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Battery Regeneration Lead acid/Gel/Agm

SERVICE MANUAL

BRT 10

CONTENTS

I. Foreword

This comprehensive operator's manual is dedicated to the users of lead acid / gel battery regenerator : BRT 10
It shall be used as the operation as well as a reference manual.
It is based on the manufacturer's technical documents issued by him and he shall be the only liable person regarding its contents.
It describes all the functions of the equipment and explains how the operator shall proceed at each stage of the regeneration process in order to preserve the user's safety as well as the normal use of the equipment.

CAUTION: one shall read carefully this manual before starting up the equipment. Specific attention shall be drawn on the safety requirements during the regeneration process as well as for the batteries manipulation.
KEEP THESE INSTRUCTIONS. THIS MANUAL CONTAINS IMPORTANT INSTRUCTIONS SAFETY AND OPERATION

This product has been manufactured in accordance with high quality norms and comply with the CE.

The treatment method is based on advanced technology developed to help find the capabilities of lead batteries by electrochemical process. This will extend their life and improve their efficiency while reducing their cost of ownership. The method is used only for so-called lead batteries with liquid electrolyte, AGM and gel.

CAUTION: This unit is designed to regenerate the batteries ONLY LEAD type. It is not designed for other types of batteries such as those using metals other than lead OTHER TYPES OF BATTERIES OR ACCUMULATERS MAY BURST OR CAUSE INJURY AND / OR SERIOUS INJURY.

As everyone knows, battery capacity is decreasing yearly, and after a few years it almost remains only 25% of the original characteristics.

During normal discharge of the battery, one can observe that oxides, lead sulphate crystals and water emerge. Usually those components are recovering their original stage (i.e. lead and sulphuric acid) once the battery is charged again. From the very first battery charge, lead sulphate crystal are emerging slowly and growing constantly. Those crystals are the main cause of the battery failure. All active agents within the battery are then solid and the electrochemical reaction can not work properly, thus reducing the electricity generation.

During charging process, a battery on which oxide and lead sulphate appear on the electrodes, may get overheated. Electrodes may then weaken and some micro parts of those may drop on the bottom of the battery rack.

The BRT 10 process is removing lead sulphate crystals on the electrodes. During regeneration process, lead parts return on the electrode dedicated surface. Electrodes get then covered with micro lead balls enlarging the electrode surface and then easing the charge.

Not only extending the battery life span, the regeneration process has also a positive impact on the battery lift carrier with direct impact on its productivity.

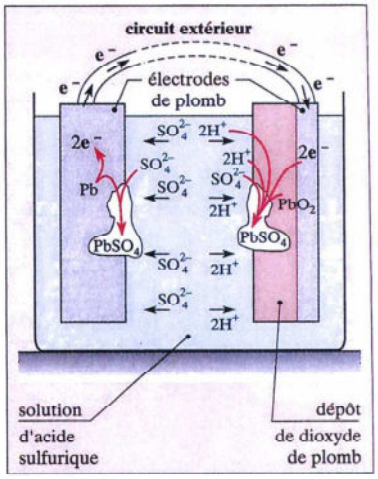
The benefit of a battery treated with BRT 10 regenerator may be better than that of untreated new battery.

Not only this regeneration extends the life of the battery, but it also has a positive effect on vehicle performance.

BATTERY DISCHARGE

During normal discharge process, electrodes generate on both side lead sulphating process.
(White liquid).

Along cycles, this liquid will slowly turn to a solid crystal form.
This emerging crystal will spread over the cycles and generate a capacity decrease of the battery.



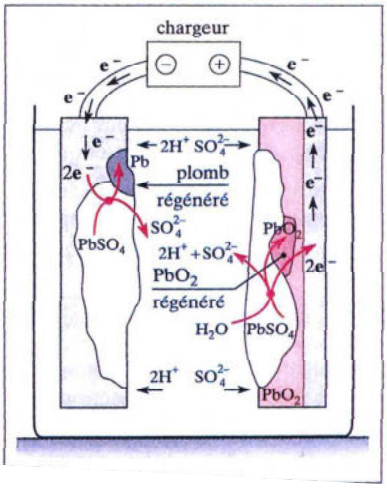
9. *Circulation des porteurs de charge (⟶) et réactions électrochimiques (⟶) lors du fonctionnement d'un accumulateur au plomb.*

CHARGING BATTERIES

When charging, the lead sulphation (white liquid) will split and reload electrodes and electolyte.

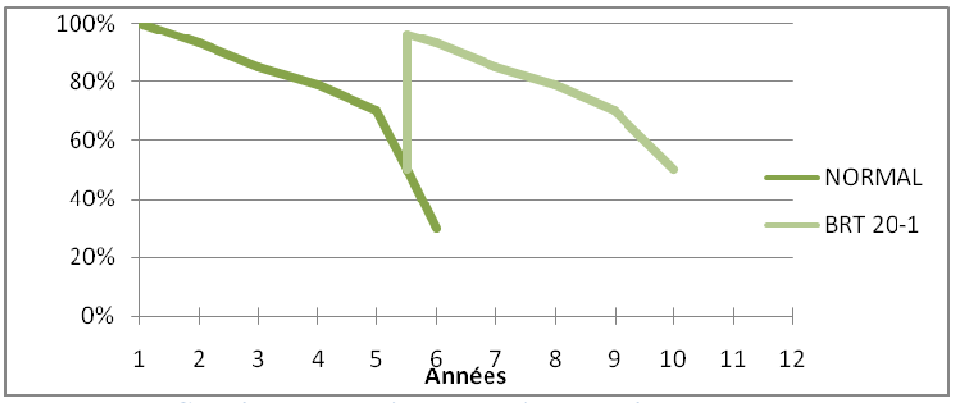
Once the lead sulphate is solid, the classic chargers can not reload electrodes and electrolyte.
Active agents turn to crystal and will be off the normal path, weakening the battery capacity.

This loss of capacity leads to the over charging for batteries so-called traction, which is self aggravating because it promotes crystallization.
Regeneration process removes the lead crystal sulphate for a total

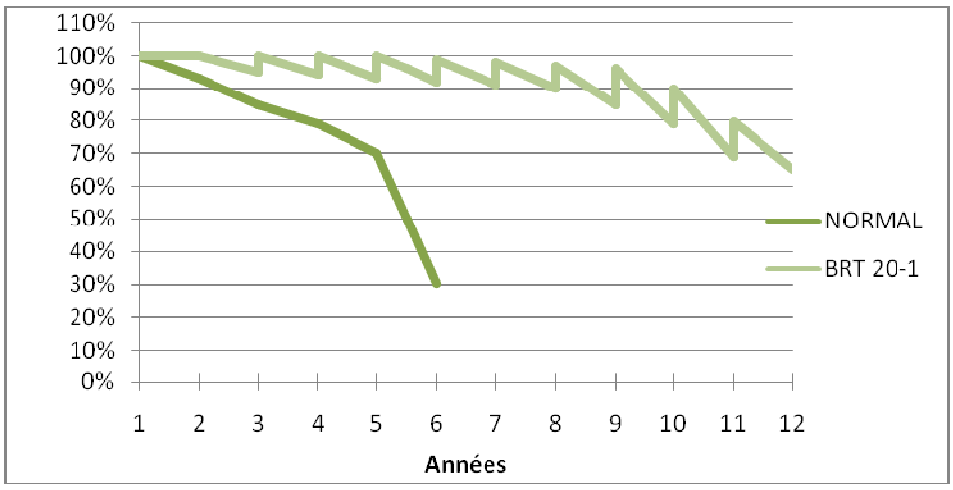


battery capacity recovery.

Regeneration can be conducted on a curative way after several years or on a preventive way once a year. Prevention allows to keep the total battery capacity during the full life of the forklift, preventing some electric failure to occur due to crystals growth and plaque distorsion.
Preventive regeneration process is conducted over short cycles whereas curative regeneration may take



Curative regeneration on traction batteries



Preventive regeneration (once a year)

II. Safety requirements and general precaution

2.1 Removing the BRT and control the machine

The BRT 10 is delivered strapped and wedged on a EUROPE type pallet with side extension

Particular attention will be paid at the time of unpacking the device to avoid to suffer from shock.

