.1 V" and requests to stop the program. After removal of the fault, the program must be restarted.

Generally, the valve plugs must be removed beforehand the electrical maintenance. The foregoing applies to working with automatic cell testers. The valve plugs can not be removed lateron with with mounted adapter.

The cover from sealed aircraft batteries have always to remove beforehand.

Take utmost care when entering the battery data, charging parameters and the number of cells of NiCd batteries. Incorrect entries may damage the battery.

The programs of the battery charger / analyzer UL60 were created with the utmost care according to the maintenance manuals of the battery manufacturers, but are offered without guarantee. Before applying the programmed programs, they must be checked for compliance with currently valid maintenance manuals of the battery manufacturer. In any doubt or in case of deviations the currently valid maintenance manual of the battery manufacturer always applies.




We ask you to inform us in any case of any discrepancies.








Working with batteries:

When used properly and according to the manufacturers instructions from batteries do not pose any particular risks.

Never use the device for maintenance of NiCd and lead-acid batteries without chemical neutralization between operational or use different cable sets.

The currently valid maintenance manuals and safety regulations of the respective battery manufacturer must be strictly followed and shall give priority to the safety instructions described here.

	<p>Note maintenance and safety instructions of the battery manufacturer!</p> <ul style="list-style-type: none"> - All maintenance on batteries exclusively carried out by properly qualified personnel.
	<p>Wear protective clothing and eye protection for all works on batteries!</p> <ul style="list-style-type: none"> - Observe the applicable accident prevention regulations.
	<p>Avoid contact of acid with skin or eyes!</p> <ul style="list-style-type: none"> - In case of emergency rinse immediately with plenty of water. - Then call a doctor immediately.

	<p>Hazardous electrical voltage!</p> <ul style="list-style-type: none"> - Do not place any metallic tools or objects on the battery. - Do not wear accessories made of metal, such as rings, watches, belts or jewelry.
	<p>Explosion and fire hazard!</p> <ul style="list-style-type: none"> - Both during and after charging, the battery can generate highly explosive detonating gas (a mixture of oxygen and hydrogen). - Avoid causing sparks when handling cables and electrical devices. - Avoid short circuits: Only insulated tools may be used. Do not place or drop any metal objects on the battery. <p>Do not wear accessories made of metal, such as rings, watches, belts or jewelry.</p>
	<p>No smoking!</p>
	<p>Follow the instructions for battery use!</p> <ul style="list-style-type: none"> - Fix them visible close to the battery. - Observe the dangers posed by batteries.
	<p>Danger of chemical burn!</p> <ul style="list-style-type: none"> - Battery acids and electrolytes are very corrosive. - Wear protective gloves and eye protection. - Do not tilt the battery.
	<p>Batteries are heavy!</p> <ul style="list-style-type: none"> - Use appropriate transport / lifting equipment. - The battery vent tubes are not intended for use as "carrying handles".
	<p>Batteries may not be disposed of with household waste!</p> <ul style="list-style-type: none"> - They are legally obliged to return used batteries, so a correct disposal can be ensured.

Working with automatic cell measuring adapter:

Risk of injury: The test prods of the cell measuring adapter are sharp-edged and can lead to injuries if they are not handled properly.

Only suitable adapters suitable for each battery should be used.

Before positioning the cell measuring adapter, ensure that the measuring prods are freely movable. This can be checked by slight lifting the cell measuring adapter. When mounting the adapter, the adapter should not be jammed. The adapter is fixed with the lid holders of the battery. The measuring prods must be placed on the battery poles or connectors.

The adapter should be stored on a soft base so the probes and the base can not be damaged.

2.2 Maintenance instructions

The battery charger / analyzer UL 60 should be kept clean and dry. You can clean it with a damp or antistatic cloth. When cleaning do not use any chemical or abrasive cleaners.

The automatic cell measuring adapter is attached directly to the battery and should be cleaned regularly. You can use clear or soapy water.

For the cleaning and maintenance of batteries, please refer to the currently valid maintenance instructions of the battery manufacturer.

3 Operating and display elements

The operating and display elements as well as the connector elements of the battery charger /analyzer UL60 are on the front panel. The connector elements for the automatic cell voltage measurement and for the interconnectedness with the personal computer are arranged on the rear panel.

3.1 Front panel



Power ON / OFF-switch with display

Switches the device on or off. Power I – O: switch on I for operation

The lighted switch indicates that mains voltage is available.

Display


TFT-display (800 × 480 pixel) communicates with the user and shows for example program and charging parameter.

Keypad




The keys **B** **C** **P** **E** permit interruption, clear faulty inputs start printing as well as acknowledge of inquiries or input.

The display allows the user numerical input for example battery parameter or identification number of the user.

The key  opens the menu to choose a different language or the time and starts the programs.

Printer

The inbuilt record printer can be activated before starting, in between or after the battery treatment by pressing the key  all essential battery parameter as well as battery failures will be printed.

Celltester

The UL60 and the manual celltester will be connected via a 6-pole connector of the type VG 95 328 C10-6PN. Cell voltage upto +4.0 V can be measured with the celltester.

Battery connection

The UL60 and the battery is connected via different battery connection cables using two 4-pole VG-electrical connectors according to VG 95 234.

USB-connection for USB flash drive

The recorded parameter can be stored on USB flash drive.

3.2 Rear Panel



Netcable

For voltage supply of the device at 230 VAC mains.

Line Fuse

To secure mains inlet.

Signal generator

The user will be informed about the state of the battery or actions to be taken by the alarm annunciator in use for battery failures, false inputs or after a treatment is finished and an action is necessary to continue.

Junction box 28-poles

For the connection of an automatic celltester which can be delivered for different NiCd-batteries.



Fig. Automatic celltester (without temperature sensor)

Sub-D (9-pole) connector plug

For connection to RS 232 interface of personal computer for software update.

Ethernet connection RJ45

For network or browser connection to view data or for being able to print data after the program finished.

4 Principles of operation

4.1 Connection activities

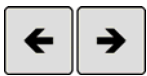
The standard procedure for all programs is as follows:


- ◆ Connect to 230 VAC-net
- ◆ Connect battery
- ◆ Net switch POWER I - O use I „In operation“

After this routine, the selftest starts.

NOTE! In case of error message the routine will not continue.

After switching on the already connected battery must be chosen in the menu. Press the keys



as well as . The possible battery types are listed in chapter 8.2 Page 30.

4.2 Installation

The device must be set up in a way that additional and used air can pass (minimum 10 cm free space behind the device).

The cooling air comes from the bottom and gets out at the rear side. Operating in open area for example in a tent take care that the device does not stand on a dusty ground because dirt can influence the cooling effect.

The device has to be operated in the supposed housings or racks because the fan in the rack is unprotected and thus can cause device damage or risk of injury.

4.3 Warning notes

Caution avoids contact!

The rear part of the rack can heat up especially during discharging programs. Increase in temperature of the heat sink is regulated and will end in a device shut down if too high.

Do not open device during operation!

After disconnecting of the device from the 230VAC net there can be dangerous voltages because of loaded capacitors. Maintenance of the device should only be done by the manufacturer in order to secure guarantees!

Attention: The manufacturer does not assume liability for damages caused by the user incorrect installation, initial operation or use.

If the UL60 is in use for aeronautical engineering the device has to be repaired and calibrated by the manufacturer only.

5 Technical data

5.1 Electrical input and output parameter

Input voltage	:	230 VAC \pm 10% (single phase)
Feed frequency	:	45 to 60 Hz
Input power	:	3000 VA
Mains fuse external	:	16 A semi time-lag
Fan power	:	About 100/300 litre/minute
Charging current range	:	0.5 – 60 A (to 31 V)
Charging current range	:	0.5 – 50 A (> 31 V)
Charging current range	:	0.5 – 40 A (> 34,1 V)
Discharging current range	:	0.5 – 60 A
Charging voltage range	:	0.1 – 40 V (using NiCd reload upto 41.5 V)
Discharging voltage range	:	0.1 – 40 V
Voltage precision	:	< 0.1 % adjusted value plus \pm 5 digits
Current precision	:	< 0.1 % adjusted value \pm 5 digits
Temperature precision	:	< \pm 2°C
Isolation	:	VDE 0160, class I
Safety class	:	IP20
Working temperature	:	0 - + 45°C
Weight	:	About 32 kg (in 19"-housing without battery cable)
Dimensions	:	Width 504 mm, height 242 mm, depth 400 mm
Distance from obstacles for used air	:	> 100 mm
Interfaces	:	USB 2.0; RS232, Ethernet RJ45

5.2 Temperature range

The functions of the device are guaranteed in temperature range from 0 °C upto +45 °C.

The precision of the visual display and the printed record of the charging and discharging parameter correspond to the precision specified in chapter 5.1.

The precision of output data is guaranteed in the temperature range from 0 °C to +45 °C for 2 years starting from the delivery date of the device.

5.3 Calibration

We recommend a first calibration by the manufacturer Nortec Electronics or by an authorized partner company after 2 years.

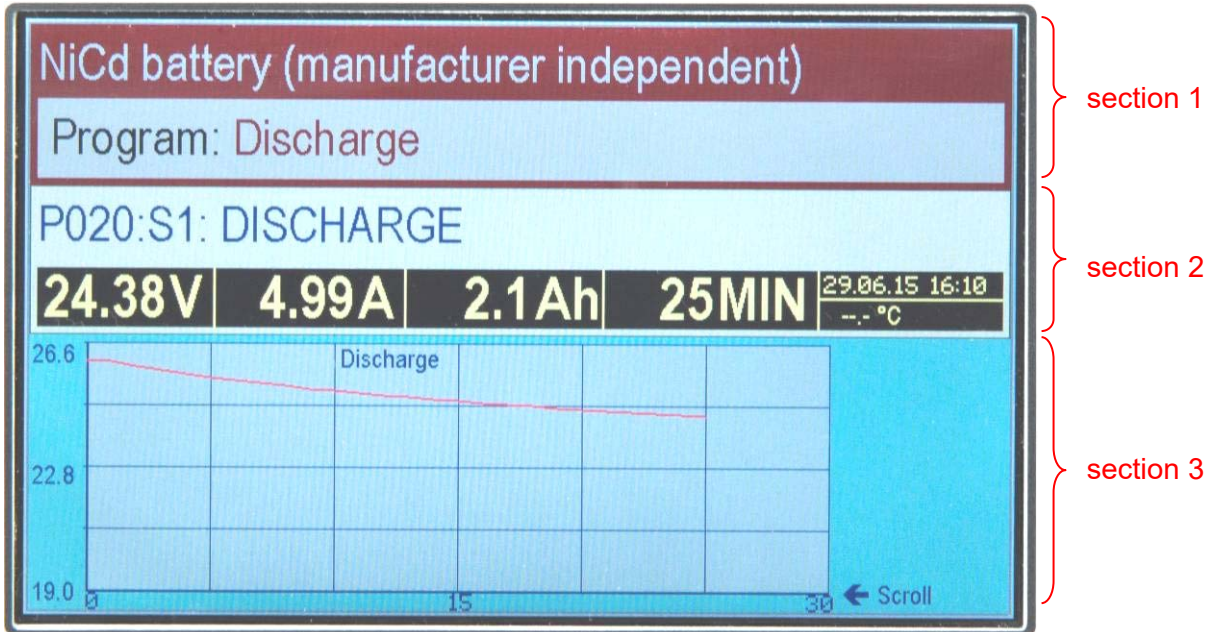
After that for safety related engineering a yearly calibration and maintenance is recommend. Additionally, please pay attention to the internal and external rules laid down by the competent authorities.

6 Handling

6.1 General handling instructions

6.1.1 Display

The display of the UL60 is divided into 3 display sections:



Section 1 (first 2 lines):

Display of battery type and type of treatment

Section 2 (3.-4. lines):

Status of program

This line displays the status of the device in general.

This could be: PROGRAM SELECTION, PROGRAM START, PROGRAM END.

Status

The information displayed shows the program step with description of the running routine.

Time

The time is displayed in the following order: hour : minute : second

Input, information or transaction parameter

In this section, all selections or parameter are shown in time such as:



- ◆ Parameter- or program selection
- ◆ Error messages
- ◆ Operating parameter (current, voltage and so on) during battery threatment process
- ◆ Information about menu process, temperature display

Section 3 (below):











In addition to a program: Help texts, additional information

During program routine:

- Help texts,
- Last discharging curve (in case the program includes discharging),
- Last charging curve (in case the program includes charging),
- Indicated value of cell measurements (in case single cells were measured),
- Bar chart of cell measurements (in case single cells were measured).

For selection, these keys are used  

6.1.2 Keyboard**Function of keys**

Key		=	Cancel entry
Key		=	Interrupt / go back
Key		=	Start program including print / print
Key		=	Entry
Key		=	Program start without print / special program
Keys	 - 	=	Numbers 1 – 9, 0
Key		=	Decimal point
Key		=	Back
Key		=	Continue



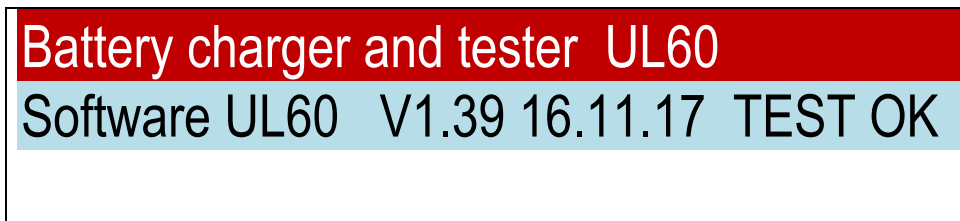
6.2 Selftest

Power I – O: switch on I “In operation”

The display is illuminated.

After switching on the supply voltage on the display for 2 seconds you will see the following:

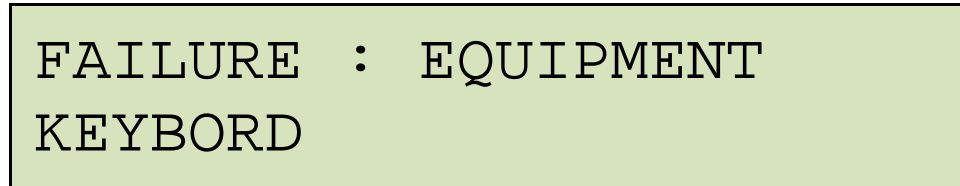
- Copyright of the manufacturer
- Device type
- Software version
- Software date
- Test status



The screenshot shows a display with two lines of text. The first line is on a red background and reads "Battery charger and tester UL60". The second line is on a light blue background and reads "Software UL60 V1.39 16.11.17 TEST OK".

Simultaneously a signal announces that the device is ready for use.

In case the result of the selftest is a failure within the device the following information is shown on the display:



The screenshot shows a display with two lines of text on a light green background. The first line reads "FAILURE : EQUIPMENT" and the second line reads "KEYBORD".

This message is always in English language.


6.3 USB

The device has got an inbuilt USB interface. This can be used to write the recorded data on an USB flash drive.

The data of the last battery measurements can be copied on the stick using menu choice „Write on USB flash drive “.

An easier method is to put in the USB flash drive before the end of the charging routine in order to transfer the data to the stick automatically after the end of the routine. You can keep the USB flash drive permanantely in the USB-interface. All data will be recorded automatically.

NOTE!

The device only records data of programs which were started using the key  (printer started). Inside the UL60 the data for the last measurements will be deleted and the new data will be stored.

The USB flash drive can be taken out as soon as the program is finished and the display shows: „Data successfully written on USB flash drive “.

On the USB flash drive 2 files are kept:

The UL 60 automatically generates the filenames continuously from the date and time.

First file:

One text file (.rtf). This file can be opened in Word or OpenOffice. This file contains the same text as printed on the inbuilt printer. Additionally, the charging and discharging curves are displayed in case the program chosen contains both routines.

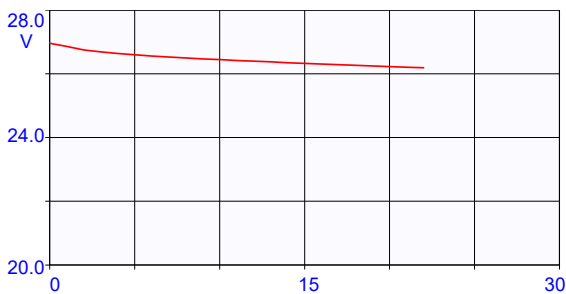
NORTEC
 2014-15 UL60 V 1.0 16.06.15
 SN: 160001

 DATE: 17.06.15
 BATTERY NO:
 OPERATOR NO:
 NOM. VOLTAGE: 24.00 V
 RATED CAP: 006.0 Ah
 PROGRAM: 020
 NiCd battery (manufacturer independent)
 DISCHARGE

 PROGRAM START 12:33:58
 VOLTAGE = 27.19 V

 P020:S1: 12:56:16
 DISCHARGE
 VOLTAGE = 26.18 V

...



Second file

The second file .csv (comma separated file) can be used in Excel or OpenOffice. This file contains the measurements:

```
Z; U; I
1;22.34;-25.03
1;20.28;-25.00
2;22.27; 12.51
2;25.44; 12.49
2;25.73; 12.50
```

The column Z means cycle, followed by voltage and current. This data are recorded 1 × per minute.

The filename is built as follows:

- 1 letter for the year
- 2 number for the month
- 2 number for the day
- 2 number for the hour
- 1 number for the ten's place of a minute

The files contain as well date and time in their attributes.

6.4 RS232

The RS 232 works with 9600 Baud,8,N,1. Tx can be found at Pin 2 and GND at Pin 7. During a program routine, the following data will be transmitted:

```
730S3;04.12. 15:40;01,18;V;-03,99;A;000,3;AH;+0005;MIN;--, -;°C
730S3;04.12. 15:41;01,18;V;-03,99;A;000,3;AH;+0006;MIN;--, -;°C
```

Program	Step	Date	Time	Voltage	Current	Capacity	Time	Temperature
---------	------	------	------	---------	---------	----------	------	-------------

The data can be recorded and saved with each final program routine. The format storage is compatible with programs like Excel or openOffice.

The data should be read in as „textfile *.CSV“. Separator is a semicolon. After that you have to fill in the data „format cells“. The format for the numbers to be given in is user-defined DD.MM. hh:mm.


6.5 Remote monitoring

The UL60 is provided with an Ethernet connection. After entering the parameter (see 7.2).

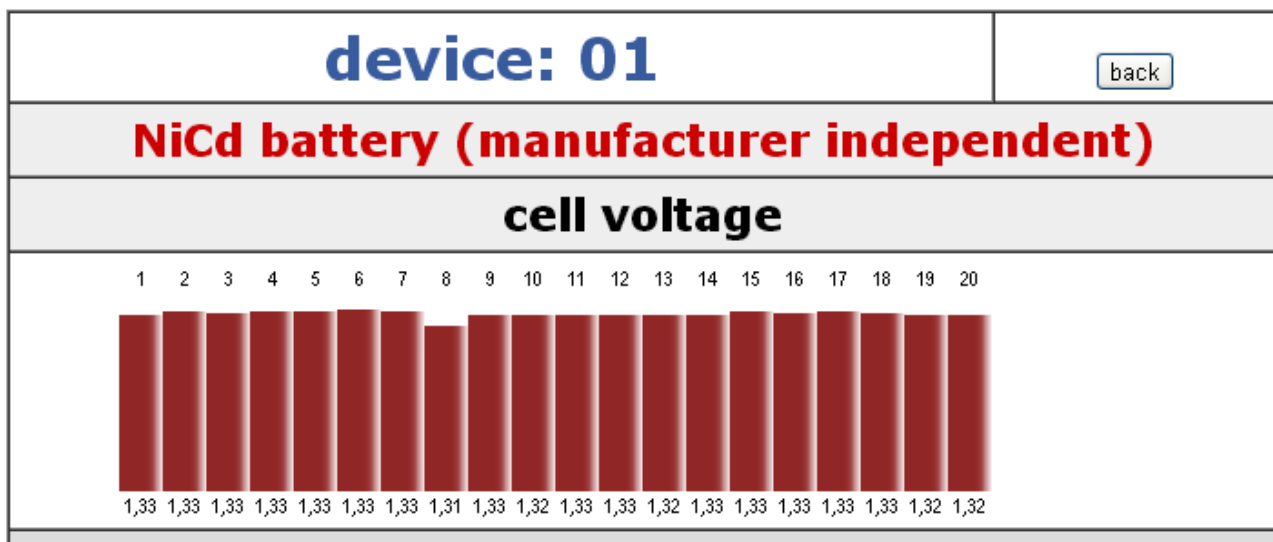
Adjust Ethernet IP-address, (see page 35) the data can be monitored from every browser. You just need to enter the IP-address of the UL60 in the address field.