The device must not be connected to the power supply if it presents a clear and visible defects such as:

- Significant shock trace on the cowling of the machine
- Display of the broken control board
- Cable / outlet / damaged or frayed supply power
- Connecting cord severed or damaged batteries
- Terminals or connectors loose or visibly damaged.

The unit weight more than 45kg.
We must therefore take all necessary precautions to handle safely for the staff and for the working environment:

- Danger of falling
- Risk of serious injury

2.2 Equipment installation

The regenerator will be exclusively used inside and placed in a clean, dry location. If used outdoors, it must be placed in a dry and sheltered area during the regeneration process. There should not be any liquid near the regenerator and the battery. Ensure to remove any leftovers of distilled water on the floor after the refilling .

CAUTION: DO NOT EXPOSE THE UNIT TO RAIN

Settle down the machine in a well-ventilated area in accordance with the provisions on batteries charging. See the necessary steps according to the requirements of EN NFC15-100 and other regulations on safety.

Place the machine on a stable level ground. By putting the regenerator into place, be sure to have easy access to power supply and to connections on side batteries. If necessary, the wall power supply must be easily accessible in order to disconnect the power of the sector.

Place the regenerator as far as possible to the battery.
Prevent the regenerator comes into contact with acid of the battery.

2.3 General precautions

No work shall be performed on the regenerator without making sure, beforehand, to fully understand its operation.

To ensure the safety of people and machines, ensure compliance with the following provisions:

Before you start using the regenerator, a complete reading of this manual and its perfect understanding are needed.

N.B. : Some components of the regenerator are at a voltage of 230 V whose contact can be fatal.

The maintenance and repair that are not described in this manual may only be performed by qualified trained personnel form conductor.

The maintenance and repair described in this manual must be performed by a qualified electrician and trained in electrical hazards.

The operator can perform the work steps described in this manual.

Do not do any work without having the necessary traineeship.

Do not use the regenerator if it needs to be repairs or adjustments.

During repair and maintenance work, always use the manufacturer's specifications when ordering spare parts or usury.

The unit can not be any adaptation or modification.

2.4 Connecting units

For the set up please refer to chapter 4-2.

The regenerator shall only be connected to an approved dedicated plug in accordance with required voltage with appropriate power.

Equipment requirements :

- 230 V AC + Ground
- **Differential electrical device 30mA.**
- 20A disjoncteur lent (Courbe D) type D20

This machine is equipped with a CEM filter requiring earth connection of 5mA. It is mandatory to connect this machine on a disruptor equipped with 300 mA differential (fire protection) or 500mA (machine protection on a dedicated connection).
A kind of protection of persons in 30mA workshop is sufficient.

The machine is equipped with a 30mA disruptor complying with the human body protection

Do not connect a dry OR frozen battery
Any metallic item is banned within the battery environment.

Check cables sector and ensure that they are intact. If not, contact with wires involves a danger of death, these being at a voltage of 230 V. Do not plug in or turn on the regenerator before you replace the cable.

Before connecting the battery to the regenerator, ensure that it is not powered. No indication should appear on the display.

The following steps must be followed:

- First, connect the battery
- Then the temperature sensor.
- Finally, connect the power cable.

Do not start up the BRT if the regenerator cables + (red) and - (black or blue) are not connected to a battery.

Do not connect battery cables to the regenerator unless they are already connected to the battery
Ensure not to cover the air vents on the sides and rear of the regenerator!

Always unplug the battery cables from the regenerator's side first before switching to another device or disconnecting the cables from the battery.

To disconnect the batteries, simply remove the connecting plug on the regenerator.

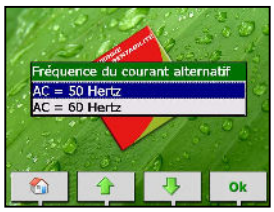
DANGER: ELECTRICAL HAZARD SHOCK.
DO NOT TOUCH NOT ISOLATED OUTPUT CONNECTOR OR NOT ISOLATED TERMINALS OF THE BATTERY

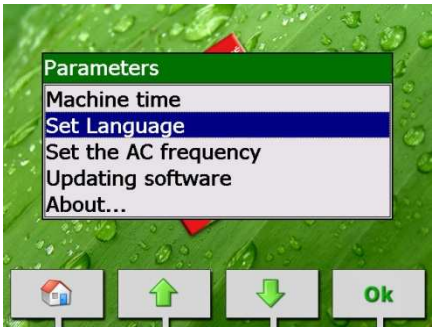
Once connected wait a few seconds
before the main screen appears.

Parameter :

In the parameters menu you have access to :

- Total running time of the BRT
- Change the language of the menu
- Set the alternating current (50/60 Hz)
- Setting the Date and Time
- Update the software with via USB port
- Serial n° of the processor card appears in the menu "About"





2.5 Airvent in the workshop

Smoking is prohibited
Sparks are banned (welding, grinding, etc.)

During regeneration and normal charging, oxy hydrogen gas is generated!

WARNING / RISK OF EXPLOSIVE MIXED GAS

During the BRT process the explosive gas formation is reduced as constant current applies only during 5% of the total cycle. Anyhow flame and spark should be avoided.

Ensure good air ventilation , in accordance with the formal standards in effect.

DO NOT OPERATE THE CHARGER IN A CLOSED SPACE AND / OR DO NOT HINDER THE BREAKDOWN

The workshop must be largely ventilated.

2.6 Required equipement and security

BEWARE :

1- Beware; it is dangerous to work close to lead acid batteries. When in tension, explosive gases are produced by the battery. Reading the service manual and referring to it all the time is then mandatory.
2- To reduce explosive risks, one must refer to the present manual but also to the instruction manual from the battery manufacturer or any other manual referring to equipments used closed to a battery. Make sure you've read the caution stickers and warnings.
3- Do not use the BRT if connecting cables are damaged. Replace the cables before using the machine again.
4- If BRT is damaged for any reason, do not use it. Call the manufacturer, ask him for advice, or for repair.

PRÉCAUTIONS GENERALES DE SÉCURITÉ :

1- Make sure someone is not too far away from you when working on a lead acid battery. This person could assist you in case of problem. In general, avoid being alone when working on lead acid battery.

2- Make sure you have a eye cleaning kit, water and soap close to you, in case your skin, clothes or eyes get in contact with acid.
3- Make sure to wear glasses and appropriate clothes to work on batteries. Do not touch your eyes while working on batteries.
4- If your skin or clothes get in contact with acid make sure to clean immediately with clear water and soap. If acid get into your eyes, rinse them with clean water for about 10 minutes and contact your closest medical care centre.
5- Do not smoke or generate sparks or flames close to batteries and BRT.
6- Be very careful not to drop any metallic tools on a battery. A spark, short circuit or any other electric hazard on a battery may involve an explosion.
7- Remove your rings, chains, bracelets, watch, or any other metallic jewel or equipment you may wear when you are working on a lead acid battery. A short circuit on a battery may generate high temperature involving metal melting and severe burns.

BEFORE STARTING REGENERATION:

1- Make sure you are operating the equipment in a place where air is circulating.
2- Clean up the main contacts of the battery as explained here after. Beware that corrosion dust doesn't get in contact with your eyes or skin.
3- Make a visual check of the battery. If cracks, rack or top damages, mechanical damages, do not use the BRT.

2.6.1 Regeneration equipment

The operator must always have the following equipment at his disposal: Acid tester, ammeter, temperature gauge for batteries, connectors and discharger / analyzer equipment.
Tools shall all be electric proofed.
The acid tester is a standard measuring device.

The multimeter must be able to measure DC voltages browsing with measurement times of less than 100ms, and this in order to measure voltages when passing in the pulsation on regeneration phase.

One can use a normal glass temperature gauge with a scale up to 65°C. Specific device dedicated to the batteries can be found on the market. An infra red temp gauge can also be used.
In order to ease the connection of different battery types, one can use intermediary cables with the most commonly used connectors you can find on forklift or the other device using traction batteries.

2.6.2 Staff safety equipment

The premises shall be a restricted area where only authorized and qualified staff is allowed.

All norms concerning electric, acid and fire risk shall be respected and implemented.

Les normes en matière de sécurité vis à vis des risques électriques, risques acides et risques incendies seront respectées.

The operator shall comply with the domestic risk management involved in the regeneration arena, as well as in terms of health and care, in case several activities are processed in the same premises or in the immediate surroundings.

The staff involved in battery regeneration shall have and wear the relevant protection and equipment to proceed.

Necklace, bracelets, watches, metallic glasses shall be banned from the regeneration workshop as they may get in contact with any electric devices and generate risk for the persons and the environment.

Recommended equipments are :

- Acid resistant gloves ;
- Acid resistant overalls ;
- Safety face cover or safety glasses ;
- Eyes cleansing, extinguisher, absorption equipment etc.…

Any specific safety operation rules within the premises where the regenerator is used shall be set up by the operator's management according to his own risk management.

III. Regeneration process

3.1 Preparatory phase and starting

Place the safety switch in the 0 position before handling the batteries.

3.1.1 Battery preparation

All work on the battery shall be done while it is disconnected.

While working, one should always wear safety clothes, gloves and glasses or face shield.

Battery should be cleaned and dried. Dust and liquid shall be removed from the upper part of the battery to avoid arcs or any hazardous electricity flow.

This phase is very important for the continuation of regeneration and also for the measurement of this work.

Clean the positive and negative poles of the battery by means of a hard brush-haired non-metallic or a tool designed specifically for that purpose so as to avoid any risk of short-circuit.

Examine the battery to detect any electrical or mechanical defects.

From qualification to the return to service, everything has to be thought of at a ergonomic workshop guaranteeing a simple, secure, and efficient for maximum efficiency to work.

Indeed contrary to traction batteries, the low cost of starting batteries requires a volume of logic in the treatment process.

Pre-selection

Preliminary capacity test to make a pre sorting out:
Detect short circuits (voltage below 10v);
Detect failures (collapse at start of test);
Check the physical integrity of the battery.
For this phase it is advisable to use a needle tester which is more telling than an analog tester

DO NOT REGENERATE WITH A BATTERY WHICH VOLTAGE IS LESS THAN 12VOLTS AND WHO DOES NOT PASS THE PRE QUALIFICATION TEST (COLLAPSE OF THE NEEDLE DURING THE TEST)

During pulsation phase process with BRT, voltage can be checked on each cell, the weakest one will then be identified easily (see later).

If any of the above mentioned is noticed, the breakdowns shall be solved before starting the regeneration process, as it cannot be regenerated. It can be repaired by replacing the faulty cell before starting up the regeneration process.

On a battery showing short circuit failure, to proceed to regeneration may endanger the operator as high risk of explosion may occur.

3.1.2 Control and battery cells measurement

An initial test on each cell shall be conducted. All measures shall be collected on the "Regeneration Test" record sheet (see appendices).
As a global rule, cells will be counted from 1 to …in ascending order, starting from the + connector.

a) Cell voltage

Measure the battery voltage using a multimeter, one battery at a time. Start with the positive pole + of the battery line and then move towards the negative - side following the serial connections.
Always proceed in the same manner.

Push the ends of good multimeter with lead terminals of the battery. Specify the values on the form "regeneration test". Indicate the different voltages in the "Volt" column. Ensure register the correct value for each battery on the form.

All measures shall be recorded at a standard temperature of 30 °C.
Above 30°C operator should decrease voltage by 0,005 Volt every degree exceeding 30° C.
The greater the temperature the higher voltage is showed on multimeter. Should be corrected to bring them to 30 ° C

Ex: Voltage red at 42° C ➔ V= 2,18V
After correction to adjust at 30°C ➔ V=2,12V

b) Electrolyte density in the Cell

At an average temperature, electrolyte density should be between 1,10 et 1,28. The highest acceptable level in a new good condition battery is 1,28.

Check the electrolyte density in each cell with the densitometer. Remove the covers and dip the densitometer in the cell. Only pick up the liquid which is in the cell. Close the cover of the cell after each measurement. Proceed according to the same sequence you did to record the cell voltage.

Record the collected values in the « Density » section of the « Regeneration Test » worksheet. Report the exact value collected on the worksheet.

In the case of maintenance-free batteries it is possible to nevertheless access to the electrolyte by piercing the upper cowling

CAUTION this process should only be performed by experienced personnel.
Risk of short circuit and explosion.

All measures shall be recorded at a standard temperature of 30 °C.
Above 30 °C operator should increase density by +0,0007 every degree exceeding 30° C.
The greater the temperature the lower the density is showed on densitometer.

Ex: Density at 45° C ➔ 1,175
Density after correction adjusted to 30° C➔ 1,185

Toutes les mesures doivent se reporter au référentiel de température standard de 30° C.
Au dessus de 30° C, augmenter la densité lue de +0,0007 par degrés au dessus de 30°C.
When the temperature increases, the bulk density decreases. It should be corrected to bring it to 30 ° C.

Ex: Density at 45° C ➔ 1,175
Density after correction adjusted to 30° C➔ 1,185

3.1.3 Electrolyte level control

Once electric and density test completed, it is sometime necessary to refill the level of water in the cells (≈ 1cm above the grid).

Never proceed to electrolyte measurement after refilling the cell with distilled water. Values would be false.

Check liquid level in each cell. Complete with distilled water in cells where the level is very low. (Check quantity on the battery manufacturer's instruction datasheet).
In most cases, the best level is 1 cm above the electrode plaques.

Do not connect a dry battery to the BRT.
Explosion risks are then greater.

Dry cells are filled with distilled water. Water may have evaporated and sulphuric acid turned into lead sulphate. However, all the active materials remain in the battery. Do not add acid unless there is no more density at all and the cell has suffered over flooding while being charge at the owners place.

Sometimes, no electric problem or short circuit can be found during the check up, however the regeneration process may have not effect on so called « disabled » cells.

It may occur in situation such as:

- When cells leak and operator keep on refilling it.
- Over refilled cell even though it was not required.

In both situation, sulphuric acid needed to generate current is spilled away and cell density is weakening.
In such a situation, the operator may proceed to complete the cell in adding acid for density recovery.

These operations can only be done by an experienced technician.
Acid risk.

Greatest care shall be taken to avoid acid contact with eyes and skin. If this shall happen, clean with still water and contact immediately the nearest medical care centre.

3.1.4 Battery(ies) connection to the BRT

Main switch should be on « 0 » (zero).

The BRT10 is designed for regenerating batteries in series line with a total voltage from 6volts at 48volts.

Example 4 batteries of 12volt in series will be in total 4x 12 = 48 volts.
In series, voltage is added.

First connect the cable + the + terminal of the first battery line.
Then connect the cable - the - terminal of the battery last of the line.
Then connect the batteries in series using jumper cables to the clips - the first battery to the + of the next.
Tighten the cables with an isolated wrench defined by the manufacturers recommended level of fastening torque (about 25Nm) or use quick suitable connectors.

Warning : When batteries are connected in series there is an addition of tensions. The maximum voltage must not exceed 48V (or 4 batteries 12v).
When connecting the batteries in series, the most attention will be paid for not to do by closing the loop and put the system in short circuit which represents a significant risk of explosion and fire.
In the case of multiple lines connected in parallel, short circuiting can be done from one line to the other!

The contacts must be clean and straightforward to avoid risk of overheating or sparks that would lead to the melting of the terminals and the risk of fire or explosion.

If one needs to connect several batteries at the same time, they must be in series as mentioned above. Only difference is that the + positive pole contact of the first battery is connected with the –negative pole contact of the second one. If more than two batteries the same connection will be done with the others.

If several batteries are connected at once, special attention shall be paid to the battery voltage which shall not exceed 48 volt. Batteries connected together shall have the same voltage and the same amperage. In order to get the best results, it would be great to connect batteries with the same background and sulphating state. (I.e. same tension on connectors).

The main switch of the BRT shall always be on ZERO.To reduce the risk we recommend a block procedure as follows:

Connection process :

Implementation and alignment of batteries on shelf, cart or pallet.