Under „device data“ you can see the data for the UL60:

		back
SN: 160001		
IP:	192.226.226. 30	
Subnet:	255.255.255. 0	
Gateway:	192.168.226.254	
MAC:	00-04-a3-db-0d-f0	
Printer:	192.168.226. 21	
Nortec Electronics GmbH&Co KG An der Strusbek 32B 22926 Ahrensburg Tel: +49 4102 42002		

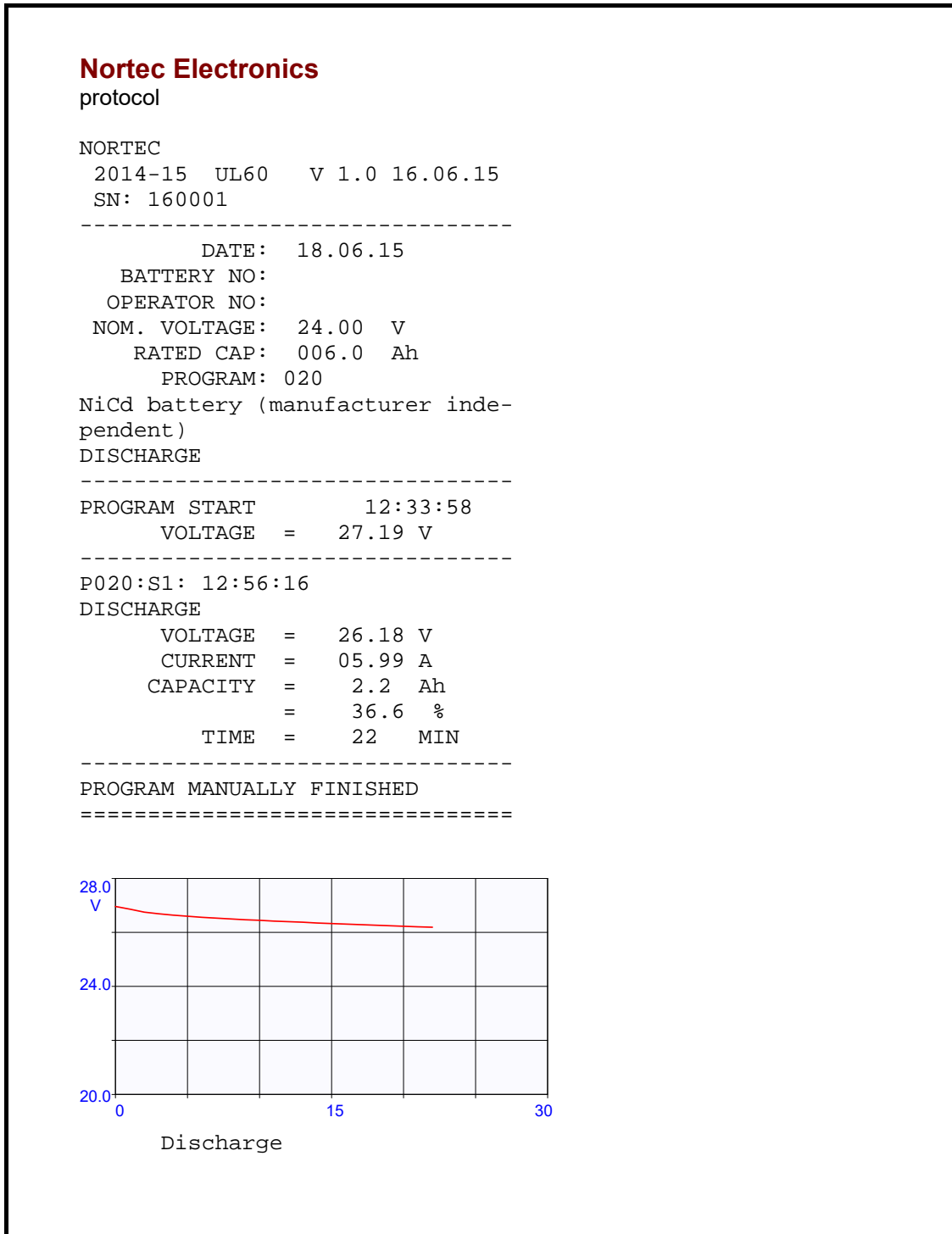
Using NiCd batteries the measurements for the single cells can be shown as well:



After finishing the battery treatments, you can download the 2 data files to be secured on a USB flash drive.

6.6 Network printer

The UL60 can be configured to secure that after the end of the program the printer starts and you get a print on the network printer automatically. The print complies with the stored .rtf-file (see 6.3, page 25). Activate the printer via menu. Adjust Ethernet IP-address (see 7.2, page 35)



All printers with PCL5 and TCP-IP-connection 9100 direct mode can be used, which means almost all network compatible laser printers.

Example: several UL60 connected to one HP Laserjet M402n:



Example configuration:

- 1. UL60: IP: 192.168.1.101
- 2. UL60: IP: 192.168.1.102
- 3. UL60: IP: 192.168.1.103
- etc.

- Printer: IP: 192.168.1.30
- PC: IP: 192.168.1.40

In case the devices are not connected to another network, it doesn't matter which address will be used. If the devices are integrated to another network, these addresses have to be used.

System preferences of the UL60: see page 31 et seq..

Configuration of the Printer, Example HP Laserjet M402n:


```
Menu Setup => Network Setup => IPv4-Configuration => Manual =>
IP-Adress: 192.168.1.30 (change due arrows, continue with OK)
Confirm
Mask: 255.255.255.0
Confirm
Std.-Gateway: 192.168.1.1
Confirm
Save
```

6.7 Functions of printer programs

The device is equipped with an inbuilt printer. Thus, it is possible to record the results of the treatments and to get a print for each battery. Independant from the charging routine the print menu can be changed at each time.

Printer programs

General information

Press the key  in main menu or sub menu and you will get the last print again.

Program P: Printer and cell voltage measurement

With the P program at any time a printout can be generated - without or within a program run, esp. in connection with the measurement and recording of the single cells voltages.

Distinguish between the following possibilities:

- Automatic printed record within a program
- Manual printed record within a program

NOTE: Automatic printed record is only possible in connection with an automatic cell tester (Optional)



Manual cell tester



Automatic cell tester

NOTE FOR ALL PRINTER APPLICATIONS

The capacity indication in % is related to the rated capacity of the battery.

The printed line TEMPERATURE is just shown if the plus- and minus cable have a thermistor. For lead-acid batteries, both poles are measured and shown the value with the respectively higher temperature.

The single cells measurement is just possible using manual printed record and is announced by three short beeps. At this moment, it is possible to measure and to print the single cell voltages using a single cell tester. At maximum 99 cell measurements are possible.

As long as you hear a beep during cell measurement the cell is ok. The following cell testing starts after a valid measurement took place. The cell voltage is shown on display and will be printed at the same time.

If ***** is printed before the cell voltage, this means that the cell voltage is below the minimum voltage in the topping charge of a NiCd cell. These values can not be changed.
The value is normally 1.55 V per cell

exceptions:

HAWKER XML battery: 1.58 V

MARATHON M³ battery: 1.60 V

SAFT VO / VP / VHP / VXP batteries: 1.50V

The user is asked for the battery type in charging and maintenance programs of these manufacturers. The UL60 then sets the identification ***** according to this input.

In case no single cells measurements have taken place the print lines CELL 01 to CELL xx and so on... will not be indicated.

If within a printer program data retrieval is not answered the device switches to the next request within 30 seconds and finally back to the program routine.

Cell voltage recording


```

=====
COPYRIGHT          NORTEC
2014-15 UL60 V1.0 16.06.15
SN: 160 001
-----
          DATE:          23.06.15
          BATTERY NO:    12345
          OPERATOR NO:   0002
          NOM. VOLTAGE:   24.00 V
          RATED CAP:     004.0 Ah
          PROGRAM:       420
NiCd battery (manufacturer independent)
Maintenance
-----
          PROGRAM START   08:42:24
          VOLTAGE =       26.66 V
-----
P420:S1: DISCHARGE 1 08:42:24
          VOLTAGE =       25.91 V
          CURRENT =       04.01 A
          CAPACITY =      000.4 Ah
                   =      010.0 %
          TIME =         006 MIN
-----
* CELL 01:  1.292 V
* CELL 02:  1.291 V
* CELL 03:  1.294 V
-----


```


7 System preferences

Immediately after switching on the UL 60 carries out a device self-test. After that selftest and bat-

tery selection, open the menu by pressing  the user can select language and time. The internal timer uses a capacitor which provides the timer with current for about a month as long as the device is not switched on.

In case a device is not in use for a long period you have to enter language and time again.


You get to an additional system menu using  :




At this place you find IP-address, device number and calibration.

7.1 Language, date, time

7.1.1 Select language

Press key  to get to the menu for system preferences

Press key i.E.  for English to keep the language until you want to change it again. After switching on the next time the display will be in English language.

Following languages can be chosen:

- German
- English
- French *)
- Dutch *)
- Russian *)
- Danish *)
- Slovak *)

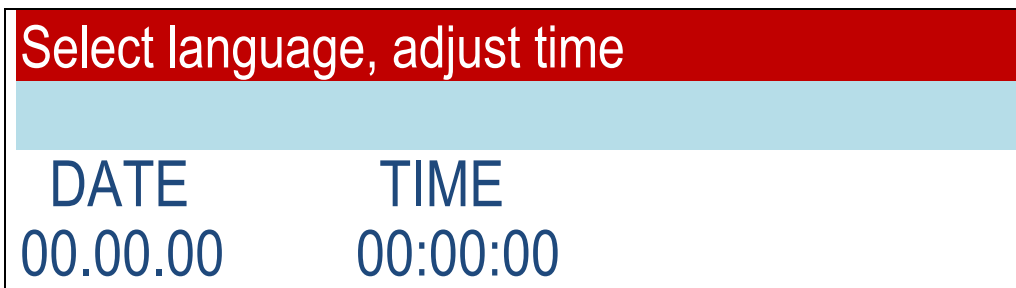
*) The help texts for these languages are displayed in English.

Additional languages are possible in case of customer request but require translations for display and print indication by the customer.




7.1.2 Change date

After the selection of the language enter the time.




Underneath the first position of the date indication you will see the cursor.

Press the key  to keep the entered date. The cursor moves to the date entry. Use the number keys (1 ...9 to 0) to enter the present date dd : mm : yy

Incorrect data for the date will not be accepted.

7.1.3 Enter time

Use the number keys (0 to 9) to enter the time hh : mm : ss.

Press the key  to confirm or after entering the last number for the minutes the display jumps back to the main menu. The counting of the seconds starts automatically.

7.2 Adjust Ethernet IP-address

Under „enter Ethernet IP-address“ all relevant parameter for the ethernet interface are shown.

7.2.1 Enter IP-address

System preferences	
Enter Ethernet IP-address	
IP-address	192.168.226.030

At first enter IP-address. All UL60 devices must have a different IP-address. Usually the address starts as follows 192.168. Quite often it will be 192.168.0.xxx. Ask your network administrator for a free IP-number in your network.

The UL60 only works with IPs, not with DHCP. The IP has to be registered in the browser in order to receive the data for the UL60:

NORTEC ELECTRONICS					device: 01		Unit data	cell voltage
NiCd battery (manufacturer independent) 6.0 Ah: Discharge								
P020:S1: DISCHARGE								
Voltage	Current	Capacity	Time	Temperature				
26.35 V	05.99 A	1.4 Ah	14 Min	Clock				
				--.- °C				
				12:48				

7.2.2 Enter subnet mask

After entering the Ethernet IP-address fill in the netmask. Usually this is 255.255.255.0.

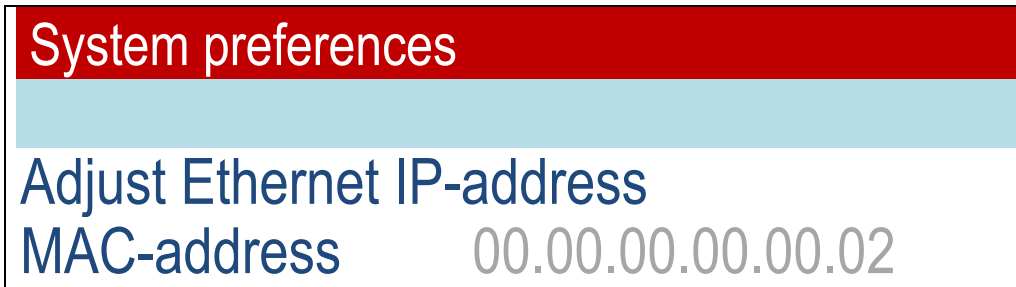
7.2.3 Adjust gateway

After that adjust gateway. Often this is 192.168.0.1.

Using Microsoft Windows asked for (cmd.exe) (start, execute and "cmd"), the program "ipconfig /all" can be performed. It issues Gateway and subnet mask.


7.2.4 MAC address

MAC stands for „Media Access-Control“. It identifies each network worldwide and is allocated just once. The MAC address is a fixed one and can not be changed by the user.



7.2.5 Adjust network printer

The UL60 can be configured to start a record on a network printer at the end of the program by

pressing the key . Network-capable laser printers are addressed with the printer language PCL5e /c. The communication is done by TCP/IP Port 9100.

The network printer is activated by entering the valid IP-address.
Entering 0:0:0:0 deactivates the printer.



7.2.6 Device number

As for device numbers, you can use numbers from 01 to 99 in order to distinguish between the different devices.

If you want to demonstrate several devices over a network, it is recommended to build a small file

```
<html>
<head>
  <title>UL60</title>
</head>

<frameset rows="50%,50%">
  <frameset cols="50%,50%">
    <frame src="http://192.168.0.70">
    <frame src="http://192.168.0.71">
  </frameset>
  <frameset cols="50%,50%">
    <frame src="http://192.168.0.72">
    <frame src="http://192.168.0.73">
  </frameset>
</frameset>
</html>
```

and save it under a file name ending with .html. If you open the file you can see 4 different devices of UL60 on the screen. Enter the different IP-addresses of the 4 devices under http://.

7.3 Calibration / Unit number,

The menu item "Calibration / Unit-No." is password protected. Changes in this part should be performed by trained personnel only.

8 Program selection

8.1 Principles for program selection

A treatment in UL60 is defined by a three-digit number.

- ◆ The first digit stands for the kind of treatment.
- ◆ Digits two and three define the battery type.

Kind of treatment

Discharge (= Treatment 0)

Each battery with an effective voltage in between the device limits of 40 V can be discharged with the UL60 with maximum 60 A. This happens in the reverse charging structure of the device so that the discharging goes to 0 Volt. The energy taken from the battery will go out in the surroundings via heat sink and fan.

Initial commissioning (= Treatment 1)

The batteries - depending on their technology – are delivered by the manufacturers charged or discharged. Often the batteries are delivered directly to the warehouses or other storage spaces. That is why the instructions from the manufacturers for the initial operation can be different. The parameters for the initial operation are saved inside the device UL60 and have to be reviewed before operation according maintenance manual of battery manufacturers. In case of discrepancies, the information provided by the battery manufacturer applies.

Charge (= Treatment 2)

Choosing the treatment 2 the UL60 applies the charging programs according to the battery type as requested from the manufacturers or the relevant users. For the optimum use of the battery the charging programs are executed automatically.

During charging process the battery data are recorded and checked for validity.

Especially the following data:

- Initial voltage
- Final voltage reached
- Current at the beginning of the charging
- Current at the end of the charging
- Charging time
- Temperature

Capacity Test (= Treatment 3)

The program is used for analysing the capacity of a NiCd-battery according to manufacturer's instructions. After the performed capacity test the battery is discharged!

Maintenance (= Treatment 4)

This program is used to analyse lead acid-, NiCd- and Lithium batteries. Relevant data for battery analysis will be recorded and illustrated. The actual capacity will be determined.

After completion of the treatment maintenance, the battery is fully charged.

Selection of the battery type passes through several testcycles. From time to time maintenance works at the batteries are necessary. The maintenance manuals of the battery manufacturer always apply.

I-Charge (= Treatment 5)

Using the program I-charge allows a free selection of charging current and charging time span.

Deep Discharge (= Treatment 6)

This program is used to deep discharge the battery according to the manufacturer's instructions.

Reconditioning (= Treatment 7)

This program is used for the reconditioning of a NiCd-battery according to manufacturer's instructions.

Constant Voltage Supply (= Treatment 8)

Using this treatment, the UL60 serves as a constant voltage supply.

Other battery = (battery type 00)

The device works as a laboratory power supply with a performance of 40 V/60 A. Voltage and current can be chosen in steps from 0.01 V/0.01 A.

With battery = (battery type 10 – 24)

If a battery type >0 is chosen, the device automatically selects the float-voltage for the chosen battery which allows an unlimited connection of the battery to the UL60 without damaging it.

8.2 The battery types

All important battery types are already included in the UL60. Rechargeable batteries can be tested and charged as well using the available treatments and the appropriate parameters

- ◆ **00:** Other battery
- ◆ **10:** Lead acid battery sealed MIL (with fixed electrolyte AGM or GEL)
- ◆ **11:** Lead acid battery sealed commercial (with fixed electrolyte AGM or GEL)
- ◆ **12:** Valve regulated lead acid aircraft battery
- ◆ **16:** Lead acid battery vented commercial
- ◆ **17:** Lead acid battery MIL P3-C Orion
- ◆ **19:** Lead acid battery (free input)
- ◆ **20:** NiCd battery (manufacturer independent)
- ◆ **21:** NiCd battery HAWKER
- ◆ **22:** NiCd battery Saft
- ◆ **23:** NiCd battery NKBN
- ◆ **24:** NiCd battery MARATHON

The following treatments are available:

- ◆ **0:** Discharge
- ◆ **1:** Initial commissioning
- ◆ **2:** Charge
- ◆ **3:** Capacity Test
- ◆ **4:** Maintenance
- ◆ **5:** I-Charge
- ◆ **6:** Deep Discharge
- ◆ **7:** Reconditioning
- ◆ **8:** Constant Voltage Supply (Power-supply)

8.3 The program – Matrix

The different charging programs result from the 9 treatments: (0 bis 8) and the 11 battery types.

	00 Other batt..	10 Lead ALL MIL	11 Lead ALL comm	12 Lead Avia- tion	16 Open Lead comm	17 Lead ORI- ON	19 Lead free entry	20 NiCd	21 NiCd HAW- KER	22 NiCd SAFT	23 NiCd NKBN	24 NiCd MAR ATHO N
0 Discharge	000	010	011		016		019	020	021	022	023	
1 Initial commissioning		110	111		116			120	121			124
2 Charge		210	211	212	216	217	219	220	221	222	223	224
3 Capacity Test				312					321	322	323	324
4 Maintenance		410	411		416	417	419	420	421	422		424
5 I-Charge		510	511		516			520				
6 Deep Discharge								620	621	622	623	624
7 Reconditioning									721	722		724
8 Constant voltage	800	810	811		816			820	821	822		

8.4 Battery data entry


8.4.1 General information

The charging program of the UL60 depends on the entry of the battery type which shall be treated and the selection of the treatment. For correct use of the program entry of the size of the connected battery type is necessary.