1- Connecting the extremity poles carefully to remove the 2-pins end of the cuircuit.
2- Bridging and connecting the batteries between them to finish the series.
3- Starting regenerator
4- Control of amperage on each line when line in parallel.

We recommend cleaning, labeling and measuring parameters of voltage and electrolyte density on an ergonomic position that will promote efficiency while minimizing handling batteries.
This can be done through a workshop including rolling trays with tank retention easy to move and a table for a ball handling batteries during their qualification.

Making treatment trays.

Starting in line and regeneration

The operation must be done according to the phases outlined before and with the most attention to avoid short circuits.
It must be done with a suitable connector (100A pliers or jump to truncated lead connector) to install while ensuring operator's safety.

ALL LINES IN PARALLEL MUST HAVE THE SAME TOTAL VOLTAGE.

When making battery lines it is important to:

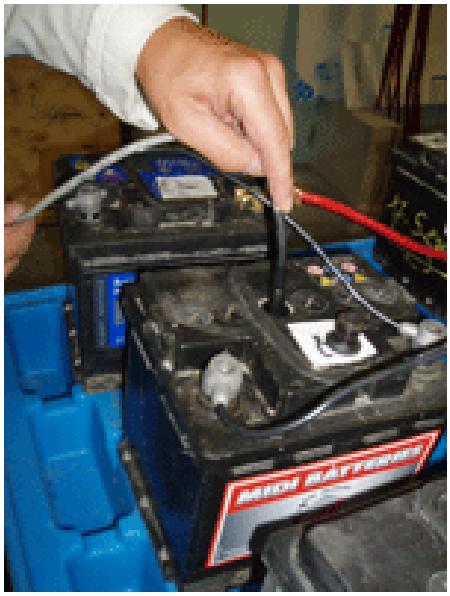
• Do not mix batteries of different families such as trucks with car batteries
• Compose the batteries in different lines to have an average capacity per equivalent line

Do not get in heterogeneous parallel lines because the lower will take charge the treatment depending on the stronger which will not be treated.

Making the connection carefully and then ensure that connections are stable.
If the contact is not perfect in the connections, it may produce sparks which is dangerous.

3.1.5 Temperature gauge connection and positionning

The socket for the cable of the temperature sensor is located in front of the regenerator.
Check that the sensor socket is switched on and its well-screwed fixing ring
By default, remove the cap from the middle of a cell of the battery and insert the temperature sensor in it. Press it down deeply, so that at least a third of sensor is located below the surface of the electrolyte. The temperature sensor can, without problems, make contact with the lead plates.



The temperature sensor is arranged in the electrolyte of the lowest battery and / or in the least cooled cell (cell in the center of the battery).

If one connects several batteries, the temperature sensor must be inserted in the battery having the lower voltage (a priori the most sulfated).

Connect the cable of the temperature sensor to the regenerator.

In general, preference will be given in the most sulfated battery (voltage and / or the lowest density) and the most in the center of the battery to be placed in the most unfavorable conditions in terms of cooling cell.

When regenerating several batteries at once, the gauge shall be placed in the cell of the weakest battery (ie the one with the highest sulphating level).

Connect the temperature gauge to the BRT.

As a global statement, temperature gauge shall always be placed in the most sulphated cell (i.e. lowest voltage or acid density) and also in the cell that will be the less air cooled (i.e. the one on the middle of the battery).

Anyhow, during the first stage of the regeneration process, a quick voltage test shall be conducted during the pulsation process which may help to identify a weak cell needing special care. Then the temperature gauge will be place in this cell. (Check Pulse charge - below).

3.1.6 Plug to the main power supply

Check first that the BRT main switch is on Zero.

Then plug in the main red plug on the mid right side of the BRT.

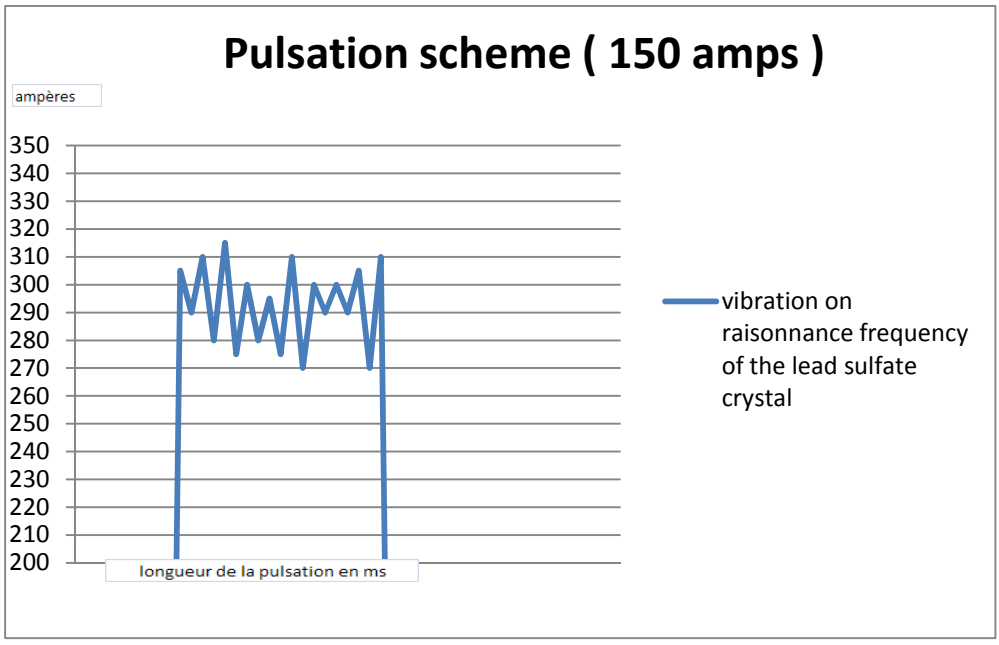
Lift the safety cover and connect the plug.

For details about general connection please report to chapter 2.3 connecting the equipment.

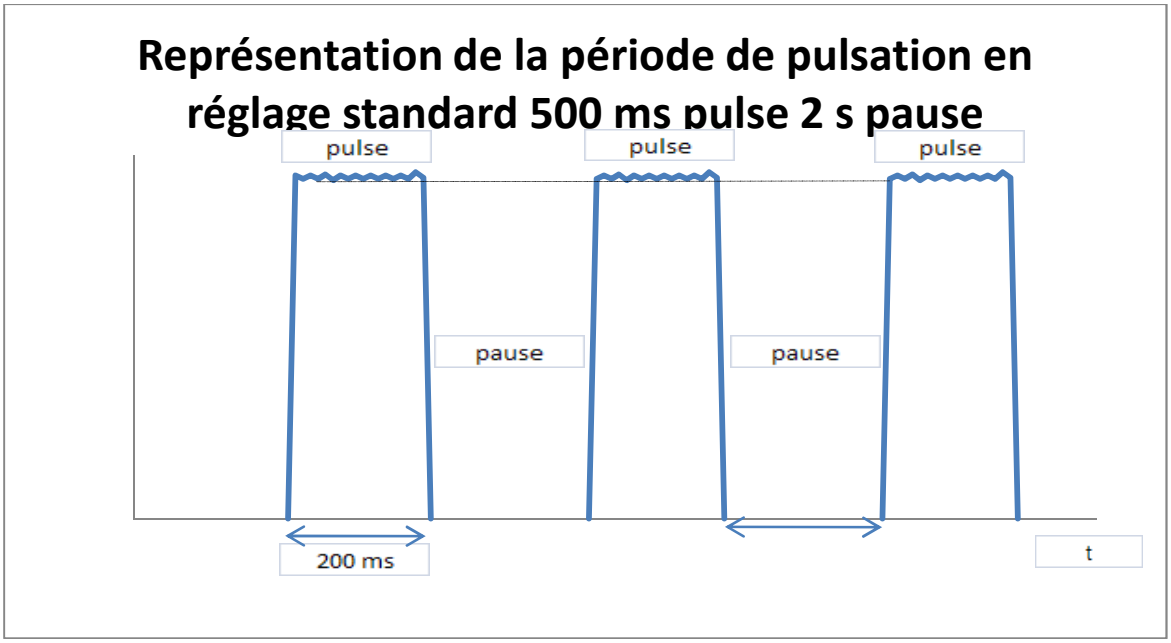
3.2 Starting up the regeneration process

Main purpose of the regeneration is to make sure that the active agents of the battery which turned into chrystal will return to their original liquid status.

To reach this point the BRT will proceed to pulsation sequences up to (50-150A) at the specific vibrating lead sulphate crystal frequency. Crystal will resound and vibration will erode it and turn it into liquid as it used to be. Along the process the plaques surface sulphation free will have greater chemical reaction withe the surounding elctrolyte, accelerating then the process.

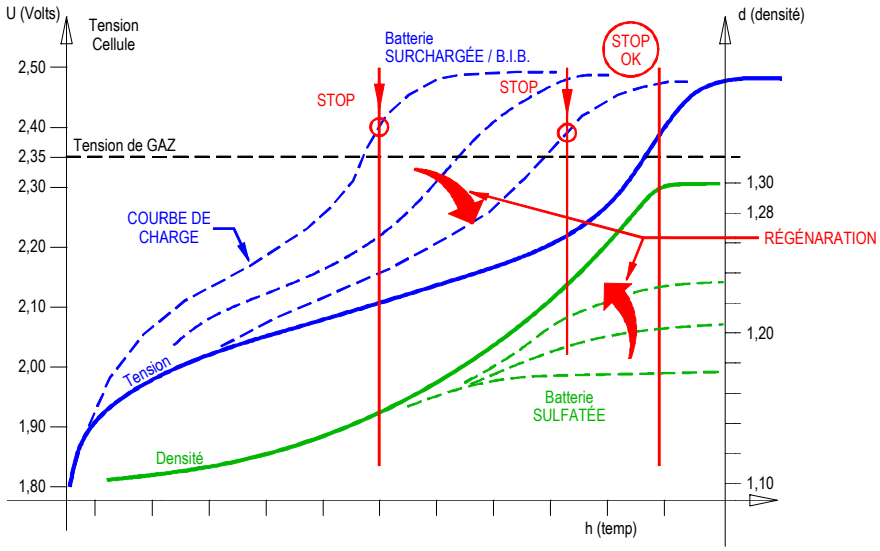


The pulsations sont séquencées (environ 200ms toutes les 3 secondes) afin d'éviter des fortes montées en température des éléments.



During the regeneration process, density is getting greater smoothly at the beginning and and increase dramatically when reaching the end of the process. Indeed at the end of the process the remains of the lead chrystal sulphate are changed to their original active element status.

The BRT 10 has safety device that will stop the process if some parameters are getting to high :



- Temp >55°C
- Voltage >2,4V per cell

The operators knowhow will then consist of reaching the best sulphation dissolution (ie no crystal remains) :

- Monitoring and mastering the temperature height
- Monitoring the voltage increase

When the High Voltage alarm appears (2,4v during pulsation and density over 1,28) that means the regeneration is almost over and the battery shall be tested on the discharger / analyzer BDX.

At a first step: turn the main switch of the BRT on the start position.

The menu of the regenerator is divided in 3 main applications:

Manual: Manual program

Automatic: Pre set program for traction batteries

Parameters : To access the parameters of the program in use

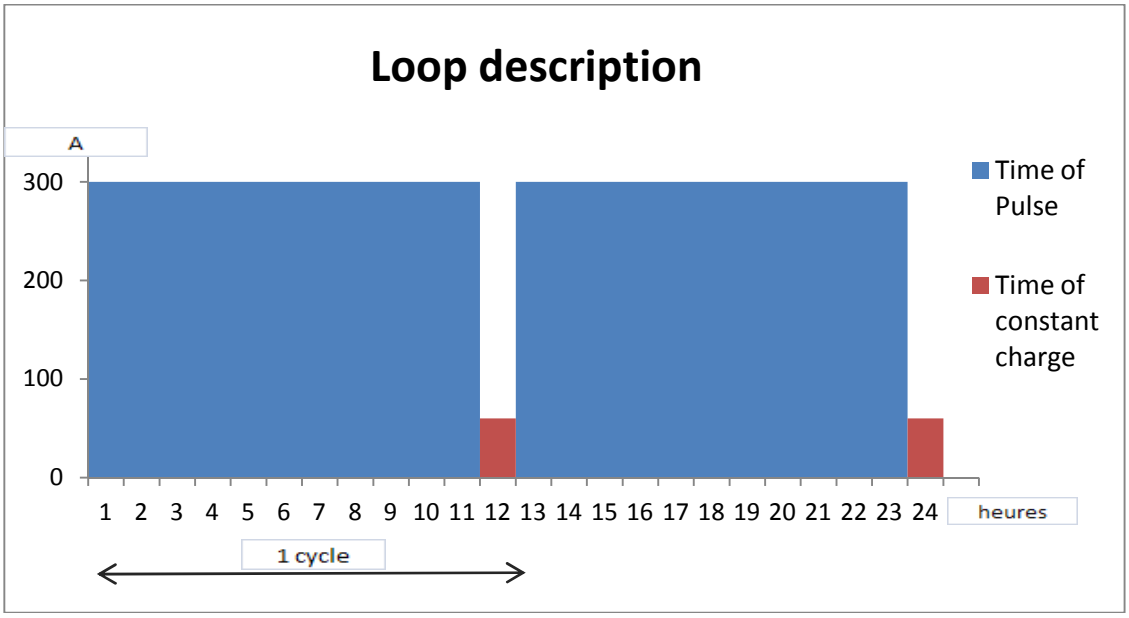
To select an application press « OK ».
Then you can select any values or choices pressing the arrows selectors.
To validate your choice once on the display screen press « OK »
and go to the next parameter.

3.2.1 MANUAL set up

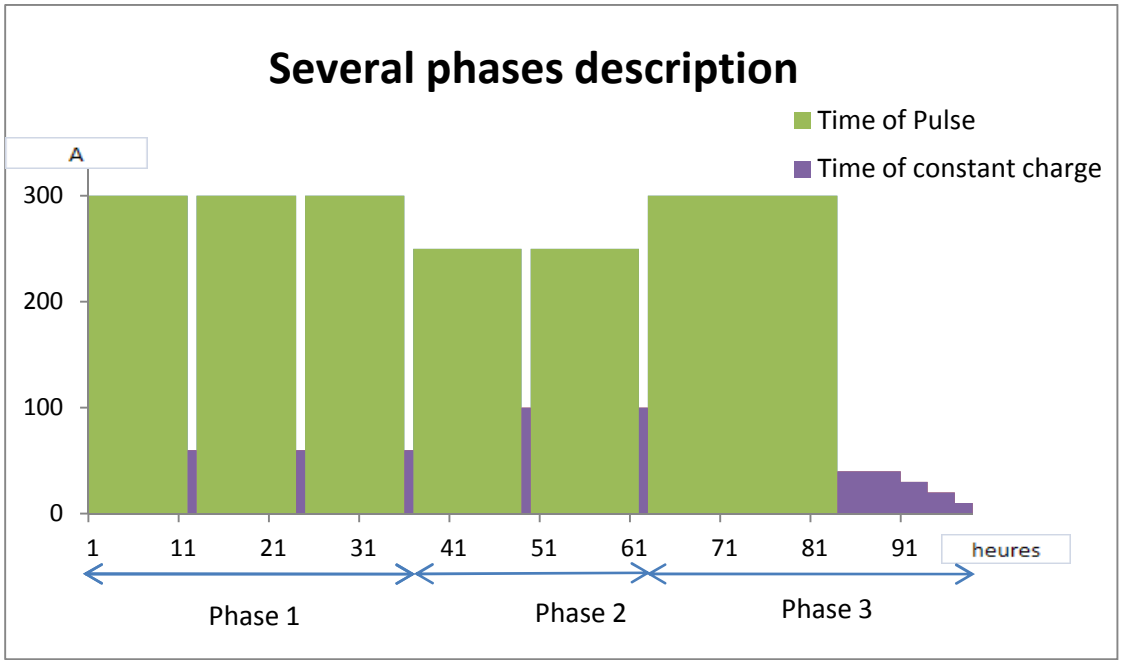
In this chapter we introduce the Manual set up which is the largest scope in terms of program possibilities. Later on, the Pre set section will be described too.