↓ select Batterytype: ↓

21: NiCd battery HAWKER

←=previous →=next **E** =select battery



the following procedures are available::

- Discharging
- Initial operation
- Charging
- Capacity test
- Rest discharging
- Reconditioning
- Constant voltage supply

After choosing the battery type you are asked for the kind of treatment:

21: NiCd battery HAWKER

↓ select Batteryprocessing: ↓

P0: Discharge

←=previous →=next **E** =select program

Discharge without Cell shorting for HAWKER with C₁

Step1: Discharging enter C₁ until voltage of 1 V for each cell is reached.
 After about 48 minutes you are asked for measurement of single cells voltages.
 Continue with discharging enter C₁ until the voltage of 1 V for each cell is reached.

8.4.2 Work with „Other battery“ P: 00

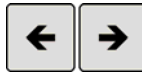
With battery type 00 (Other battery) you can maintain individual batteries, such as Lithium or ZnO. The treatments 8 constant voltage source and 0 discharging can be selected.

8.4.3 Work with lead batteries

All battery types starting with 1x respond. In particular, these are:



Type 10:	Lead acid battery sealed MIL
Type 11:	Lead acid battery sealed commercial
Type 12:	Valve regulated lead acid aircraft battery
Type 16:	Lead acid battery vented commercial
Type 17:	Lead acid battery MIL P3-C Orion
Type 19:	Lead acid battery (free input)

Choose the type using the following keys



and confirm with pressing the key  afterwards select kind of treatment.

For example, select the charging of a military sealed lead battery:

Use this key  to get to the desired kind of treatment and confirm by pressing the key  On display you will see:



Enter the nominal voltage of the battery. You find it on the identification plate of the battery.

NOTE:

Lead batteries usually consist of several cells of 2 V each.

Commercially common:

- 2 V cells
- 6 V batteries
- 12 V batteries
- 24 V batteries

The device only accepts 2.0 V and the multiple. All other entry will be rejected as defective.

Confirm the entered voltage by pressing . The display shows:

10: Pb battery sealed MIL

P410: ➤ Please enter parameter:
RATED CAPACITY ? 000.0 Ah


The nominal capacity is measured in ampere hours (Ah). The energy content of the cell determines at the maximum admitted current for charging and discharging.

The identification plate of the battery contains the capacity information. Depending on the choice of the level of the discharging current the batteries of identical construction types have different capacities.

Rule of thumb: If the chosen discharging current is higher, the capacity available will be lower.

Military lead batteries are often defined according to the "5 hour-capacity".






The definition of the capacities for civil batteries is based on the area of application and the norm to be applied differs from 10hours to 100hours discharging currents. The treatments which are implemented in the UL60 consider these problems. After entering the capacity possible in steps of 0.1 Ah

Confirm with  and a start menu will be displayed:

10: Lead battery sealed MIL


Program: **Maintenance**

Start:  =with print  =without print  =time

- Entering  or  you will return to the mask where battery type and treatment can be selected again.
- Entering  starts a testing routine with discharging with 5-hours current as the first step. Entering  the internal printer will be activated. By entering  a time-delayed start kann be chosen eg.starting the device at night.

Enter

- battery number
- user number

and confirm with 

8.4.4 Work with NiCd batteries

All open batterie types starting with numbers 2x respond.
In detail this are:

- ◆ 20: NiCd battery (manufacturer independent)
- ◆ 21: NiCd battery HAWKER
- ◆ 22: NiCd battery Saft
- ◆ 23: NiCd battery NKBN
- ◆ 24: NiCd battery MARATHON

After chosing the type using the following buttons   confirm with  and select the treatment.

All treatments can be selected.

For chosing the treatment „P4: Maintenance“ display is as follows:

20: NiCd battery (manufacturer independent)

P420: ➤ Please enter parameter:

NUMBER OF CELLS? 00 CELLS

For NiCd batteries enter the number of cells. The battery voltage is calculated by the device.

NOTE:

The NiCd-cell has got a nominal voltage of 1.2 V. In order to completely charge it a voltage of 1.55 V/cell has to be reached. In opposition to the lead batteries unusual number of cells is possible. In addition to the usual number of cells which lead to volt values of comparable lead batteries you will find unusual number of cells.

In contrast to lead batteries sometimes exist very different cell counting. In addition to the "usual" numbers of cells that match to comparable voltage level of lead-acid batteries, there are "Rare types" as well.

Excamles for number of cells:

5	Cells	$5 \times 1.2 = 6 \text{ V battery}$
10	Cells	$10 \times 1.2 = 12 \text{ V battery}$
20	Cells	$20 \times 1.2 = 24 \text{ V battery}$

NOTE:

Enter the number of cells for NiCd-batteries with the **utmost care** in order to prevent damage of the battery.

For determination of the maximum currents the capacity of the battery has to be indicated in Ah.








20: NiCd battery (manufacturer independent)

P420: ➤ Please enter parameter:
RATED CAP: 000.0 Ah


After entering of the capacity confirm with  the start menu is shown on the display.

20: NiCd battery (manufacturer independent)

Program: **Maintenance**
Start: **P**=with print *****=without print


- Entering  or  you will return to a mask where Battery type and treatment can again be selected.
- ◆ Entering  starts the testing routine with discharging with 1 hour current as the first step for 6 minutes. Enter  to request a printed record. Enter the following details
 - battery number
 - user number
and confirm with .
- ◆ Enter  starts a testing routine after battery number and user number have been given in. Confirm by pressing the key .

In case a cell tester is connected the measurement of the cell voltage of the NiCd batteries takes place automatically.

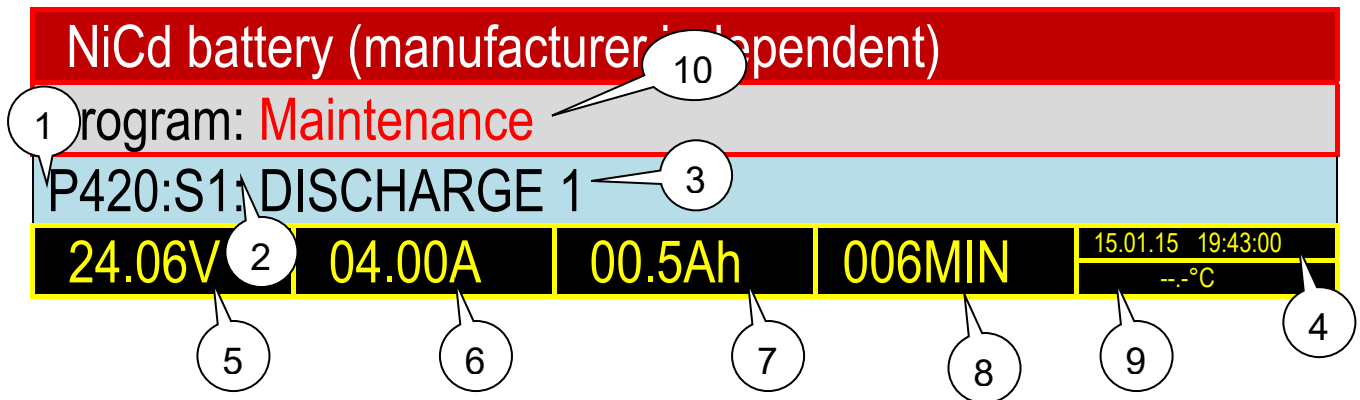
By pressing the button  again you can start a printed record in between. Pressing the red start key once starts the recording of the measurement of the cell voltages on the positive cell probe.

8.5 The display screen for program 420

For a military NiCd battery (manufacturer independent) = Type 20 with a nominal voltage of 24 V and 4 Ah the testing cycle = Treatment 4 is shown as an example.

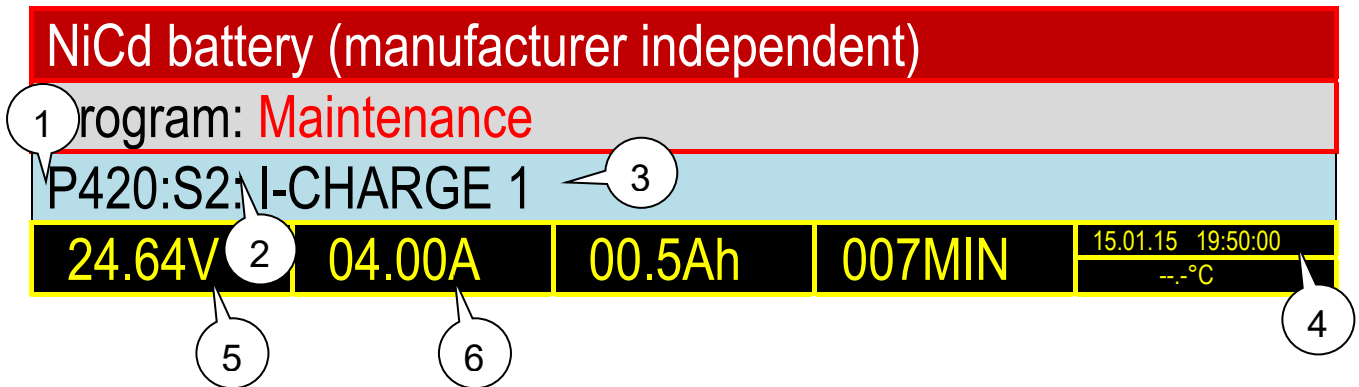
Program No 420 follows after entering the user specific data. Confirm with  and the following display is shown:

8.5.1 Program 420 Step 1



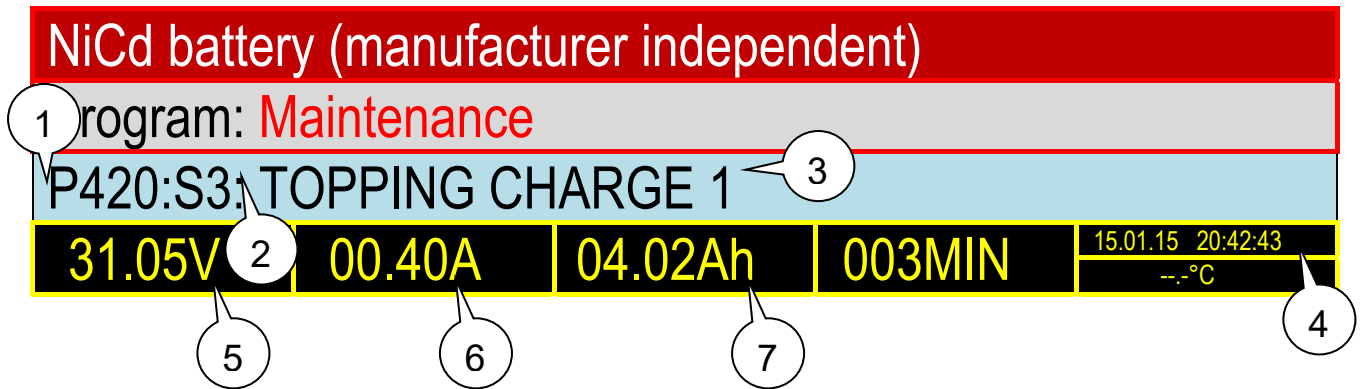
1	Program number	
2	Step number	= S1
3	Step type	= DISCHARGE 1
4	19:43:00	= present time
5	24.06 V	= present battery voltage
6	04.00 A	= present discharging current
7	000.5 Ah	= present capacity taken at stage of print
8	+006 MIN	= time span
9	--. °C	= no active temperature measuring
10	Maintenance	= kind of treatment

8.5.2 Program 420 Step 2



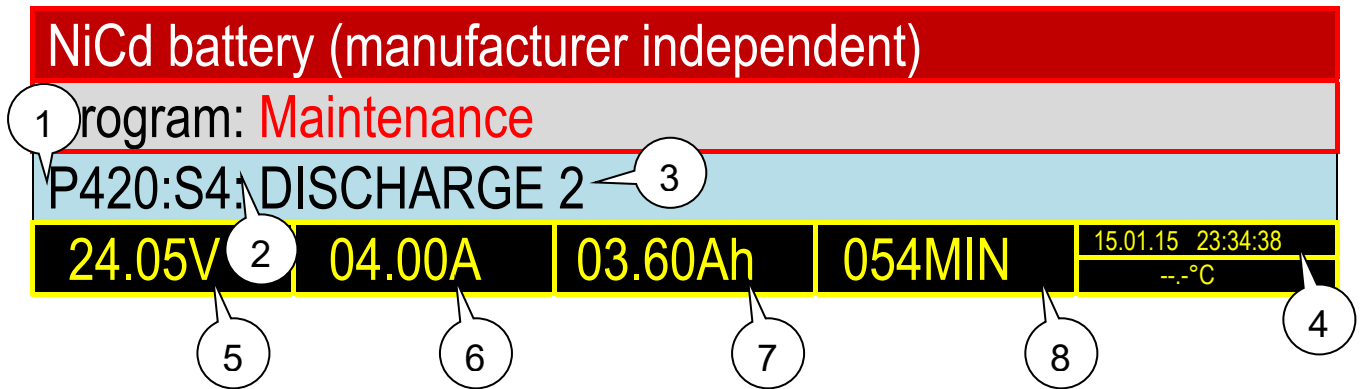
- | | | |
|---|-------------------|---|
| 1 | Program number | 4 = Maintenance |
| | Kind of treatment | 20 = NiCd battery (manufacturer independent) |
| | Battery type | = S2 |
| 2 | Step number | = I-CHARGE 1 |
| 3 | Step type | = present time |
| 4 | 19:50:00 | = present battery voltage |
| 5 | 24.64 V | = present charging current |
| 6 | 04.00 A | The charging current in the test routine for NiCd batteries is selected in a way that the capacity will be charged within 1 h. 4 A if it is the correct current for a 4 Ah battery. |

8.5.3 Program 420 Step 3



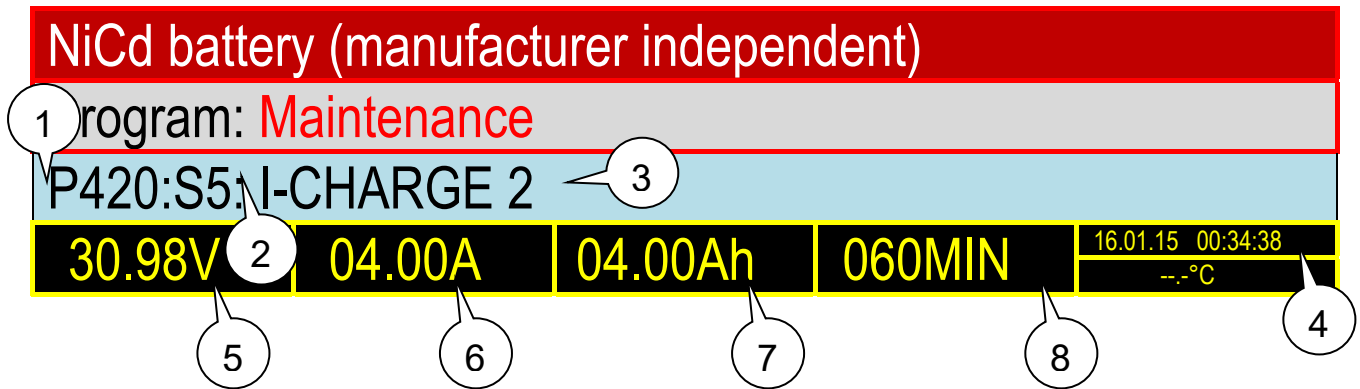
1	Program number Kind of treatment Battery type	4 = Maintenance 20 = NiCd battery (manufacturer independent) = S3
2	Step number	= TOPPING CHARGE 1
3	Step type	= present time
4	20:42:38	= present battery voltage there is no voltage limit to 31 V.
5	31.05 V	= present charging current The topping charge with 10-hours current 4 Ah/10 h = 0.4 A takes 1.5 hours. The reason for doing this is to equalize the voltages of the cells.
6	0.40 A	The display of the capacity continues which means the inloaded capacity during I-CHARGE 1 plus capacity for TOPPING CHARGE 1.
7	4.02 Ah	

8.5.4 Program 420 Step 4



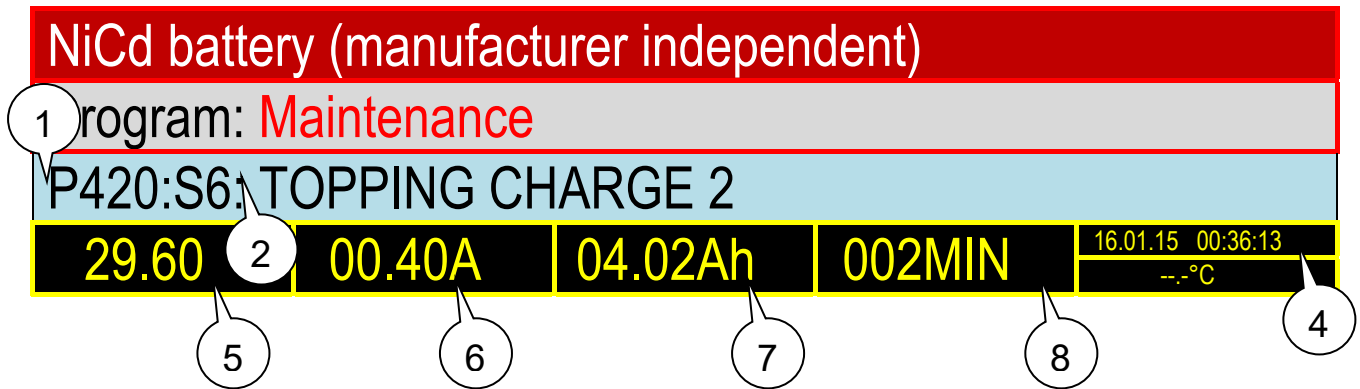
1	Program number	4 = Maintenance
	Kind of treatment	20 = NiCd battery (manufacturer independent)
	Battery type	= S4
2	Step number	= DISCHARGE 2
3	Step type	= present time
4	23:34:38	= present battery voltage
5	24.05 V	= present discharging current
6	4.0 A	The testing current for NiCd batteries is 1 C (A) which means a current is chosen which discharges the battery with a capacity of 4 Ah within 1 hour completely. The current is 4 A.
7	3.60 Ah	= actual taken capacity at time of printing.
8	0054 MIN	DISCHARGE 2 the battery will be discharged with 1 hour current = 4 A until the battery voltage is 1 V for each cell which means decreased to 20 V.
		The time for discharging until this display is shown takes 54 minutes.
		At the end of step 4 a record is done automatically when the shut down voltage of 20 V is reached. The actual voltage recovers immediately after stopping discharge current.

8.5.5 Program 420 Step 5



- | | | |
|---|-------------------|---|
| 1 | Program number | 4 = Maintenance |
| | Kind of treatment | 20 = NiCd battery (manufacturer independent) |
| | Battery type | = S5 |
| 2 | Step number | = I-CHARGE 2 |
| 3 | Step type | = present time |
| 4 | 00:34:38 | = present battery voltage |
| 5 | 30.98 V | = present charging current |
| 6 | 4.0 A | The charging current with the test program for NiCd batteries is chosen in a way that the capacity is charged again within 1 h. |
| | | 4 A if a 4 Ah battery is in use. |
| 7 | 4.00 Ah | Capacity loaded in 60 minutes in Ah. |
| 8 | 0060 MIN | Display of charging time with positive sign (forward count). |

8.5.6 Program 420 Step 6



1	Program number Kind of treatment Battery type	4 = Maintenance 20 = NiCd battery (manufacturer independent) = S6
2	Step number	= TOPPING CHARGE 2
3	Step type	= present time
4	00:36:13	= present battery voltage
5	29.6 V	= present charging current
6	0.40 A	The charging voltage is allowed to exceed 31 V. The cell capacities are equalized.
7	4.02 Ah	The capacity continues to be counted. The main-charge plus topping charge is 4 Ah + 2 minutes 0.4 A = 0.02 Ah; in total 4.02 Ah.
8	0002 MIN	Display of charging time span.

After 115 minutes an acoustic signal sounds.

- The cell voltages must be taken using the cell tester.
- Electrolyte has to be adjusted with distilled water.

9 Tabular overview of the program procedures

The UL60 has treatment programs for several battery types implemented. Special cases not covered by these programs, can be maintained by the programs for battery types "NiCd battery (manufacturer independent)" and "Pb battery (free input)". With the programs "Pb battery (free input)" you can individual set the parameters within defined limits. With the program "I-charge" for "NiCd battery (manufacturer independent)" you can set the cut-off voltage and charging time. A program for discharging with free input of all parameters is in the menu item "Other battery" available.

For batteries of manufacturer "Changhong (20GNCxx)", you can use the "Charge" program under "NiCd Battery (manufacturer independent)" and the C₂ setting. The Capacity Test can be done using the program "NiCd battery (manufacturer independent)". The initial operation of the 20GNCxx batteries is possible with the "Initial commissioning" program HAWKER (input 10 hours).

Batteries from HBL (NCSP ...) can also be treated with the UL60.

The following programs were created with the utmost care according to the maintenance manuals of the battery manufacturers, but are offered without guarantee. Before applying the below programmed programs this must be checked for compliance with currently valid maintenance manuals of the battery manufacturer. If in doubt or in case of deviations the currently valid maintenance manual of the battery manufacturer always applies.

For all programs the following restrictions apply:

Sealed lead batteries:

Minimum capacity:	2 Ah
Maximum capacity:	900 Ah
Minimum nominal voltage:	2 V
Maximum nominal voltage:	30 V
Nominal voltage to be divided by	2

Vented lead batteries:

Minimum capacity:	10 Ah
Maximum capacity:	900 Ah
Minimum nominal voltage:	2 V
Maximum nominal voltage:	30 V
Nominal voltage to be divided by	2

NiCd batteries:

Minimum capacity:	1 Ah
Maximum capacity:	230 Ah
Minimum number of cells:	1 (nominal voltage: 1.2 V)
Maximum number of cells:	24 (nominal voltage: 28.8 V)
Nominal voltage to be divided by	1.2

The UL60 can charge / discharge at maximum 60 A. If a battery is connected which usually requires a higher current it will be charged / discharged with 60 A. The monitored times will be automatically adjusted by the program.

In case cables with temperature sensors are used the program shut down will take place under the following conditions:

- ◆ Temperature > 65°C
- ◆ Temperature increase since program start for more than 40°C

9.1 Discharge

The discharging of the batteries according to manufacturers instructions takes place using the program „P0: DISCHARGE“. In addition to the program „P0: DISCHARGE“ for some NiCd battery types the programs „P6: Deep Discharge“ and „P7: Discharge to 23 V“ are available.

Example:

```
=====
COPYRIGHT          NORTEC
2014-15 UL60  V 1.0 16.06.15
SN: 160001
-----
      DATE: 28.06.15
      BATTERY NO:
      OPERATOR NO:
      NOM. VOLTAGE: 24.00 V
      RATED CAP: 040.0 Ah
      PROGRAM: 022
NiCd battery SAFT
DISCHARGE
-----
PROGRAM START      10:38:02
      VOLTAGE = 25.41 V
-----
P022:S1: 11:26:53
DISCHARGE
      VOLTAGE = 20.00 V
      CURRENT = 40.01 A
      CAPACITY = 32.07 Ah
              = 080 %
      TIME = 048 MIN
-----
PROGRAM AUTOMATICALLY FINISHED
=====
```

9.1.1 Program 000: Discharge (without data specification of a battery)

00: Other battery
↓ select Batteryprocessing: ↓
P0: Discharge

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Discharging current
- ◆ Cut-off voltage per cell

Step 1:

Discharging with discharging current until the cut-off voltage inserted by the user for each cell multiplied by the number of cells is reached.

In case no automatic cell tester is connected:

After 48 minutes you get an acoustic signal and are asked to measure the single cells.

Otherwise: cell measurement takes place automatically

End of program

Time monitoring:

Discharging maximum 130 minutes.

9.1.2 Program 010: Discharge Pb battery sealed MIL

10: Pb battery sealed MIL
↓ select Batteryprocessing: ↓
P0: Discharge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

Discharging with C_5 until a voltage of 1.5 V for each cell is reached.

End of program

Example:

A 12 V battery with 100 Ah is connected.

The battery will be discharged with 20 A to 9 V.

Time monitoring:

Discharging maximum 6 hours.

9.1.3 Program 011: Discharge Pb battery sealed commercial

11: Pb battery sealed commercial
⇩ select Batteryprocessing: ⇩
P0: Discharge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

Discharging with C_{10} until a voltage of 1.8 V for each cell is reached.

End of program

Example:

A 12 V battery with 100 Ah is connected.
The battery will be discharged 10 A to 10.8 V.

Attention! Some battery manufacturers call the criteria for shut down 80 %-limit which means just 80 % capacity of the battery can be taken out of the battery without damaging it.

Time monitoring:

Discharging maximum 12 hours.

9.1.4 Program 016: Discharge Pb battery vented commercial

16: Pb battery vented commercial
⇩ select Batteryprocessing: ⇩
P0: Discharge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

Discharging with C_{20} until a voltage of 1.8 V for each cell is reached.

End of program

Example:

Connected is a 12 V battery with 100 Ah. The battery will be discharged with 5 A to 10.8 V.
Attention! Some battery manufacturers call the criteria for shut down 80 %-limit which means just 80 % capacity of the battery can be taken out of the battery without damaging it.

Time monitoring:

Discharging maximum 24 hours.

9.1.5 Program 019: Discharge Pb battery (free input)

19:Pb battery (free input)
↓ select Batteryprocessing: ↓
P0: Discharge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity
- ◆ Discharging current C1, C2, C5, C10 or C20
- ◆ Discharging final voltage of each cell (selectable 1.5 - 1.9 V)

Step 1:

Discharging until the voltage of final discharging voltage for each cell is reached.

End of program

Time monitoring:

Discharging maximum 24 hours.

9.1.6 Program 020: Discharge NiCd battery (manufacturer independent)

20: NiCd battery (manufacturer independent)
↓ select Batteryprocessing: ↓
P0: Discharge

Enter :

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Cut-off voltage per cell

Step 1:

Discharging with C₁ until a voltage of 1 V for each cell is reached.

In case no automatic cell tester is connected:

After 48 minutes a signal asks for the measurement of the single cells voltages.

Otherwise: cell measurement takes place automatically.

End of program

Example:

Connected is a 12 V battery with 40 Ah.

The battery will be discharged with 40 A to 10 V.

Time monitoring:

Discharging maximum 90 minutes.

9.1.7 Program 021: Discharge NiCd battery HAWKER

Name according to manual: Discharge (without Cell shorting) for HAWKER with C₁

21: NiCd battery HAWKER
↓ select Batteryprocessing: ↓
P0: Discharge

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C₁ until a voltage of 1 V for each cell is reached.

In case no automatic cell tester is connected:

After 48 minutes a signal asks for the measurement of the single cells voltages.

Otherwise: cell measurement takes place automatically.

End of program

Example:

Connected is a 24 V battery with 40 Ah. The battery will be discharged with 40 A to 20 V.

Time monitoring:

Discharging maximum 90 minutes.

This program is identical to the program 020.

9.1.8 Program 022: Discharge NiCd battery SAFT

Name according to manual: Deep Discharge (without Cell shorting) for SAFT with C₁

22: NiCd battery SAFT
↓ select Batteryprocessing: ↓
P0: Discharge

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C₁ to a voltage of 1 V for each cell.

Example:

Connected is a 24 V battery with 40 Ah. The battery will be discharged with 40 A to 20 V.

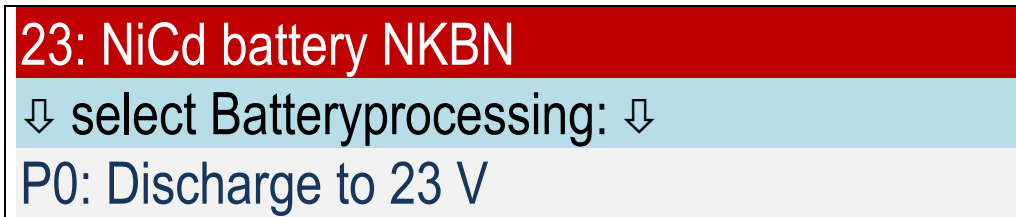
End of program

Time monitoring:

Discharging maximum 90 minutes.

9.1.9 Program 023: Discharge to 23 V NiCd battery NKBN

Name according to manual: Discharge down to voltage of 23 V for НКБН



Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with 0.4 C₁ until a voltage of 1.15 V for each cell is reached.

In case no automatic cell tester is connected:

Shortly before the end a signal asks for the measurement of the single cells voltages.

Otherwise: cell measurement takes place automatically.

End of program

Example:

Connected is a 24 V battery with 40 Ah.

The battery will be discharged with 16 A to 23 V.

Time monitoring:

Discharging maximum 4 hours.

9.2 Initial commissioning

9.2.1 Program 110: Initial commissioning Pb battery sealed MIL

10: Pb battery sealed MIL
↓ select Batteryprocessing: ↓
P1: Initial commissioning

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

In case voltage is < 1.5 V for each cell the message is as follows:

U<1.5 V: select program 410
--

Otherwise:

Discharging with C_5 until a voltage of 1.5 V for each cell is reached.

Step 2:

I-charge with $0.4 C_1$ until a charging voltage of 2.4 V \times number of cells is reached.

Step 3:

U-charge with 2.4 V \times number of cells until charging current decreased to $0.02 C_1$.

End of program

Time monitoring:

I- and U-charge maximum for 8 hours, capacity maximum $1.5 \times C$

In case charged capacity is $< 0.9 C$: failure message: CAPACITY TOO LOW

9.2.2 Program 111: Initial commissioning Pb battery sealed commercial

11: Pb battery sealed commercial
↓ select Batteryprocessing: ↓
P1: Initial commissioning

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

In case voltage is < 1.5 V for each cell the message is as follows:

U$<$1.5 V: choose program 411
--

Otherwise:

Discharging with C_5 until a voltage of 1.5 V for each cell is reached.

Step 2:

I-charge with $0.36 C_1$ until a charging voltage of 2.4 V \times numbers of cells is reached.

Step 3:

U-charge with 2.4 V \times number of cells until charging current decreased to $0.04 C_1$.

End of program

Time monitoring:

I- and U-charge maximum 8 hours, capacity maximum $1.5 \times C$

In case inloaded capacity is $< 0.8 C$: failure message: CAPACITY TOO LOW.

9.2.3 Program 116: Initial commissioning Pb battery vented commercial

16: Pb battery vented commercial

↓ select Batteryprocessing: ↓

P1: Initial commissioning

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

The message is as follows:

CHECK ELECTROLYTE LEVEL
WAIT 20 MINUTES E=CONTINUE

The program waits at maximum for 20 minutes.

In case the voltage is < 1.5 V for each cell the message is as follows:

U <1.5 V: select program 416

Otherwise:

Discharging with C_5 until a voltage of 1.5 V for each cell is reached.

Step 2:

I-charge with $0.25 C_1$ until a charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 3:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until charging current is decreased to $0.04 C_1$.

End of program

Time monitoring:

I- and U-charge at maximum 8 hours, capacity maximum $1.5 \times C$

In case inloaded capacity $< 0.8 C$: failure message: CAPACITY TOO LOW.

9.2.4 Program 120: Initial commissioning NiCd battery (manufacturer independent)

20: NiCd battery (manufacturer independent)
↓ select Batteryprocessing: ↓
P1: Initial commissioning

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Charging with C_1 until a voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached within at maximum 1 hour.

Step 2:

Discharging with C_1 to $1 \text{ V} \times \text{number of cells}$ within at maximum 30 minutes.

Step 3:

Charging with C_1 until a voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached.

Step 4:

Topping charge C_5 for 1.5 hours.

Step 5:

Discharging with C_1 to $1 \text{ V} \times \text{number of cells}$ at maximum 30 minutes.

Step 6:

Charging with C_1 until a charging voltage of $1.55 \text{ V} \times \text{numbers of cells}$ is reached.

Step 7:

Topping charge C_5 for 1.5 hours.

In case no automatic cell tester is connected:

15 minutes before the end of the topping charge a signal asks for the measurement of the single cells voltages and to control the electrolyte level.

Otherwise:

15 minuten before the end of the topping charge you are asked to control the electrolyte level.

End of program

Time monitoring:

Charging for maximum 90 minutes. Capacity maximum 1.6 C.

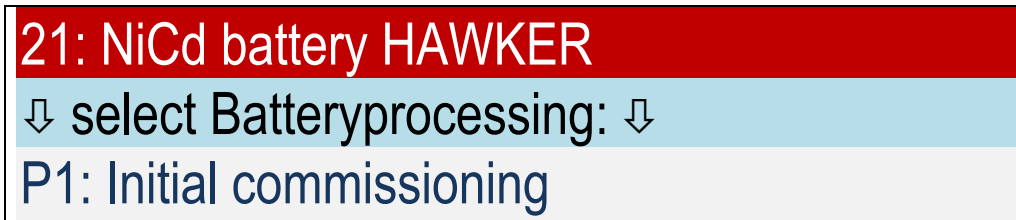
Voltage monitoring:

Monitoring minus $\Delta U > 30\text{mV}/\text{cell}$ during charging, error message:
minus delta U detected

9.2.5 Program 121: Initial operation NiCd battery HAWKER

Name according to manual: Commissioning charge (8 h)

This program also can be performed for maintenance charge (7 h).



Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Charging time span (set value: 8 hours)

Step 1:

Charging with C_5 for 8 hours or the time given in (eg. maintenance charge 7 h).

In case no automatic cell tester is connected:

15 minutes before the end of the charging a signal asks for the measurement of the single cells voltages and to control the electrolyte level.

Otherwise:

15 minutes before the end of the charging you are requested to control the electrolyte level.

End of program

After the end of the program the battery needs to cool down to room temperature. Subsequent proceed with program Capacity Test 321 or Maintenance 421 according to Hawker instructions.

Voltage monitoring:

Monitoring minus $\Delta U > 30\text{mV/cell}$ during charging, error message:
minus delta U detected

9.2.6 Program 124: Initial operation NiCd battery MARATHON

Name according to manual:

Charge (Constant current) Step IA for MARATHON with main charge current

24: NiCd battery MARATHON
↓ select Batteryprocessing: ↓
P1: Initial commissioning

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Charging current main charge

Step 1:

Charging with charging current main-charge until the charging voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached minimum 150 minutes.

In case the voltage is below 1.55 V charging continues for 5 minutes and again you are requested to measure the cell voltage otherwise continue with Step 2.

In case the number of the measured cells does not conform with the number of cells - for example a cell has been measured twice – the device can not decide what to do and asks the user whether all cells are $> 1.55 \text{ V}$. Enter: 1=YES 0=NO.

Step 2:

Topping charge with $0.4 \times \text{charging current main-charge}$ for 2 hours.

15 minutes before the end of the topping charge a signal requests to control the electrolyte level.

In case no automatic cell tester is connected:

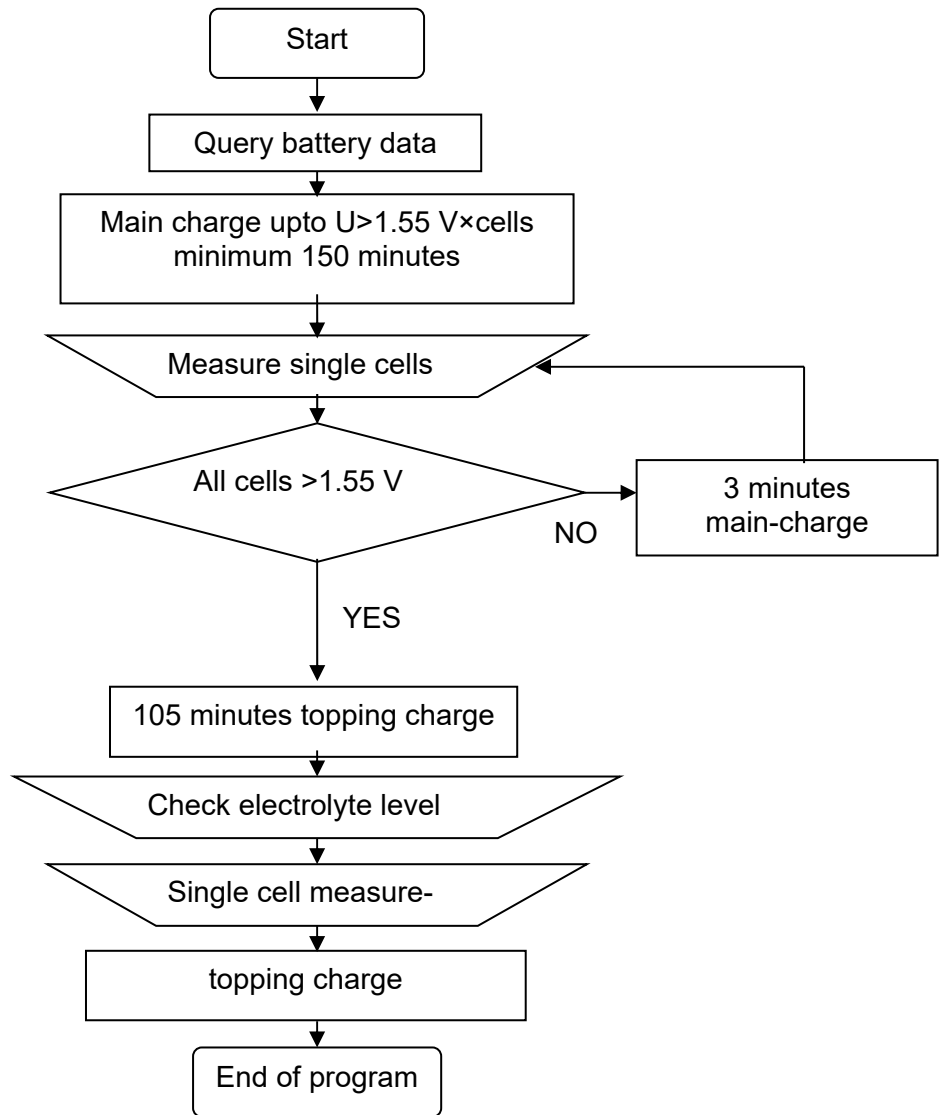
Before the end of the topping charge a signal requests the measurement of single cells voltages.

End of program

Voltage monitoring:

Monitoring minus $\Delta U > 30\text{mV}/\text{cell}$ during charging, error message:

minus delta U detected



9.3 Charge

With program „Charge“ the batteries are charged according to manufacturers instructions.