DEFINITIONS

One loop is a full period of time including pulsation period followed by a constant charge period.



A phase is a number of loops.



Manual program :

1

press « Select application », Go to Manual.

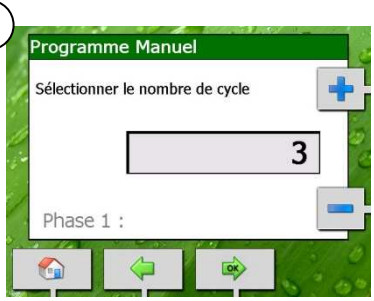
2

Set battery voltage

3

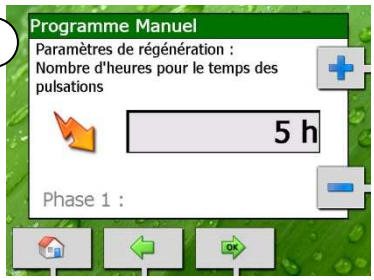
Set battery AH
Enter 0 if not mentionned

4



Set number of loop (1 to 50) One loop includes pulse and constant charge period

5

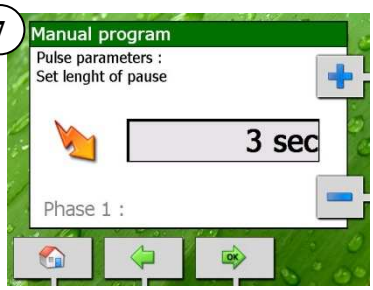


Set pulse duration (0 to 24 hours)

6

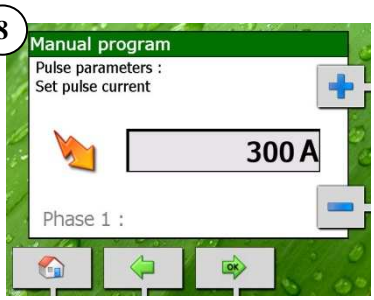
Set pulse lenght in milliseconds (80 to 500 ms)

7



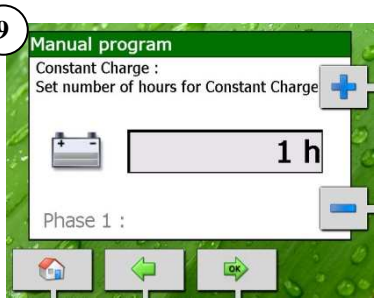
Set pause lenght (1 to 7 seconds)

8



Set pulse current in Amp (0 to 400 A)

9



Set constant charge duration (0 to 24 hours)

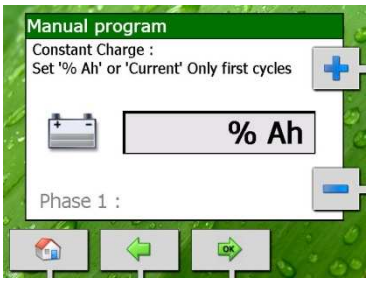
NB : : Standard current used for traction batteries is between 50 and 100A. Processing with a lower current, 25 A, allows to decrease the electric consumption of the BRT, to reduce the temperature picks risks, but it will required a greater number of loops.

ATTENTION TO RESPECT THE INTENSITY IN MANUAL MODE DEFINED IN AUTOMATIC PROGRAMS STORED IN THE MACHINE

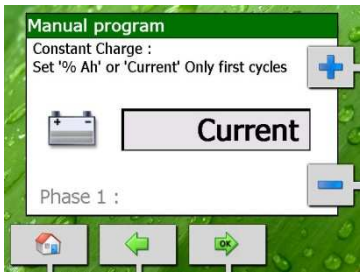
If pulses are too long cells may reach temperature highs. A good setting of pauses between the pulses will help mastering temperatures and current.

10

If battery Ah has been set previously, adjustment can be done either in % of capacity or a current fixed limit.

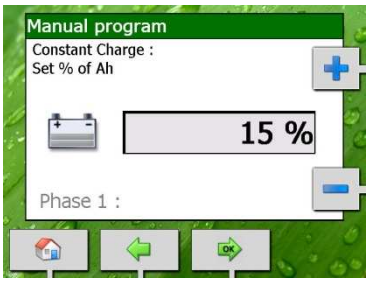


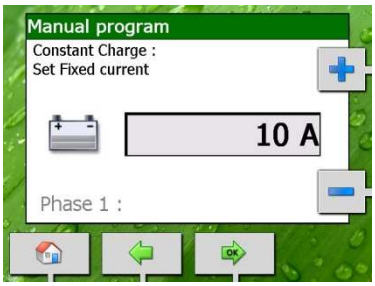
If **« % Ah »** is selected, constant charge current limit will be adjusted between 5% and 25% of the battery capacity.

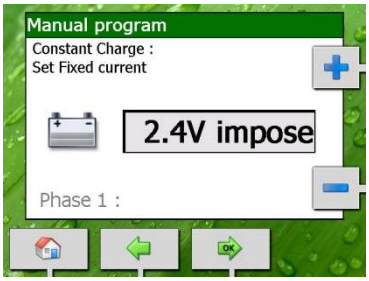


If **« Current »** is selected constant charge current shall be manually adjusted between 0 and 120 A or « 2.4V imposed ».
If « 2.4V imposed » is selected, charge will be done via equalisation of charge at 2.4 V per cell.