Examples:

Lead battery

```

=====
COPYRIGHT          NORTEC
2014-15 UL60   V 1.0 16.06.15
SN: 160001
-----
          DATE: 28.06.15
        BATTERY NO:
      OPERATOR NO:
    NOM. VOLTAGE: 12.00 V
      RATED CAP: 100.0 Ah
        PROGRAM: 210
Pb battery sealed MIL
Charge
-----
PROGRAM START          10:00:02
      VOLTAGE = 12.21 V
-----
P210:S1: 10:03:53
TOPPING CHARGE
      VOLTAGE = 14.40 V
      CURRENT = 40.01 A
      CAPACITY = 002.0 Ah
              = 002 %
      TIME = 003 MIN
-----
P210:S2: 12:03:53
I-CHARGE
      VOLTAGE = 14.40 V
      CURRENT = 40.01 A
      CAPACITY = 82.07 Ah
              = 082 %
      TIME = 120 MIN
-----
P210:S3: 13:07:53
U-CHARGE
      VOLTAGE = 14.40 V
      CURRENT = 02.01 A
      CAPACITY = 100.7 Ah
              = 100 %
      TIME = 184 MIN
-----
P210:S4: 15:08:25
TOPPING CHARGE
      VOLTAGE = 14.40 V
      CURRENT = 1.21 A
      CAPACITY = 103.0 Ah
              = 103 %
      TIME = 120 MIN
-----
PROGRAM AUTOMATICALLY FINISHED
=====
    
```

NiCd-battery

```

=====
COPYRIGHT          NORTEC
2014-15 UL60   V 1.0 16.06.15
SN: 160001
-----
          DATE: 28.06.15
        BATTERY NO:
      OPERATOR NO:
    NOM. VOLTAGE: 24.00 V
      RATED CAP: 040.0 Ah
        PROGRAM: 222
NiCd battery SAFT
Charge
-----
PROGRAM START          08:13:02
      VOLTAGE = 25.09 V
-----
P222:S1: 09:17:36
I-CHARGE
      VOLTAGE = 31.39 V
      CURRENT = 40.01 A
      CAPACITY = 042.7 Ah
              = 106 %
      TIME = 064 MIN
-----
P222:S2: 13:02:43
TOPPING CHARGE
      VOLTAGE = 33.00 V
      CURRENT = 04.01 A
      CAPACITY = 057.7 Ah
              = 144 %
      TIME = 225 MIN
-----
      CELL 01: 1.612 V
      CELL 02: 1.610 V
              ↓
      CELL 20: 1.600 V
-----
P222:S2: 13:17:36
TOPPING CHARGE
      VOLTAGE = 32.99 V
      CURRENT = 04.01 A
      CAPACITY = 058.7 Ah
              = 146 %
      TIME = 240 MIN
-----
PROGRAM AUTOMATICALLY FINISHED
=====
    
```

Only for deep discharged batteries

9.3.1 Program 210: Charge Pb battery sealed MIL

10: Pb battery sealed MIL
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

In case the battery voltage before starting charging is below $2.15 \text{ V} \times$ numbers of cells:
Precharging with $2.4 \text{ V} \times$ number of cells until charging current of $0.4 C_1$ is reached.
This step will not be printed if it takes less than 3 minutes.

Step 2:

I-charge with $0.4 C_1$ until a charging voltage of $2.4 \text{ V} \times$ number of cells is reached.

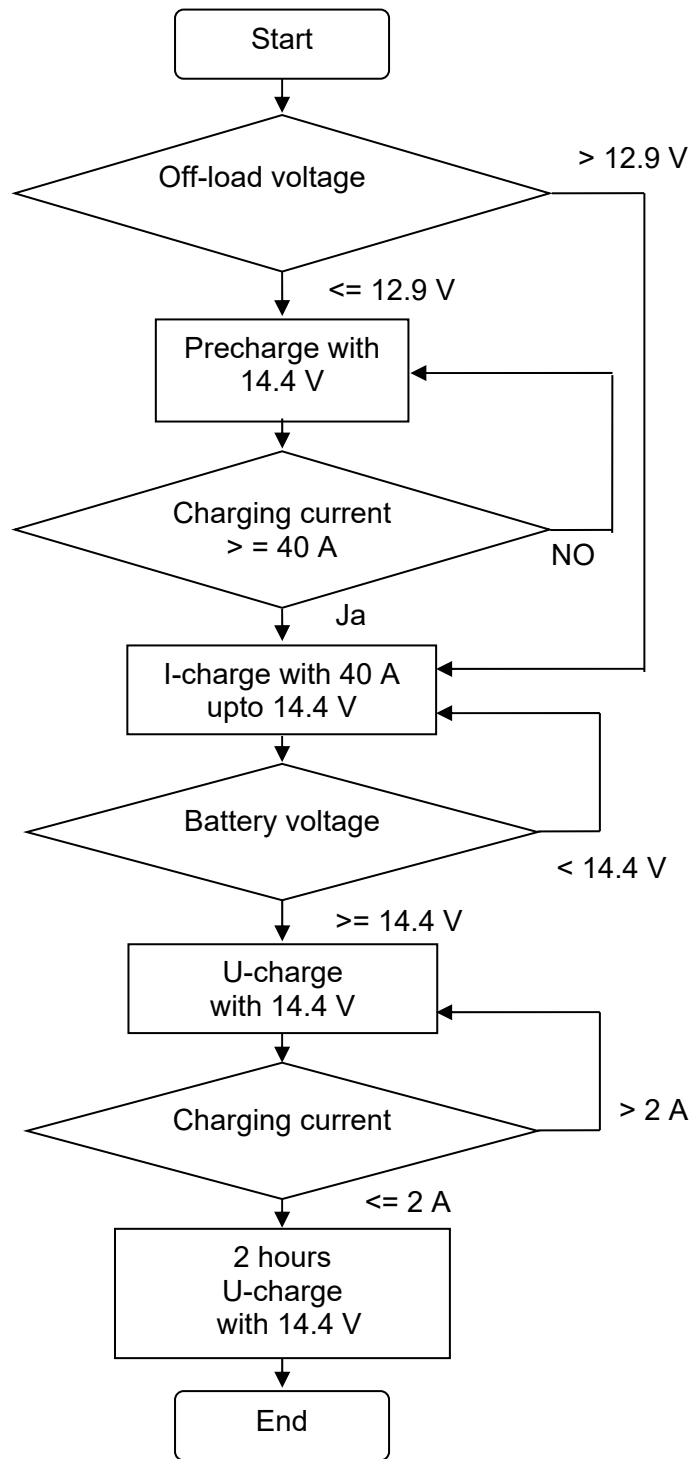
Step 3:

U-charge with $2.4 \text{ V} \times$ number of cells until the charging current is decreased to $0.02 C_1$.

End of program

Time monitoring:

Precharge maximum 2 hours, I- and U-charge maximum 8 hours, capacity maximum $1.5 \times C$



Monitoring:

Precharge maximum 2 hours, I- and U-charge maximum 8 hours.

9.3.2 Program 211: Charge Pb battery sealed commercial

11: Pb battery sealed commercial
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

In case battery voltage before starting charge is below $2.15 \text{ V} \times \text{number of cells}$:
Precharge with $2.4 \text{ V} \times \text{number of cells}$ until a charging current of $0.36 C_1$ is reached.
This step will not be printed if it takes less than 3 minutes.

Step 2:

I-charge with $0.36 C_1$ until a charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 3:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until the charging current is decreased to $0.02 C_1$.

End of program

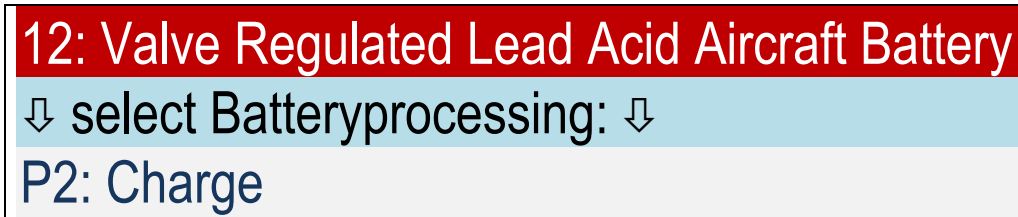
Time monitoring:

Precharge maximum 2 hours, I- and U-charge maximum 6 hours, capacity maximum $1.5 \times C$

9.3.3 Program 212: Charge Valve Regulated Lead Acid Aircraft Battery

Name according to manual:

Constant Potential Charge for Valve Regulated Lead Acid Aircraft Batteries



Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

Constant charging voltage with 2.33 V / cell and $I = C_2$ for 7 hours

End of program

Example:

Connected is a 24 V battery with 40 Ah.

The battery will be charged with 20 A to 28 V.

GILL batteries are charged with 2.4 V per cell until the current is < 0.5 A

9.3.4 Program 216: Charging lead battery commercial open

16: Lead battery vented commercial
↓ Select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

In case battery voltage before charging is below $2.15 \text{ V} \times \text{number of cells}$:
 Precharge with $2.4 \text{ V} \times \text{number of cells}$ until charging current of 0.25 C_1 is reached.
 This step is not printed if it takes less than 3 minutes.

Step 2:

I-charge with 0.25 C_1 until the charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 3:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until charging current is decreased to 0.04 C_1 .

End of program

Time monitoring:

Precharge maximum 6 hours, I- and U-charge maximum 8 hours, capacity maximum $1.5 \times \text{C}$

9.3.5 Program 217: Charge Pb battery MIL P3-C Orion

17: Pb battery MIL P3-C Orion
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ None, nominal voltage and capacity are preselected by the program

Step 1:

I-charge with C_5 for 5 hours (limit 2.375 V/cell).

Step 2:

I-charge with C_{10} for 2.5 hours (limit 2.375 V/cell).

End of program

9.3.6 Program 219: Charge Pb battery (free input)

19: Pb battery (free input)
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity
- ◆ Final charging voltage
- ◆ Charging current

Step 1:

In case battery voltage before charging is below $2.15 \text{ V} \times \text{number of cells}$:
Precharge with $2.4 \text{ V} \times \text{number of cells}$ until charging current of $0.36 C_1$ is reached.
This step will not be printed if it takes less than 3 minutes.

Step 2:

I-charge with charging current until charging voltage \times number of cells is reached.

Step 3:

U-charge with charging voltage \times number of cells until charging current is decreased to $0.04 C_1$.

End of program

Time monitoring:

Precharge maximum 2 hours, I- and U-charge maximum 6 hours, capacity maximum $1.5 \times C$.

9.3.7 Program 220: Charge NiCd battery (manufacturer independent)

20: NiCd battery (manufacturer independent)
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ C₁ or C₂
- ◆ Topping charge time

Step 1:

Charge with C₁ or C₂ until charging voltage of 1.55 V × number of cells is reached.

Step 2:

Topping charge C₅ or C₁₀ for for the entered time.

In case no automatic cell tester is connected:

15 (30) minutes before the end of the topping charge a signal asks for the measurement of the single cells voltages and to control the electrolyte level.

Otherwise:

15 (30) minutes before the end of the topping charge you are requested to control the electrolyte level.

End of program

Time monitoring:

Charging maximum 72 or 144 minutes.

Voltage monitoring:

Monitoring minus $\Delta U > 30\text{mV/cell}$ during charging, error message:
minus delta U detected

9.3.8 Program 221: Charge NiCd battery HAWKER

Name according to manual: IUI charge - method

21: NiCd battery HAWKER
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ XML Battery or not

Step 1:

Charging with C_1 until a charging voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached.

Step 2:

Topping charge C_5 for 2 hours.

In case no automatic cell tester is connected:

15 minutes before the end of the topping charge a signal asks for the measurement of the single cells voltages and to control the electrolyte level.

Otherwise:

15 minutes before the end of the topping charge you are requested to control the electrolyte level.

End of program

Example:

Connected is a 24 V battery with 40 Ah.

The battery will be charged with 40 A to 31 V.

Afterwards the battery will be charged with 8 A for another 2 hours.

Time monitoring:

Charging maximum 90 minutes.

Voltage monitoring:

Monitoring minus $\Delta U > 30\text{mV}/\text{cell}$ during charging, error message:
minus delta U detected

9.3.9 Program 222: Charge NiCd battery SAFT

Name according to manual: Constant Current Charge for SAFT with C_1

22: NiCd battery SAFT
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ ULM Battery or not

Step 1:

Charging with C_1 until a charging voltage of $1.57 \text{ V} \times \text{number of cells}$ is reached.

Step 2:

Topping charge C_{10} for 4 hours.

In case no automatic cell tester is connected:

30 minutes before the end of the topping charge a signal asks for the measurement of the single cells voltages and to control the electrolyte level

Otherwise:

30 minutes before the end of the topping charge you are requested to control the electrolyte level.

End of program

Time monitoring:

Charging maximum 75 minutes.

Voltage monitoring:

Monitoring minus $\Delta U > 30\text{mV}/\text{cell}$ during charging, error message:
minus delta U detected

9.3.10 Program 223: Charge NiCd battery NKBN

Name according to manual: Constant Current Charge for HK5H with C₁

23: NiCd battery NKBN
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Charging with C₁ until a charging voltage of 1.55 V × number of cells is reached.

Step 2:

Topping charge C₅ for 2 hours.

60 minutes before the end of the topping charge a signal asks for the measurement of the single cells voltages and to control the electrolyte level.

30 minutes before the end of the topping charge a signal requests to control the electrolyte level

10 minutes before the end of the topping charge a signal requests to measure the single cells voltages.

End of program

Time monitoring:

Charging maximum 72 minutes.

Voltage monitoring:

Monitoring minus $\Delta U > 30\text{mV/cell}$ during charging, error message:
minus delta U detected

9.3.11 Program 224: Charging NiCd battery MARATHON

Name according to manual:

Charge (Constant Current) for MARATHON with main charge current

24: NiCd battery MARATHON
↓ select Batteryprocessing: ↓
P2: Charge

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Charging current main-charge
- ◆ M³ or not M³

Step 1:

Charging with charging current main-charge until a charging voltage of 1.55 or 1.60 V × number of cells is reached.

If an automatic cell tester is connected, the individual cell voltages are printed out after 5 minutes. After that a signal requests the measurement of the single cells voltages. In case the voltage is below 1.55 V(1.60 V) charging continues for 5 minutes and again a cell voltage measurement is requested. Otherwise step 2 follows.

In case the number of measured cells does not conform to the number of cells for example a cell has been measured twice the device is not able to decide how to continue and the user is asked if all cells are > 1.55 V(1.60 V). Enter: 1=YES 0=NO.

Step 2:

Topping charge with 0.4 × charging current main-charge for 1 hour.

15 minutes before the end of the topping charge a signal requests to control the electrolyte level.

In case no automatic cell tester is connected:

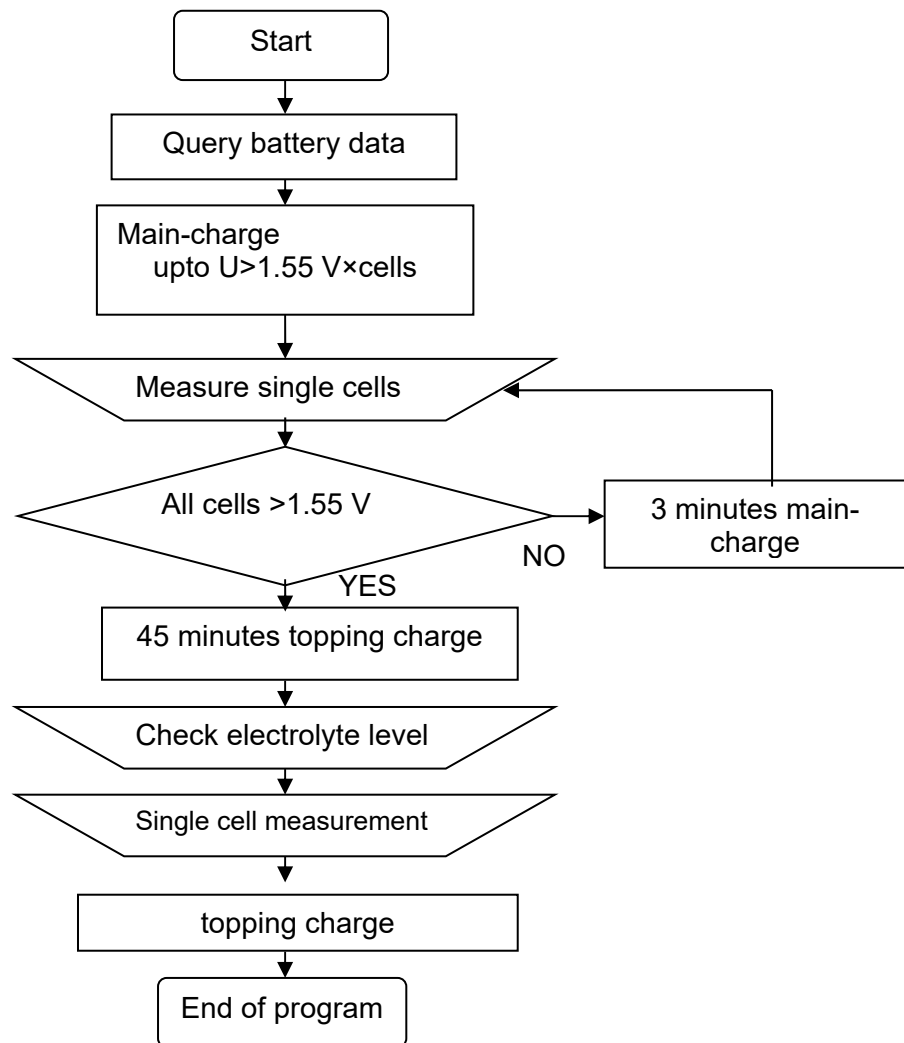
Before the end of the topping charge a signal requests the measurement of single cells voltages.

End of program

Voltage monitoring:

Monitoring minus $\Delta U > 30\text{mV}/\text{cell}$ during charging, error message:

minus delta U detected



9.4 Capacity test

The program "P3: Capacity Test" is a specific part of the maintenance (program "P4: Maintenance") and is used for capacity testing of aviation batteries. It meets the requirements of the battery manufacturer.

Example for NiCd-batteries:

```

=====
COPYRIGHT          NORTEC
2014-15 UL60  V 1.0 16.06.15
SN: 160001
-----
          DATE: 28.06.15
    BATTERY NO:
      USER NO:
NOM. VOLTAGE: 24.00 V
      CAPACITY: 040.0 Ah
      PROGRAM: 322
NiCd Battery SAFT
Capacity Test
-----
PROGRAM START          10:38:02
      VOLTAGE = 25.41 V
-----
P322:S1: 11:29:53
DISCHARGE
      VOLTAGE = 20.70 V
      CURRENT = 40.01 A
      CAPACITY = 34.02 Ah
              = 085 %
      TIME = 051 MIN
-----
      CELL 01: 1.052 V
      CELL 02: 1.073 V

      ↓

      CELL 20: 1.032 V
-----
P322:S1: 11:32:53
DISCHARGE
      VOLTAGE = 20.00 V
      CURRENT = 40.01 A
      CAPACITY = 36.07 Ah
              = 090 %
      TIME = 054 MIN
-----
BATTERY DISCHARGED
-----
      CAPACITY = 36.07 Ah
              = 090 %
-----
PROGRAM AUTOMATICALLY FINISHED
=====

```

9.4.1 Program 312: Capacity Test Valve Regulated Lead Acid Aircraft Battery

Name according to manual: Capacity Test for Valve Regulated Lead Acid Aircraft Batteries

12: Valve Regulated Lead Acid Aircraft Battery

↓ select Batteryprocessing: ↓

P3: Capacity Test

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

Discharging with C_1 until the voltage of 1.67 V for each cell is reached (20 V at 24 V nominal voltage). After 48 minutes a record is printed (80 %).

After that continue with discharging C_1 until the complete time of 54 minutes (90 %) or until the voltage of 1.67 V for each cell is reached.

Step 2:

Charging with C_2 and 2.33 V for each cell for 7 hours.

End of program

Displayed is the capacity measured during discharging:

Example:

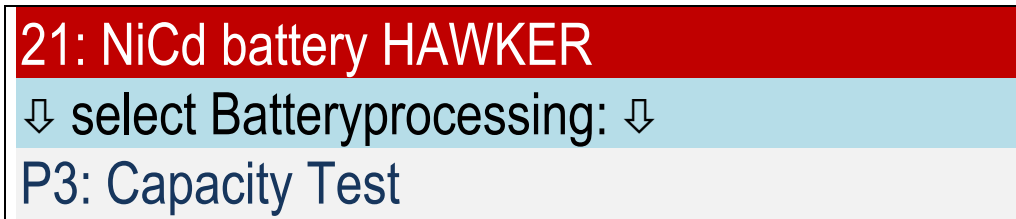
Connected is a 24 V battery with 40 Ah.

The battery is discharged with 40 A to 20 V.

After that it is charged with 20 A to 28 V.

9.4.2 Program 320: Capacity Test NiCd battery (manufacturer independent)**9.4.3 Program 321: Capacity Test NiCd battery HAWKER**

Name according to manual: Capacity Check for HAWKER with C₁



Refer also program 421 Maintenance.

While the program P3: Capacity Test requires a fully charged battery, the program maintenance can treat partially charged batteries. After the program maintenance you get a fully charged battery. **After the program P3: Capacity Test the battery is discharged.** After a waiting period of at least 8 hours, the battery can be recharged.

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Query, when the cell test measurement should be taken (80 - 100% or 48 - 60 minutes)

Step 1:

Discharging with C₁ until battery voltage has reached 1 V × number of cells.

In case no automatic cell tester is connected:

After 48 minutes a signal requests the measurement of single cell voltages.

Otherwise: The actual discharge time will be registered automatically when one of the cells is discharged below 1.0 V.

After that continue discharging with C₁ until the battery voltage has reached 1 V × number of cells.

WARNING NOTE: „Battery discharged“

End of program

In case an automatic cell tester is connected:

Displayed is the capacity which was measured during discharging until the moment when the first cell has decreased below 1 V.

Example:

Connected is a 24 V battery with 40 Ah. The battery will be discharged with 40 A to 20 V.

Time monitoring:

Discharging maximum 90 minutes.

Example:

```

=====
COPYRIGHT          NORTEC
2014-15 UL60   V 1.0 16.06.15
SN: 160001
-----
      DATE: 28.06.15
      BATTERY NO:
      USER NO:
      NOM.VOLTAGE: 24.00 V
      CAPACITY: 040.0 Ah
      PROGRAM: 321
NiCd Battery HAWKER
Capacity Test
-----
PROGRAM START          08:14:12
      VOLTAGE = 26.96 V
-----
P321:S1: 09:02:44
DISCHARGE
      VOLTAGE = 23.93 V
      CURRENT = 40.01 A
      CAPACITY = 031.8 Ah
              = 079 %
      TIME = 048 MIN
-----
      CELL 01: 1.196 V
      CELL 02: 1.194 V

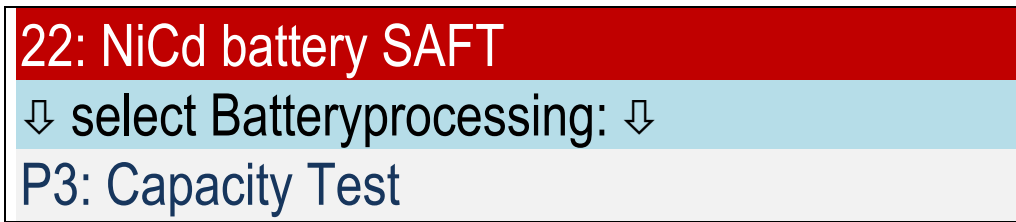
      ↓

      CELL 20: 1.187 V
-----
P321:S1: 09:14:39
DISCHARGE
      VOLTAGE = 20.00 V
      CURRENT = 40.01 A
      CAPACITY = 039.8 Ah
              = 099 %
      TIME = 060 MIN
-----
BATTERY EVALUATION
C>80%: Battery is OK
      CAPACITY = 039.8 AH
              = 099 %
PROGRAM AUTOMATICALLY FINISHED
=====

```

9.4.4 Program 322: Capacity Test NiCd battery SAFT

Name according to manual: Capacity Check for SAFT with C₁



Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C₁ until a voltage of 1 V for each cell is reached.

In case no automatic cell tester is connected:

After 51 minutes a signal requests to measure the single cells voltages.

Otherwise: cell measurement is done automatically as soon as a cell is below 1.0 V.

Continue with discharging with C₁ until a voltage of 1 V for each cell is reached.

WARNING NOTE: „Battery discharged “

End of program

In case an automatic cell tester is connected:

Displayed is the capacity measured during discharging at the moment when the first cell is below 1 V.

Example:

Connected is a 24 V battery with 40 Ah. The battery will be discharged with 40 A to 20 V.

Time monitoring:

Discharging maximum 90 minutes.

9.4.5 Program 323: Capacity Test NiCd battery NKBN

Name according to manual: Control Discharge for HKBH

23: NiCd battery NKBN
↓ select Batteryprocessing: ↓
P3: Capacity Test

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C_1 until a voltage of 1 V for each cell is reached.

In case no automatic cell tester is connected:

At voltages 23 V, 22 V and 21 V (values for a 24 V battery) or after 60 minutes a signal - up to 4 times - requests the measurement of the single cells voltages.

Otherwise: cell measurement is done automatically

After that discharging with C_1 until a voltage of 1 V for each cell is reached.

WARNING NOTE: „Battery discharged“

End of program

Example:

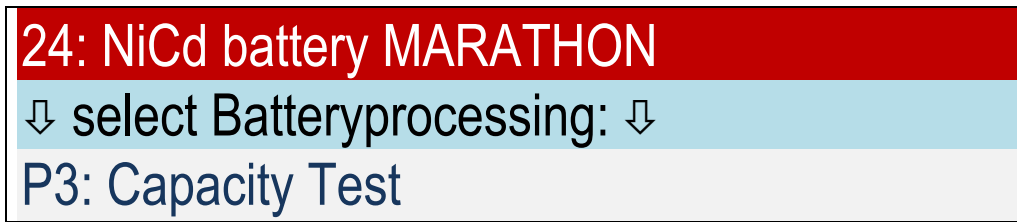
Connected is a 24 V battery with 40 Ah. The battery will be discharged with 40 A to 20 V.

Time monitoring:

Discharging maximum 90 minutes.

9.4.6 Program 324: Capacity Test NiCd battery MARATHON

Name according to manual: Capacity Check for MARATHON with C₁



Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C₁ until a voltage of 1 V for each cell is reached.

In case no automatic cell tester is connected:

After 51 and 60 minutes a signal requests the measurement of the single cells voltages.

Otherwise: Cell measurement is done automatically as soon as a cell is below 1.0 V.

After that discharging with C₁ until a voltage of 1 V for each cell is reached.

WARNING NOTE: „Battery discharged“

End of program

In case an automatic cell tester is connected:

Displayed is the capacity during discharging measured at the moment the first cell is below 1 V.

Example:

Connected is a 24 V battery with 40 Ah. The battery is discharged with 40 A to 20 V.

Time monitoring:

Discharging maximum 90 minutes.

9.5 Maintenance

With the help of the program „Maintenance “ the capacity of the lead acid and NiCd batteries will be tested. For NiCd-batteries the program „P3: Capacity Test“ according to manufacturers instructions is available in addition.

Example: Lead battery

```

=====
COPYRIGHT          NORTEC
2014-15 UL60   V 1.0 16.06.15
SN: 160001
-----
          DATE: 28.01.14
        BATTERY NO:
      OPERATOR NO:
    NOM. VOLTAGE: 12.00 V
      RATED CAP: 100.0 Ah
      PROGRAM: 410
Pb battery sealed MIL
Maintenance
-----
PROGRAM START          12:07:46
  VOLTAGE = 12.81 V
-----
P410:S1: 16:42:46
DISCHARGE 1
  VOLTAGE = 09.00 V
  CURRENT = 20.01 A
  CAPACITY = 091.4 Ah
            = 091 %
            TIME = 274 MIN
-----
P410:S2: 16:45:53
PTOPPING CHARGE 1
  VOLTAGE = 14.40 V
  CURRENT = 40.01 A
  CAPACITY = 002.0 Ah
            = 002 %
            TIME = 003 MIN
-----
P410:S3: 18:35:18
I-CHARGE 1
  VOLTAGE = 14.40 V
  CURRENT = 40.01 A
  CAPACITY = 74.70 Ah
            = 074 %
            TIME = 111 MIN
-----
P410:S4: 20:04:58
U-CHARGE 1
  VOLTAGE = 14.40 V
  CURRENT = 02.01 A
  CAPACITY = 091.7 Ah
            = 091 %
            TIME = 201 MIN
-----
P410:S5: 22:04:25
TOPPING CHARGE 1
  VOLTAGE = 14.40 V
  CURRENT = 00.71 A
  CAPACITY = 094.0 Ah
            = 094 %
            TIME = 120 MIN
-----
P410:S6: 02:46:41
DISCHARGE 2
  VOLTAGE = 09.01 V
  CURRENT = 20.01 A
  CAPACITY = 093.9 Ah
            = 093 %
            TIME = 282 MIN
-----
P410:S7: 04:42:00
I-CHARGE 2
  VOLTAGE = 14.39 V
  CURRENT = 40.01 A
  CAPACITY = 076.6 Ah
            = 076 %
            TIME = 114 MIN
-----
P410:S8: 06:09:53
U-CHARGE 2
  VOLTAGE = 14.40 V
  CURRENT = 02.01 A
  CAPACITY = 093.7 Ah
            = 093 %
            TIME = 201 MIN
-----
P410:S9: 08:09:01
TOPPING CHARGE 2
  VOLTAGE = 14.40 V
  CURRENT = 00.68 A
  CAPACITY = 095.9 Ah
            = 095 %
            TIME = 120 MIN
-----
BATTERY EVALUATION
C>80%: Battery is OK
      CAPACITY = 093.9 Ah
            = 093 %
PROGRAM AUTOMATICALLY FINISHED
=====

```

} Only for deep discharged batteries

Example: NiCd-battery

```

=====
COPYRIGHT          NORTEC
2014-15 UL60     V 1.0 16.06.15
SN: 160001
-----
          DATE: 28.06.15
          BATTERY NO:
          OPERATOR NO:
          NOM. VOLTAGE: 24.00 V
          RATED CAP: 040.0 Ah
          PROGRAM: 420
NiCd battery
Maintenance
-----
PROGRAM START          08:40:32
          VOLTAGE = 26.27 V
-----
P420:S1: 08:46:38
DISCHARGE 1
          VOLTAGE = 24.37 V
          CURRENT = 40.01 A
          CAPACITY = 003.5 Ah
                  = 008 %
          TIME = 006 MIN
-----
P420:S2: 09:11:53
I-CHARGE 1
          VOLTAGE = 30.99 V
          CURRENT = 40.01 A
          CAPACITY = 016.6 Ah
                  = 041 %
          TIME = 24 MIN
-----
P420:S3: 10:26:00
TOPPING CHARGE 1
          VOLTAGE = 33.06 V
          CURRENT = 04.00 A
          CAPACITY = 021.6 Ah
                  = 054 %
          TIME = 075 MIN
-----

```

```

P420:S4: 11:30:30
DISCHARGE 2
          VOLTAGE = 20.00 V
          CURRENT = 40.01 A
          CAPACITY = 042.6 Ah
                  = 106 %
          TIME = 064 MIN
-----

```

```

P420:S5: 12:33:36
I-CHARGE 2
          VOLTAGE = 30.99 V
          CURRENT = 40.01 A
          CAPACITY = 041.9 Ah
                  = 104 %
          TIME = 062 MIN
-----

```

```

P420:S6: 13:48:08
TOPPING CHARGE 2
          VOLTAGE = 32.90 V
          CURRENT = 08.00 A
          CAPACITY = 051.8 Ah
                  = 129 %
          TIME = 075 MIN
-----
          CELL 01: 1.612 V
          CELL 02: 1.610 V
          ↓
          CELL 20: 1.600 V
-----

```

```

P420:S7: 14:02:55
TOPPING CHARGE 2
          VOLTAGE = 32.90 V
          CURRENT = 08.01 A
          CAPACITY = 053.8 Ah
                  = 134 %
          TIME = 090 MIN
-----

```

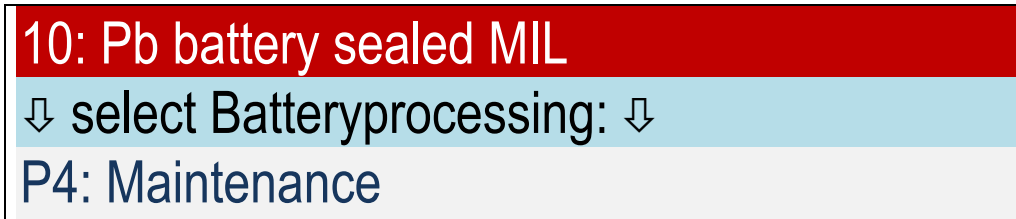
```

BATTERY EVALUATION
C>80%: Battery is OK
          CAPACITY = 042.6 Ah
                  = 106 %
-----

```

PROGRAM AUTOMATICALLY FINISHED

9.5.1 Program 410: Maintenance Pb battery sealed MIL



Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

Discharging with C_5 until a voltage of 1.5 V is reached.

Step 2:

In case battery voltage is below $2.15 \text{ V} \times \text{number of cells}$:

Precharge with $2.4 \text{ V} \times \text{number of cells}$ until charging current $0.4 C_1$ is reached.

Step 3:

I-charge with $0.4 C_1$ until charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 4:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until charging current is decreased to $0.02 C_1$.

Step 5:

Discharging with C_5 to 1.5 V for each cell. The here detected capacity will be used to ascertain the effective capacity.

Step 6:

I-charge with $0.4 C_1$ until the charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 7:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until charging current is decreased to $0.02 C_1$.

End of program

Display Battery evaluation:

$C > 90\%$: BATTERY OK

or

$C > 70\%$: BATTERY FOR UNCRITICAL USE

or

$C < 70\%$: BATTERY WITH RECORD TAKE DISCHARGED BATTERY OUT OF SERVICE

Time monitoring:

Precharge maximum 2 hours, I- and U-charge maximum 8 hours, capacity maximum $1.5 \times C$

9.5.2 Program 411: Maintenance Pb battery sealed commercial

11: Pb battery sealed commercial
↓ select Batteryprocessing: ↓
P4: Maintenance

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

Discharging with C_{10} until the voltage of 1.8 V is reached.

Step 2:

In case battery voltage is below $2.15 \text{ V} \times \text{number of cells}$:

Precharge with $2.4 \text{ V} \times \text{number of cells}$ until charging current of $0.36 C_1$ is reached.

Step 3:

I-charge with $0.36 C_1$ until charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 4:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until charging current is decreased to $0.02 C_1$.

Step 5:

Discharging with C_{10} to 1.8 V for each cell. The here detected capacity will be used to ascertain the effective capacity.

Step 6:

I-charge with $0.36 C_1$ until the charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 7:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until the charging current is decreased to $0.02 C_1$.

End of program

Display battery evaluation:

$C > 80\%$: BATTERY is OK

or

$C > 60\%$: BATTERY FOR UNCRITICAL USE

or

$C < 60\%$: BATTERY WITH RECORD TAKE DISCHARGED BATTERY OUT OF SERVICE

Time monitoring:

Precharge maximum 2 hours, I- and U-Charge maximum 8 hours, capacity maximum $1.5 \times C$

9.5.3 Program 416: Maintenance Pb battery vented commercial

16: Pb battery vented commercial
↓ select Batteryprocessing: ↓
P4: Maintenance

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity

Step 1:

The message is displayed:

P416:S1: FILL IN ELECTROLYTE wait for 20 MINUTES E=continue
--

The program waits for at maximum of 20 minutes.
Discharging with C_{20} until a voltage of 1.8 V is reached.

Step 2:

In case battery voltage is below $2.15 \text{ V} \times \text{number of cells}$:
Precharge with $2.4 \text{ V} \times \text{number of cells}$ until charging current of $0.25 C_1$ is reached.

Step 3:

I-charge with $0.25 C_1$ until charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 4:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until charging current is decreased to $0.04 C_1$.

Step 5:

Discharging with C_{20} to 1.8 V for each cell. The here detected capacity will be used to ascertain the effective capacity.

Step 6:

I-charge with $0.25 C_1$ until the charging voltage of $2.4 \text{ V} \times \text{number of cells}$ is reached.

Step 7:

U-charge with $2.4 \text{ V} \times \text{number of cells}$ until the charging current is decreased to $0.04 C_1$.

End of program

Display battery evaluation:

C>70%:BATTERY IS OK
or
C>50%:BATTERY FOR UNCRITICAL USE
or
C<50%:BATTERY WITH RECORD TAKE DISCHARGED BATTERY OUT OF SERVICE

Time monitoring:

Precharge maximum 2 hours, I- and U-charge maximum 8 hours, capacity maximum $1.5 \times C$

9.5.4 Program 417: Maintenance Lead Battery P3-C Orion

17: Lead Battery P3-C Orion
↓ Select Batteryprocessing: ↓
P4: Maintenance

Enter:

- ◆ None, nominal voltage and capacity are preselected by the program

Step 1:

Discharging with C₁ until a voltage of 1.5 V is reached.

Step 2:

I-charge with C₅ for 5 hours (limit 2.375 V/cell).

Step 3:

I-charge with C₁₀ for 2.5 hours (limit 2.375 V/cell).

Step 4:

Discharging with C₁ to 1.5 V for each cell. The here detected capacity will be used to ascertain the effective capacity.

Step 5: (not applicable if capacity is below 100 %)

I-charge with C₅ for 5 hours (limit 2.375 V/cell).

Step 6: (not applicable if capacity is below 100 %)

I-charge with C₁₀ for 2.5 hour (limit 2.375 V/cell).

End of program

Display battery evaluation:

C>100%:BATTERY IS OK

or

C<99%:BATTERY WITH RECORD TAKE DISCHARGED BATTERY OUT OF SERVICE

9.5.5 Program 419: Maintenance Pb battery (free input)

19: Pb battery (free input)
↓ select Batteryprocessing: ↓
P4: Maintenance

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity
- ◆ Discharging current C_1 , C_2 , C_5 , C_{10} or C_{20}
- ◆ Final discharging voltage
- ◆ Final charging voltage
- ◆ Charging current

Step 1:

Precharge with $2.4 \text{ V} \times$ number of cells until charging current of $0.25 C_1$ is reached.

Step 2:

I-charge until the charging voltage \times number of cells is reached.

Step 3:

U-charge with charging voltage \times number of cells until current is decreased to $0.04 C_1$.

Step 4:

Discharging with discharging current to final charging voltage \times number of cells.
The here detected capacity will be used to ascertain the effective capacity.

Step 5:

I-charge

Step 6:

U-charge

End of program

Display battery evaluation:

$C > 80\%$: BATTERY IS OK

or

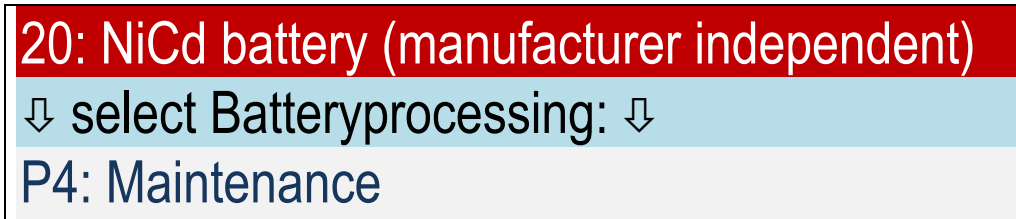
$C > 60\%$: BATTERY FOR UNCRITICAL USE

or

$C < 60\%$: BATTERY WITH RECORD TAKE DISCHARGED BATTERY OUT OF SERVICE

Time monitoring:

Precharge maximum 2 hours, I- and U-charge maximum 8 hours, capacity maximum $1.5 \times C$

9.5.6 Program 420: Maintenance NiCd battery (manufacturer independent)**Enter:**

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C_1 for 6 minutes.

Step 2:

Charging with C_1 until the charging voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached.

Step 3:

Topping charge C_{10} for 1.5 hours.

Step 4:

Discharging with C_1 to 1 V for each cell. The here detected capacity will be used to ascertain the effective capacity.

Step 5:

Charging with C_1 until a charging voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached.

Step 6:

Topping charge C_5 for 1,5 hours.

In case no automatic cell tester is connected:

15 minutes before the end of the topping charge a signal requests for measurement of single cells voltages and to control the electrolyte level.

Otherwise:

15 minutes before the end of topping charge you are asked to control the electrolyte level.

End of program

Display battery evaluation:

$C > 80\%$: BATTERY IS OK

or

$C < 80\%$: BATTERY WITH RECORD TAKE DISCHARGED BATTERY OUT OF SERVICE

Time monitoring:

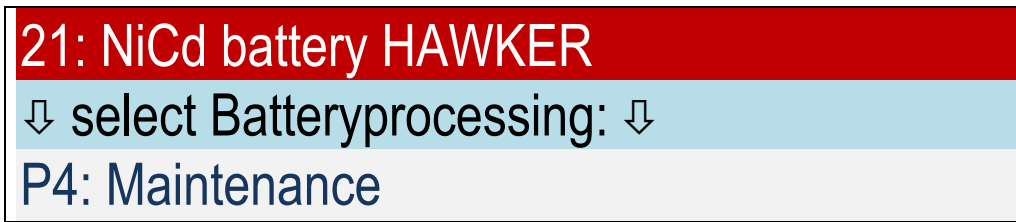
Charging maximum 72 minutes; capacity maximum $1.7 \times C$

Voltage monitoring:

Voltage decreased 30 mV/cell (minimum 50 mV) during charging error message: minus delta U detected.