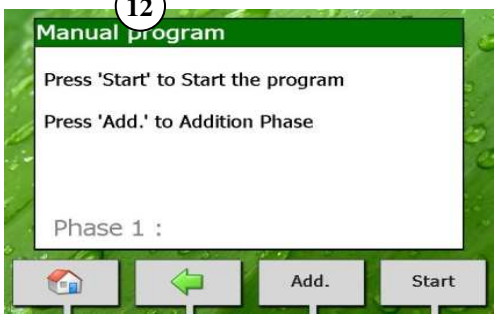
11







12

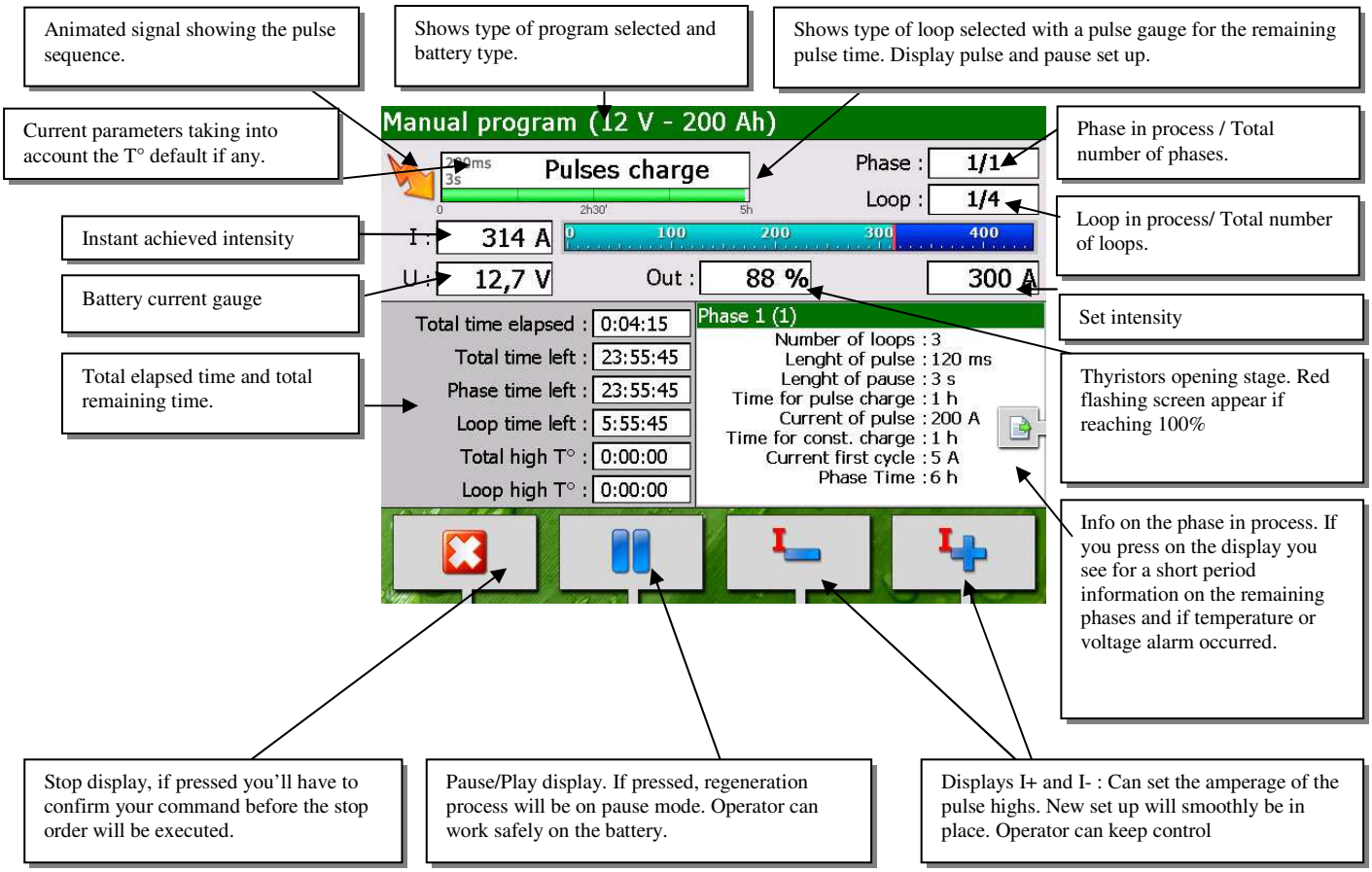


One or several phases can be added. Select « add ». If selected, setting will start again from the « set number of loops » section. 1 to 3 phases can be input. If no phases to be added, simply press « start » to initiate the process.

During the regeneration process, the operator shall control every day the water in the cells and adjust to the appropriate level.
This is to prevent any risk of deterioration due to the drying cells.

a) Charge by pulse

Regeneration by pulsation, screen display:



Pulse are set to increase intensity smoothly over 2 minutes to reach set level, in order not to damage the battery. 1 to 3 minutes may pass until pulses get stabilized sometimes.
One may notice some difference between pulses that may go from 10 to 20%. Those variations are normal and may be even greater at the beginning of the regeneration process during the first loop. Those variations disappear smoothly to reach the set value.

During the process, amperage of the pulse highs can be adjusted. One shall simultaneously press on « I+ or I– » buttons and on the upper right button. The new order will smoothly be executed over the two minutes onwards.
Caution: The modification will only apply to the loop on course and will resume the initial settings at the following loop.

This thyristors value shall remain between 50 and 98 %.

If you read 100% it is a failure alarm (report to chapter 4.5.4 hereafter).

After a few minutes of pulsation, once nominal amperage is stabilized, it is recommended to check voltage of each cell of the battery. Tension may reach 13 Volts + or – 2 volt PER BATTERY during normal pulsation.
If one battery's tension reaches 15 or 16 volts during pulsation, this comes from the following problems :

- ✓ Cell is more sulphated than the others ;
- ✓ Cell might have been short in water during its operation ;
- ✓ Cell is not the same quality as the other ones ;
- ✓ There is a possible short circuit.

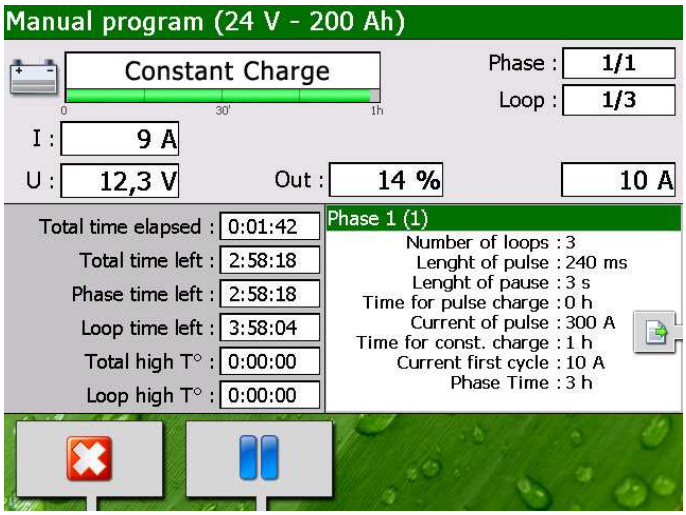
In this situation, the temperature gauge shall be placed in this cell as it may be more sensitive to high temperature. This will help to protect the battery and secure the process.

b) Constant charge process

Constant charge screen display :

Type of cycle in process, and gauge for the remaining constant charge time .

Animated signal showing the constant charge sequence.



If fixed current or AH % has been selected for the first cycle, screen displays the intensity in process; if « 2.4V imposed »has been selected, Max targeted charging intensity will be displayed.

When a regeneration phase includes several loops, the constant charge is as follows:

- At first, amperage is locked at a % of Ah current or at a preset value (see display 10 and 11 on previous pages), and this will last during a period of 30% of the number of total loops set.

This value shall be between 10 and 15% of the battery capacity in order to keep pressure on the current value pulsed in the battery..

- Then the amperage is set automatically by the BRT to reach 2.4 V per cell. Charge is then so called “free charge”. Constant charge is applied to the battery in order to proceed to equalization in each cell to reach 2.4 V per cell. Amperage is automatically set by the BRT upon the intra resistance of the battery at the end of the pulse loops, to reach 2.4 V. No manual setting can be done.

It is then very important to check that the number of set loops is sufficient to make sure that, when the BRT switches to free charge, imposed current shall not be too high.

For specific situation, when voltage is below 1,7 volts per cell, you should report to the specific procedures described later on in this service manual. Procedure shall be adapted whether the weakness is on one cell, several or all of them.

c) Automatic program

Automatic program:

Select « automatic program » from the main menu. Three programs are displayed :

- Traction battery program
- Starting battery program
- Stationary battery program

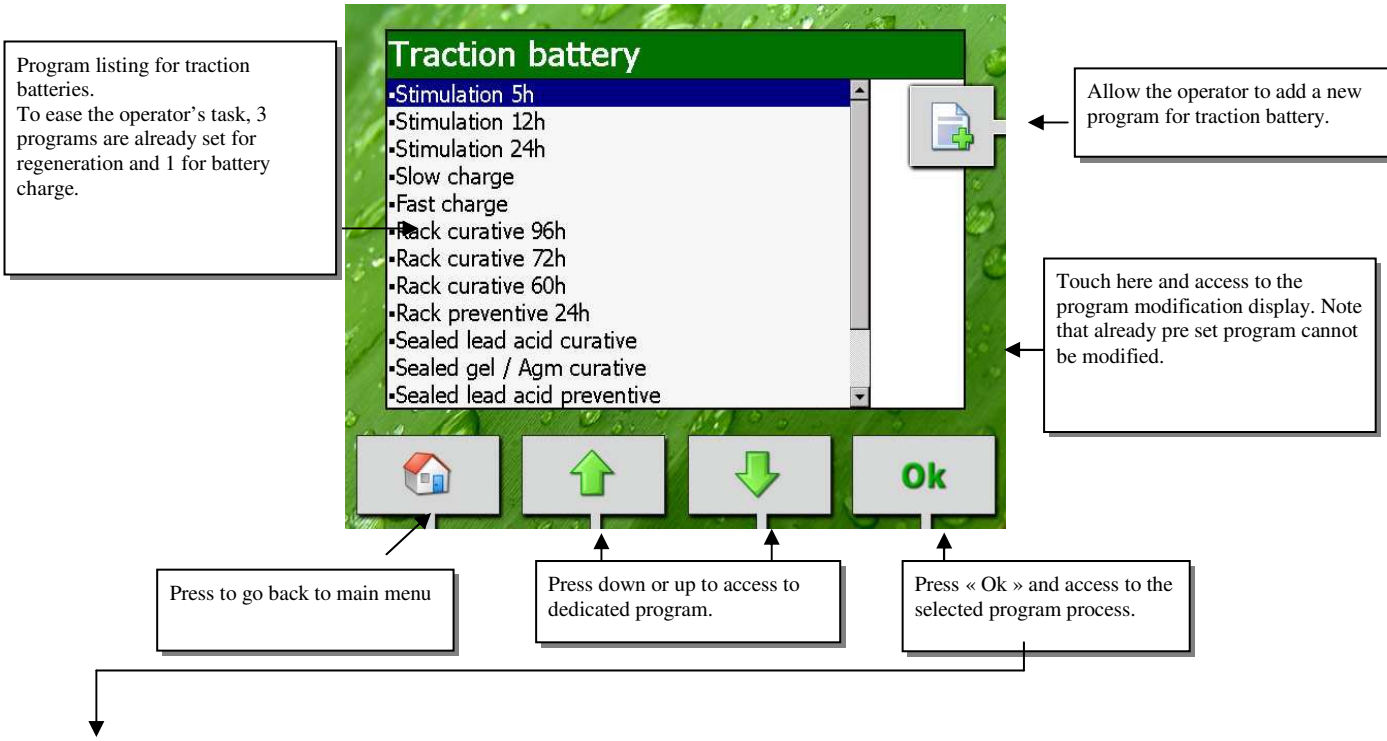
3.2.2 Automatic program for traction batteries