9.5.7 Program 421: Maintenance NiCd battery HAWKER

Name according to manual: Capacity Check for HAWKER with C₁



Refer also to program P321: Capacity Test.

The program Capacity Test involves only the discharge with capacity test!

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Query, when the cell test measurement should be taken (80 - 100% or 48 - 60 minutes)
- ◆ Query, if the manufacturer's recommended procedure or a fast maintenance
- ◆ XML Battery or not

- A) The **recommended procedure** of Hawker extends battery life and ensures maximum life-span.
- B) **Fast maintenance** can be applied to temporal bottlenecks, if any repairs on the battery are required and the battery has met the requirements of the insulation test (> 0.5 MΩ).

A) Recommended procedure:

Step 1:

Discharging with C₁ until a voltage of 1 V for each cell is reached.

Step 2:

8 hours break.

The message is displayed:

„wait 8 hours.  to skip waiting time: press .

Step 3:

I-Charge with C₁ until charging voltage of 1.55 V × number of cells is reached.

Step 4:

Topping charge with C₅ for 2 hours.

In case no automatic cell tester is connected:

15 minutes before the end of the topping charge a signal requests for measurement of single cells voltages and to control the electrolyte level.

Otherwise:

Cell measurement is performed automatically und you are asked to control the electrolyte level.

In case that step 1 has been completed with a capacity rated above the nominal capacity, the program ends with this step.

Schritt 5:

Discharging with C_1 to 1 V for each cell.

In case no automatic cell tester is connected:

After 48 minutes a signal requests for measurement of single cells voltages.

Otherwise:

Cell measurement is performed automatically once a cell has fallen below 1.0V.



Thereafter further discharge C_1 to the voltage of 1 V per cell is reached.

The determined capacity in this step is used at the end for the battery rating.

Step 6:

8 hours break.

The message is displayed:

„wait 8 hours.  skip waiting time possible: press  .“

Step 7:

I-Charge with C_1 until charging voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached.

Step 8:

Topping charge with C_5 for 2 hours.

In case no automatic cell tester is connected:

15 minutes before the end of the topping charge a signal requests for measurement of single cells voltages and to control the electrolyte level.

Otherwise:

Cell measurement is performed automatically und you are asked to control the electrolyte level.

End of program.

In case an automatic cell tester is connected:

The capacity which was measured during the discharge until the time will be displayed, until the first cell has fallen below 1.0V.

Example:

Connected is a 24 V battery with 40 Ah. The battery is discharged with 40 A to 20 V.

Waiting time 8 hours.

After that the battery will be charged with 40 A to 31 V. Furthermore the battery will be charged for another 2 hours with 8 A. The battery is discharged a second time with 40 A at 20 V.

Waiting time 8 hours.

After that the battery will be charged with 40 A to 31 V. Furthermore the battery will be charged for another 2 hours with 8 A.

B) Fast maintenance:**Step 1:**

I-Charge with C_1 until charging voltage of $1.55 \text{ V} \times \text{number of cells}$ is.

Step 2:

Topping charge with C_5 .

Duration 3 hours.

In case no automatic cell tester is connected:

15 minutes before the end of the topping charge a signal requests for measurement of single cells voltages and to control the electrolyte level.

Otherwise:

Cell measurement is performed automatically und you are asked to control the electrolyte level.

Step 3:

Discharging with C_1 until a voltage of 1 V for each cell is reached.

Step 4:

I-Charge with C_1 until charging voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached.

Step 5:

Topping charge with C_5 for 2 hours.

In case no automatic cell tester is connected:

15 minutes before the end of the topping charge a signal requests for measurement of single cells voltages and to control the electrolyte level.

Otherwise:

Cell measurement is performed automatically und you are asked to control the electrolyte level.

End of program.

In case an automatic cell tester is connected:

The capacity which was measured during the discharge until the time will be displayed, until the first cell has fallen below 1.0V.

Example:

Connected is a 24 V battery with 40 Ah. The battery will be charged with 40 A to 31 V.

Furthermore the battery will be charged with 8 A. After 3.5 hours the battery will be discharged with 40 A to 31 V. Furthermore the battery will be charged for another 2 hours with 8 A.

**Example NiCd battery HAWKER –
recommended procedure**

=====

COPYRIGHT **NORTEC**
 2014-15 UL60 V 1.0 16.06.15
 SN: 160001

 DATE: 28.06.15
 BATTERY NO:
 OPERATOR NO:
 NOM. VOLTAGE: 24.00 V
 RATED CAP: 040.0 Ah
 PROGRAM: 421
 NiCd battery HAWKER
 Maintenance

 PROGRAM START 08:14:12
 VOLTAGE = 26.96 V

 P421:S1: 09:14:39
 DISCHARGE
 VOLTAGE = 20.00 V
 CURRENT = 40.01 A
 CAPACITY = 039.8 Ah
 = 099 %
 TIME = 060 MIN

 P421:S3: 18:01:39
 I-CHARGE 1
 VOLTAGE = 30.99 V
 CURRENT = 40.01 A
 CAPACITY = 030.4 Ah
 = 076 %
 TIME = 045 MIN

 P421:S4: 20:01:39
 TOPPING CHARGE 1
 VOLTAGE = 33.05 V
 CURRENT = 08.00 A
 CAPACITY = 042.3 Ah
 = 106 %
 TIME = 120 MIN

 CELL 01: 1.196 V
 CELL 02: 1.194 V

↓

CELL 20: 1.187 V

 P421:S5: 21:01:39
 DISCHARGE
 VOLTAGE = 20.00 V
 CURRENT = 40.01 A
 CAPACITY = 039.8 Ah
 = 099 %
 TIME = 060 MIN

 P421:S7: 05:46:39
 I-CHARGE 1
 VOLTAGE = 30.99 V
 CURRENT = 40.01 A
 CAPACITY = 030.4 Ah
 = 076 %
 TIME = 045 MIN

 P421:S8: 07:31:39
 TOPPING CHARGE 1
 VOLTAGE = 33.06 V
 CURRENT = 08.00 A
 CAPACITY = 041.6 Ah
 = 105 %
 TIME = 105 MIN

 CELL 01: 1.653 V
 CELL 02: 1.650 V

↓

CELL 20: 1.658 V

 P421:S8: 07:45:39
 TOPPING CHARGE 1
 VOLTAGE = 33.05 V
 CURRENT = 08.00 A
 CAPACITY = 042.3 Ah
 = 106 %
 TIME = 120 MIN

 BATTERY EVALUATION
 C>80%: Battery is OK
 CAPACITY = 039.8 Ah
 = 099 %

PROGRAM AUTOMATICALLY FINISHED

=====

9.5.8 Program 422: Maintenance NiCd battery SAFT

Name according to manual: Capacity Check or Regular Check

22: NiCd battery SAFT
↓ select Batteryprocessing: ↓
P4: Maintenance

Refer also to program P322: Capacity Test.

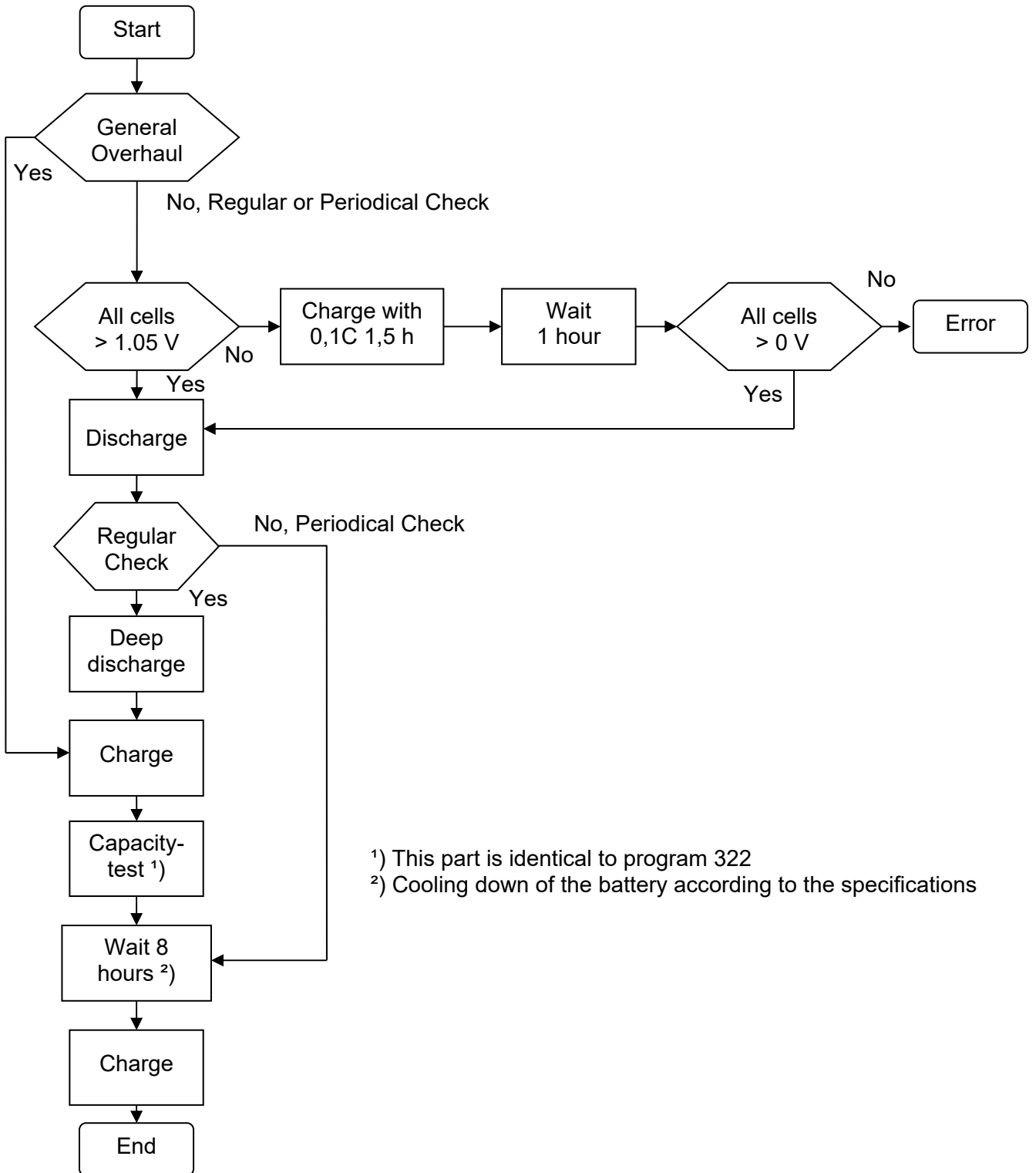
The program Capacity Test involves only the discharge with capacity test!

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Query, when the cell test measurement should be taken (80 - 100% or 48 - 60 minutes)
- ◆ Query, if Capacity Check or Regular Check
- ◆ ULM Battery or not
- ◆ When "Regular Check" has been selected:
 Waiting after program step "Deep Discharge"? (see step 2)

Regular check requires an automated cell tester.

General Overhaul starts after the reassembly of the battery.



1) This part is identical to program 322

2) Cooling down of the battery according to the specifications

Step 0:

If „General Overhaul“ has been selected:
Continue with step 3

If „Regular Check“ or „Periodical Check“ have been selected:

All cells over 1.05V?

If not: Charge with 0.1C for 1.5 hours. If polarity of cells reversed, then error message.

Step 1:

Residual Discharge with C_1 until a voltage of 1 V for each cell is reached.

Step 2:

A) If "Regular check" has been selected

Deep discharge with device internal 1 Ohm resistors on each cell for 12 hours.

Depending on settings the device might wait after executing Step 3. This will prevent, that e.g. in the night the request to control the electrolyte level might occur.

B) If "Periodical check" has been selected

Continue with step 6

Step 3:

I-Charge with C_1 until charging voltage of $1.57 \text{ V} \times \text{number of cells}$ is reached.

Step 4:

Topping charge (final charge) with C_{10} for 4 hours.

In case no automatic cell tester is connected:

30 minutes before the end of the topping charge a signal requests for measurement of single cells voltages and to control the electrolyte level.

Otherwise:

30 minutes before the end of the topping charge a signal requests to control the electrolyte level.

Step 5:

Residual discharge with C_1 to 1 V for each cell.

In case no automatic cell tester is connected:

After 51 minutes a signal requests for measurement of single cells voltages.

Otherwise:



Cell measurement is performed automatically once a cell has fallen below 1.0V.

Thereafter further discharge C_1 to the voltage of 1 V per cell is reached.

Step 6:

8 hours break.

The message is displayed:

„wait 8 hours.  skip waiting time possible: press  .“

Step 7:

I-Charge with C_1 until charging voltage of $1.57 \text{ V} \times \text{number of cells}$ is reached.

Step 8:

Topping charge with C_{10} for 4 hours.

30 minutes before the end of the topping charge a signal requests for measurement of single cells voltages and to control the electrolyte level.

Otherwise:

30 minutes before the end of the topping charge a signal requests to control the electrolyte level.

End of program.

In case an automatic cell tester is connected:

The capacity which was measured during the discharge until the time will be displayed, until the first cell has fallen below 1.0V.

9.5.9 Program 424: Maintenance NiCd battery MARATHON

Name according to manual: Battery Maintenance

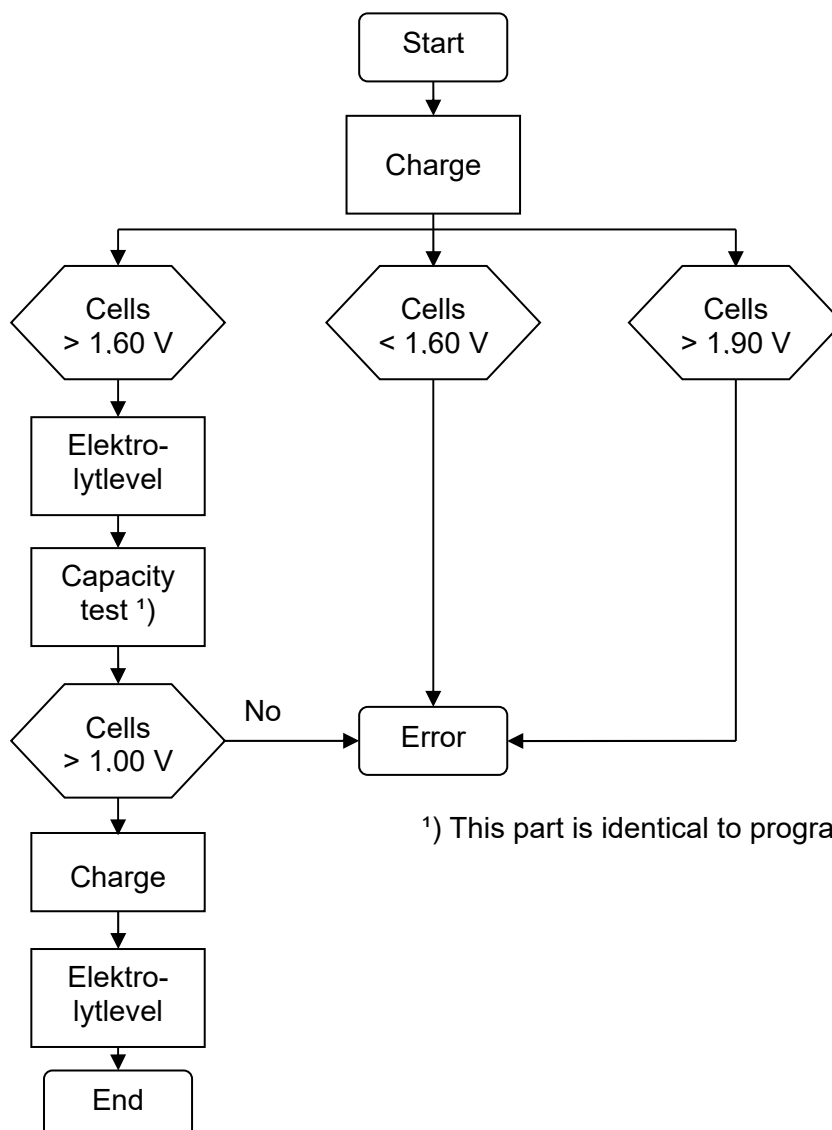
24: NiCd battery MARATHON
⇩ select Batteryprocessing: ⇩
P4: Maintenance

Refer also to program P324: Capacity Test.

The program Capacity Test involves only the discharge with capacity test!

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Charging current main charge
- ◆ M³ or not M³
- ◆ Query, when the cell test measurement should be taken (80 - 100% or 48 - 60 minutes)



Step 1:

Charge with constant current main charge until charging voltage of 1.55 or 1.60 V × number of cells is reached.

Thereafter an acoustic signal requests to measure the single cells voltages.

If a voltage is below 1.55 (1.60) V, charging continues for 3 minutes and there is a renewed request for cell voltage measurement, otherwise proceed to step 2.

If the number of measured cells does not match the number of cells, eg. perhaps because a cell was measured twice. In this case, the program can not proceed automatically and prompt the user to decide whether all cells have > 1.55 V (1.60 V). Enter: 1 = yes 0 = no.

Step 2:

Topping charge with 0.4 × charging current main-charge for 1 hour.

15 minutes before the end of the topping charge a signal requests to control the electrolyte level.

In case no automatic cell tester is connected:

Before the end of the topping charge a signal requests the measurement of single cells voltages.

The further steps are carried out only if the following conditions are met:

- All cell voltages are above 1.55 V (1.60 V).
- No cell voltage is above 1.90 V.

Step 3:

Discharge with C_1 for 60 minutes or one cell has reached 1 V.

In case no automatic cell tester is connected:

After 51 and 60 minutes a signal requests for measurement of single cells voltages.

Otherwise:

Cell measurement is performed automatically once a cell has fallen below 1.0V.

The further steps are carried out only if the following conditions are met:

- All cell voltages during the 51 minutes measurement above 1.00V.



Otherwise

WARNING NOTE: „Battery discharged “

Step 4:

8 hours break.

The message is displayed:

„wait 8 hours.  skip waiting time possible: press  .“

Step 5:

Charge with constant current main charge until charging voltage of 1.60 V × number of cells is reached.

Thereafter an acoustic signal requests to measure the single cells voltages.

If a voltage is below 1.55 V(1.60 V), charging continues for 3 minutes and there is a renewed request for cell voltage measurement, otherwise proceed to step 2.

If the number of measured cells does not match the number of cells, eg. perhaps because a cell was measured twice. In this case, the program can not proceed automatically and prompt the user to decide whether all cells have > 1.55 V (1.60 V). Enter: 1 = yes 0 = no.

Step 6:

Topping charge with 0.4 × charging current main-charge for 2 hours.

15 minutes before the end of the topping charge a signal requests to control the electrolyte level.

In case no automatic cell tester is connected:

Before the end of the topping charge a signal requests the measurement of single cells voltages.

End of program.

In case an automatic cell tester is connected:

The capacity which was measured during the discharge until the time will be displayed, until the first cell has fallen below 1.0V.

9.6 I-Charge

With the help of program "P5: I-Charge" individual charging programs can be started. Charging time span and final charging voltage free selection possible.

Example: NiCd battery

Enter:

1.55 V shut down voltage
 maximum 1:00 hour charging time span

```

20: NiCd battery (manufacturer independent)
P520: PARAMETER INPUT
MAX. CHARGE TIME      01:00 H
    
```

```

20: NiCd battery (manufacturer independent)
P520: PARAMETER INPUT
MAX. VOLTAGE/CELL ?   1.55 V/C
    
```

```

=====
COPYRIGHT      NORTEC
2014-15 UL60  V 1.0 16.06.15
SN: 160001
-----
          DATE: 28.06.15
    BATTERY NO:
    OPERATOR NO:
    NOM. VOLTAGE: 24.00 V
    RATED CAP:  040.0 Ah
    PROGRAM: 520
NiCd battery
I-Charge
-----
PROGRAM START          10:38:02
    VOLTAGE = 25.41 V
-----
P520:S1: 11:35:53
I-CHARGE
    VOLTAGE = 31.00 V
    CURRENT = 40.01 A
    CAPACITY = 38.07 Ah
              = 096 %
    TIME = 057 MIN
-----
PROGRAM AUTOMATICALLY FINISHED
=====
    
```

Termination because shut down voltage has been reached.

```

=====
COPYRIGHT      NORTEC
2014-15 UL60  V 1.0 16.06.15
SN: 160001
-----
          DATE: 28.06.15
    BATTERY NO:
    OPERATOR NO:
    NOM. VOLTAGE: 24.00 V
    RATED CAP:  040.0 Ah
    PROGRAM: 520
NiCd battery
I-Charge
-----
PROGRAM START          10:38:02
    VOLTAGE = 25.41 V
-----
P520:S1: 11:38:03
I-CHARGE
    VOLTAGE = 30.55 V
    CURRENT = 40.01 A
    CAPACITY = 40.00 Ah
              = 100 %
    TIME = 060 MIN
-----
PROGRAM AUTOMATICALLY FINISHED
=====
    
```

Termination because maximum charging time span has been reached.

- 9.6.1 Program 510: I-Charge Pb battery sealed MIL
- 9.6.2 Program 511: I-Charge Pb battery sealed commercial
- 9.6.3 Program 516: I-Charge Pb battery vented commercial

10: Pb battery sealed MIL
↓ select Batteryprocessing: ↓
P5: I-Charge

Enter:

- ◆ Nominal voltage
- ◆ Rated capacity
- ◆ Charging current
- ◆ Charging time span
- ◆ Switch off voltage of each cell

Step 1:

I-Charge with entered charging current for the input time span. If shut down voltage is reached the program will be terminated.

End of program

9.6.4 Programm 520: I-charge NiCd battery (manufacturer independent)

20: NiCd battery (manufacturer independent)
↓ select Batteryprocessing: ↓
P5: I-Charge

Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Charging current
- ◆ Charging time span
- ◆ Switch off voltage of each cell

Step 1:

I-Charge with the entered charging current for the input time span. If the shut down voltage is reached the program will be terminated.

End of program

9.7 Deep Discharge

With the help of program „P6: Deep Discharge” the NiCd batteries will be completely discharged according to manufacturers instructions.

Example:

```
=====
COPYRIGHT          NORTEC
2014-15 UL60 V 1.0 16.06.15
SN: 160001
-----
          DATE: 28.06.15
    BATTERY NO:
    OPERATOR NO:
    NOM. VOLTAGE: 24.00 V
          RATED CAP: 040.0 Ah
          PROGRAM: 624
NiCd battery MARATHON
Deep Discharge
-----
PROGRAM START          10:38:02
          VOLTAGE = 25.41 V
-----
P624:S1: 11:26:53
DISCHARGE
          VOLTAGE = 20.00 V
          CURRENT = 40.01 A
          CAPACITY = 32.07 Ah
                  = 080 %
          TIME = 048 MIN
-----
P624:S1: 12:33:34
DISCHARGE
          VOLTAGE = 10.00 V
          CURRENT = 04.00 A
          CAPACITY = 33.27 Ah
                  = 080 %
          TIME = 066 MIN
-----
PROGRAM AUTOMATICALLY FINISHED
=====
```

9.7.1 Program 620: Deep Discharge NiCd battery (manufacturer independent)

20: NiCd battery (manufacturer independent)
↓ select Batteryprocessing: ↓
P6: Deep Discharge

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C_1 until a voltage of 1 V for each cell is reached.

In case no automatic cell tester is connected:

Step 2:

Discharging until total voltage of $0.4 \text{ V} \times \text{number of cells}$ is reached. Here, the current is continuously reduced.

Single cell measurements are requested at a total voltage of $0.6 \text{ V} \times \text{number of cells}$.

In case of cells are above 0.3V: Continuing the discharge

In case of cells are below 0.3V, however, all cells above 0.1V: continue discharging with reduced current

In case of one cell is below 0.1 V or the user does not measure the cells: end of program

At $0.5 \text{ V} \times \text{number of cells}$, a renewed request for cell measurement is made.

Note: Ignoring the cell metering request will discharge the battery to $0.6 \text{ V} \times \text{number of cells}$. Otherwise, the battery is discharged to $0.4 \text{ V} \times \text{number of cells}$.

In case of an automatic cell scan adapter:

Step 2:

Continue discharge with reduced current. The current is continuously reduced.

Discharge until the first cell $< 0.1 \text{ V}$ or discharge current $< 1.5 \text{ A}$.

Step 3:

Deep discharging with device integrated 1 Ohm resistors over each cell.

The duration of this step depends on the battery capacity and voltage of the cell with the highest cell voltage.

Step 4:

Check that all cells have a cell voltage of less than 0.2V reached.

If not: continue the deep discharge.

End of program.

Time monitoring:

Discharging (without deep discharge) maximum 90 minutes.

9.7.2 Program 621: Deep Discharge NiCd battery HAWKER

Name according to manual: Deep Discharge with Cell shorting for HAWKER with C₁

21: NiCd battery HAWKER
↓ select Batteryprocessing: ↓
P6: Deep Discharge

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C₁ until a voltage of 1 V for each cell is reached.

In case no automatic cell tester is connected:

After 48 minutes a signal requests the measurement of the single cells voltages.

Otherwise: Cell measurement takes place automatically

Continue with discharging with C₁ until the voltage of 1 V multiplied by the number of interconnected cells is reached.

Step 2:

Afterwards discharging with C₁₀ until a voltage of 0.5 V for each cell is reached.

In case of an automatic cell scan adapter :

Step 3:

Deep discharging with device integrated 1 Ohm resistors over each cell for 24 hours.

End of program

Example:

Connected is a 24 V battery with mit 40 Ah.

The battery at first will be discharged with 40 A to 20 V. Afterwards discharging with 4 A to 10 V.

After that 1 Ohm resistors will be shifted over the cells.

Time monitoring:

Discharging with C₁ maximum 90 minutes, discharging with C₁₀ maximum 180 minutes.

9.7.3 Program 622: Deep Discharge NiCd Battery SAFT

Name according to manual: Deep Discharge with Cell shorting for SAFT with C₁



Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C₁ until a voltage of 1 V for each cell is reached.

In case of an automatic cell scan adapter:

Step 2:

Deep discharging with device integrated 1 Ohm resistors over each cell for 12 hours.

End of program

Example:

Connected is a 24 V battery with 40 Ah.

The battery is discharged with 40 A to 20 V. Afterwards the 1 Ohm resistors will be shifted over the cells.

Time monitoring:

Step 1: Discharging maximum 90 minutes.

9.7.4 Program 623: Deep Discharge NiCd battery NKBN

Name according to manual: Re-Discharge for НКБН

23: NiCd battery NKBN
↓ select Batteryprocessing: ↓
P6: Deep Discharge

Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C_1 until a voltage of 1 V for each cell is reached.

In case no automatic cell tester is connected:

If voltages are 23 V, 22 V and 21 V a signal requests the measurement of the single cells voltages.
Otherwise: cell measurement is done automatically

Afterwards discharging with C_1 until a voltage of 1 V for each cell is reached.

End of program

Example:

Connected is a 24 V battery with 40 Ah.

The battery is discharged with 40 A to 20 V.

Time monitoring:

Discharging maximum 90 minutes.

9.7.5 Program 624: Deep Discharge NiCd battery MARATHON

Name according to manual: Deep Discharge (with Cell shorting) for MARATHON with C₁



Enter:

- ◆ Number of cells
- ◆ Rated capacity

Step 1:

Discharging with C₁ until a voltage of 1 V for each cell is reached.

Step 2:

Afterwards discharging with C₁₀ until a voltage of 0.5 V for each cell is reached.

In case of an automatic cell scan adapter :

Step 3:

Deep discharging with device integrated 1 Ohm resistors over each cell for 12 hours.

End of program

Example:

Connected is a 24 V battery with 40 Ah.

The battery is discharged with 40 A to 20 V. Continue discharging with 4 A to 10 V.

After that 1 Ohm resistors are shifted over the cells.

Time monitoring:

Discharging with C₁ maximum 90 minutes, discharging with C₁₀ maximum 180 minutes.

9.8 Reconditioning

9.8.1 General

Reaching the cells in test capacity less than 80% of its rated capacity, the battery manufacturer recommends as measure reconditioning.

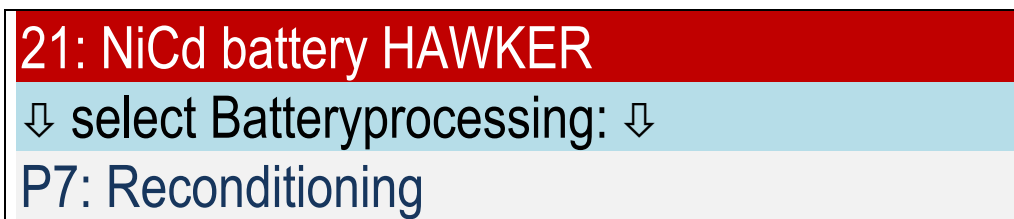
The reconditioning may be performed manually by the programs DISCHARGE, DEEP DISCHARGE with individual resistors and CHARGE / INITIAL COMMISSIONING. The details refer to the Maintenance Manuals of the battery manufacturer. An alternative to using individual resistors provides Nortec Electronics comfortable Zero-volt adapter as accessories.

The UL60 has an automatic program for reconditioning, for this the use of automatic Zellmeßadapters is required. Please note that during auto reconditioning with UL60, the device can not be used elsewhere.

In the following, the automatic reconditioning with UL60 will now be described.

9.8.2 Program 721: Reconditioning NiCd battery HAWKER

Name according to manual: Reconditioning



Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Waiting after program step "Deep Discharge"? (see step 4)

Step 1:

Discharging with C_1 until a voltage of 1 V for each cell is reached.

Step 2:

Afterwards discharging with C_{10} until a voltage of 0.5 V for each cell is reached.

Step 3:

Deep discharging with device integrated 1 Ohm resistors over each cell for 24 hours.

Step 4:

Depending on settings the device might wait after executing Step 4. This will prevent, that e.g. in the night the request to control the electrolyte level might occur.

8 hours charging with $0.2 \times C_1$

15 minutes before the end of the charging you are asked to control the electrolyte level

Step 5:

Wait for 60 minutes.

Step 6:

Discharging with C_1 until a voltage of 1 V for each cell is reached.

End of program

Delivery of battery:

Battery must rest for 8 hours. Afterwards start P1 Initial operation with parameter 7 hours.

Time monitoring:

Discharging with C_1 maximum 90 minutes, discharging with C_{10} maximum 180 minutes.

ATTENTION:

The user has to wait for 8 hours after the end of the program until the program initial operation with the parameter 7 hours can be started.

9.8.3 Program 722: Reconditioning NiCd battery SAFT

Name according to manual: Deep Discharge, Cell shorting and Charge



Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Waiting after program step "Deep Discharge"? (see step 4)

Step 1:

Discharging with C_1 until a voltage of 1 V for each cell is reached.

Step 2:

Afterwards discharging with C_{10} until a voltage of 0.5 V for each cell is reached.

Step 3:

Deep discharging with device integrated 1 Ohm resistors over each cell for 12 hours.

Step 4:

Depending on settings the device might wait after executing Step 4. This will prevent, that e.g. in the night the request to control the electrolyte level might occur.

Charging with C_1 until the charging voltage of $1.57 \text{ V} \times \text{number of cells}$ is reached.

Step 5:

Topping charge C_{10} for 4 hours.

30 minutes before the end of the topping charge you are asked to control the electrolyte level

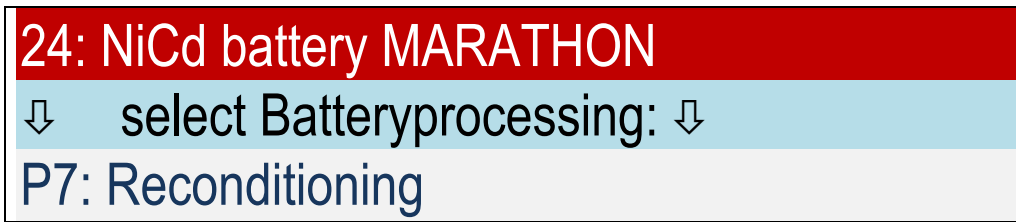
End of program

Time monitoring:

Discharging with C_1 maximum 90 minutes, discharging with C_{10} maximum 180 minutes.

9.8.4 Program 724: Reconditioning NiCd battery MARATHON

Name according to Manual: Reconditioning



Enter:

- ◆ Number of cells
- ◆ Rated capacity
- ◆ Charging current main-charge
- ◆ Waiting after program step "Deep Discharge"? (see step 4)

Step 1:

Discharging with C_1 until voltage of 1 V for each cell is reached.

Step 2:

Afterwards discharging with C_{10} until a voltage of 0.5 V for each cell is reached.

Step 3:

Deep discharging with device integrated 1 Ohm resistor over each cell for 12 hours.

Step 4:

Depending on settings the device might wait after executing Step 4. This will prevent, that e.g. in the night the request to control the electrolyte level might occur.

Charging with charging current main-charge until the charging voltage of $1.55 \text{ V} \times \text{number of cells}$ is reached minimum duration 150 minutes.

In case the voltage is under 1.55 V the charging continues for further 5 minutes and a new measurement takes place.

Step 5:

Topping charge $0.4 \times \text{charging current main-charge}$ for 2 hours.

15 minutes before the end of the topping charge you are asked to control the electrolyte level.

End of program

Time monitoring:

Discharging with C_1 maximum duration 90 minutes, discharging with C_{10} maximum 180 minutes.

9.9 Constant Voltage Supply

9.9.1 Program 800: Constant Voltage Supply

00: Other battery
↓ select Batteryprocessing: ↓
P8: Constant Voltage Supply

Enter:

- ◆ Charging current
- ◆ Nominal voltage

Step 1:

Constant voltage supply with input voltage and input current.

Time: 24 hours

End of program

9.9.2 Program 810: Constant Voltage Supply Pb battery sealed MIL

9.9.3 Program 811: Constant Voltage Supply Pb battery sealed commercial

9.9.4 Program 816: Constant Voltage Supply Pb battery vented commercial

9.9.5 Program 819: Constant Voltage Supply Pb battery (free input)

10: Pb battery sealed MIL
↓ select Batteryprocessing: ↓
P8: Constant Voltage Supply

Enter:

- ◆ Charging current
- ◆ Nominal voltage

Step 1:

Constant voltage supply with 2.25 V for each cell and with the input current.

Time: 24 hours

End of program

9.9.6 Program 820: Constant Voltage Supply NiCd battery (manufacturer independent)

9.9.7 Program 821: Constant Voltage Supply NiCd battery HAWKER

20: NiCd battery (manufacturer independent)
↓ select Batteryprocessing: ↓
P8: Constant Voltage Supply

Enter:

- ◆ Charging current
- ◆ Nominal voltage

Step 1:

Constant voltage supply with 1.42 V for each cell and with the entered current.
Time span: 7 hours

End of program

9.9.8 Program 822: Constant Voltage Supply NiCd battery SAFT

22: NiCd battery SAFT
↓ select Batteryprocessing: ↓
P8: Constant Voltage Supply

Enter:

- ◆ Charging current
- ◆ Nominal voltage

Step 1:

Constant voltage supply with 1.42 V for each cell and with the entered current.
Time span: 5 hours.

End of program

10 Change printer paper and ink ribbon

Preparation:

- Untighten 2 finger screws at the printer
- Pull the printer out of the printer housing from the front side
- Continue with chapter 10.1 and/or 10.2

10.1 Changing of ink ribbon

Name: Ink ribbon (pack of two) HTZ/TKZ: 101 033 111 000

For changing of the ink ribbon use the following procedure:

- Pull out the used ink ribbon from the opened printer
- Pull out the printer paper for several centimetres

10.2 Changing of printer paper roll:

Name: printer paper roll (pack of six) HTZ/TKZ: UL60.40071

For changing of the printer paper proceed as follows:

- Remove ink ribbon from the opened printer
- Pull down the consumed paper roll from the printer. Here pressing the retaining brackets to the side. Tear through printer paper.
- Pull the remaining paper out of the printer from the front in the direction of the paper feed.
- Thread printer paper through the printer housing and insert the printer.

Reassembling:

- Arrange the printer paper in ink ribbon and insert the ink ribbon in the printer pressing softly. Position for inserting ink ribbon: the exposed ink ribbon must be at the bottom, the wheel of the transportation mechanical system at the left side
- Insert the front panel of the printer
- Move the printer in the printer housing
- Fix the 2 finger screws at the printer
- Connect the device to the 230 V mains
- Start the printer selftest: printer does proof copy if the device is switched on while pressing the button for paperfeed

Switch off device



11 Used terms

This part contains a summary of abbreviations and terms used in this operation manual:

Battery sealed

The sealed battery contains cells that can not be opened, that allow no refill of water. The cells are generally closed with space membranes, which open at the first excessive pressure. These batteries with non-removable fasteners are designated by manufacturers as no maintenance-free battery with a fixed electrolyte (gel / AGM).

Battery closed

The term "open" battery was replaced by "closed" battery according to DIN-Standard as an "open" battery has got a degassing stopper.

The term "open" ("vented") is used quite distinctly on the display and on the printed records.

Final charging- and discharging voltage

The terms charging-/discharging voltage stand for voltages regulated by the manufacturer the range you can charge / discharge a battery without damage.

Nominal voltage

The nominal voltage is a determined voltage set by battery technology (for example: Lead batteries: 2V/cell; NiCd- batteries: 1,2V/cell) which is drafted as feature size of a battery.

The term „nominal voltage“ is used to calculate a switching voltage (number of cells x voltage) and within the charging- or discharging programs which are defined for different battery construction types.

Nominal voltage is not equal to cell voltage!

Nominal capacity

The nominal capacity (Ah) as feature size of a battery is based on a preset discharging at a distinct temperature upto a set discharging voltage (discharging current, battery temperature, final discharging voltage).

Example:

Nominal current or 0.2 or C_5 (A)

5-hours constant discharging current (formerly I_5) of a battery which is calculated as follows:

$$\frac{C_5 \text{ (Ah)}}{5\text{h}} = 0.2 C_5 \text{ (A)}$$

Cell voltage

The term „cell voltage“ is used in connection with the number of cells of the treated battery to describe a program related switching voltage within charging or discharging programs.

Cell voltage is not equal to nominal voltage!

Reconditioning

Reconditioning is a process to recover reversible capacity losses on cells imbalanced during shallow cycling and discharge voltage reduction by continuous float charge, or storage.

Testcycle / tests

In order to find out the real capacity of the battery and to make the battery ready for further use “Testcycle /tests” means a cycle of discharge-charge-discharge-charge.

Charging

“Charging” means a non-damaging full-charge within the shortest possible time. Charging is done in a way that the battery can be used immediately after the charging.

Note

Terms which are not described here are explained in the procedures for each program use (for example IU-charging, IUI-charging or similar).

Battery manufacturer

For the programs, which are marked with a manufacturer name the battery treatments follow the instructions of the following battery manufacturers:

- Hawker ®
- Saft
- НКБН (NKBN)
- MarathonNorco Aerospace®

The following programs were created with the utmost care according to the maintenance manuals of the battery manufacturers, but are offered without guarantee. Before applying the below programmed programs this must be checked for compliance with currently valid maintenance manuals of the battery manufacturer. If in doubt or in case of deviations the currently valid maintenance manual of the battery manufacturer always applies.