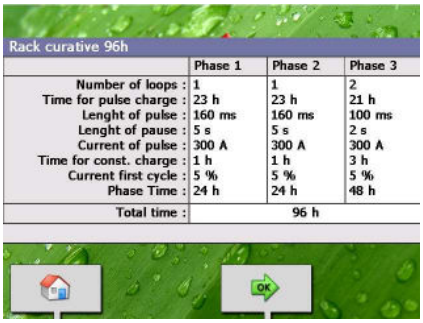
To ease the operators' procedure, the BRT has already some pre set programs ready to use.

You can access to those programs in the menu at the **« set application »** page.

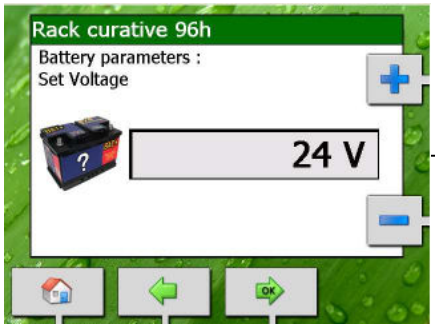
Several cases have been pre informed on the machine.

Traction battery program :

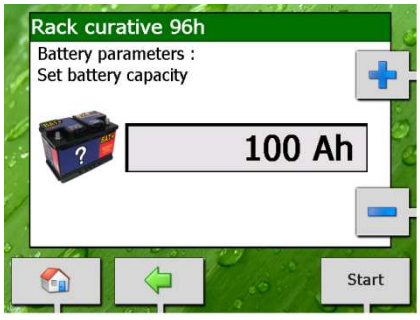




Settings

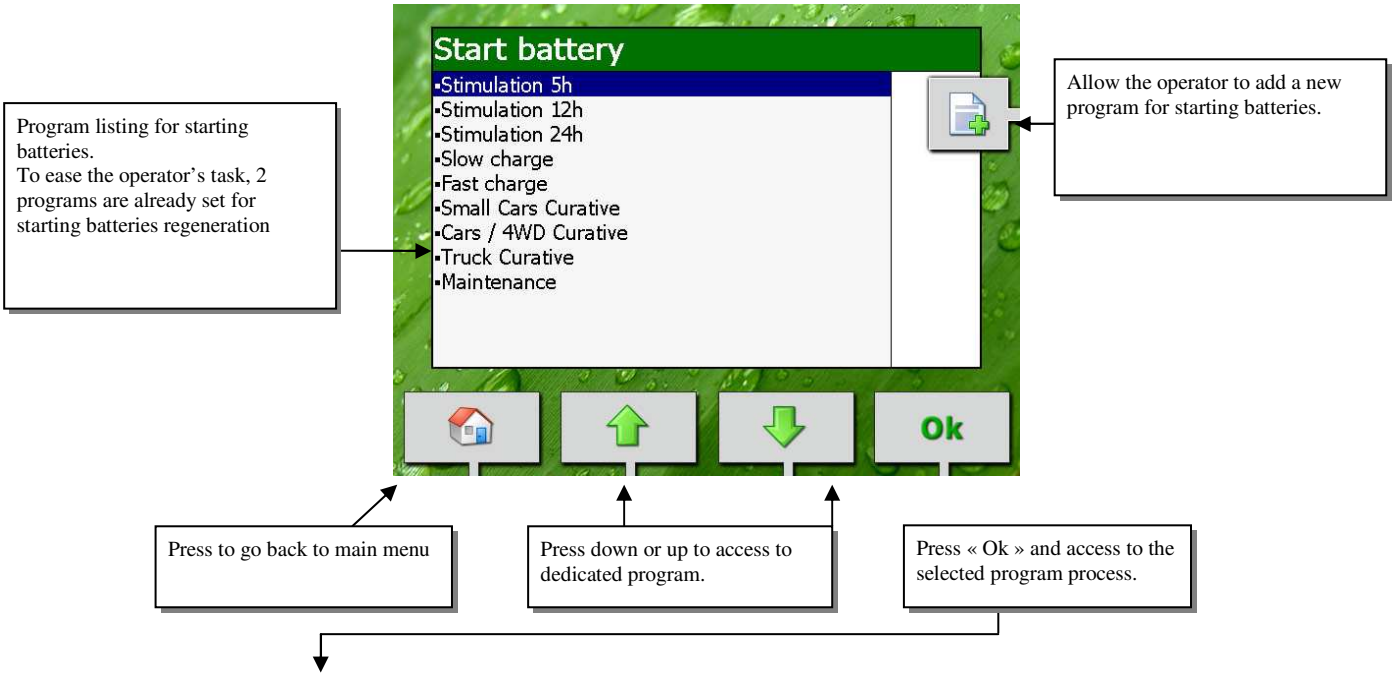


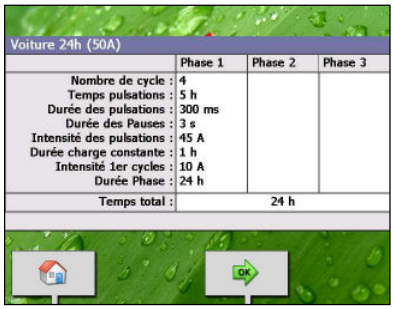
Set voltage of the battery



Set charge capacity of the battery then press « start » to proceed.

12 V starting batteries program :





Program settings

Set number of battery per line. This setting will determine the current to be processed which is not the total number of batteries.

Set the number of parallel lines. It is mandatory that all lines have the same global current. Press « start » when ready to proceed..

Batteries shall be gathered and regenerated within the same scope of capacity, current and age.
Do not mix car and Lorrie batteries.
All lines shall be balanced and with the same total voltage.

Check the current balance at the beginning of the regeneration phase.

Constant charge session starts and last for 10 minutes. This time frame shall be used to control the current balance on each line..
The current balance shall be balanced with a frame tolerance of 10 %.

If balance is not reached, press the stop button. Dispatch the batteries in a new order to reach the greatest balance. After 10 minutes, the auto program will start.

During the process, amperage of the pulse highs can be adjusted. One shall simultaneously press on « I+ or I– » buttons and on the upper right button. The new order will smoothly be executed over the two minutes onwards.

Qualification of the battery
The real capacity of the batteries can be measured with an analogical starting tester. The electrolyte density is considered good from 1,26 and up (i.e., a little lower than the traction batteries)

Dismantling the lines
After regeneration is over, lines should be dismantled. This operation shall be conducted with the greatest care to avoid short circuits as the batteries are now fully charged.

3.2.4 STATIONARY BATTERIES

Stationary batteries are constantly kept in floating charge.

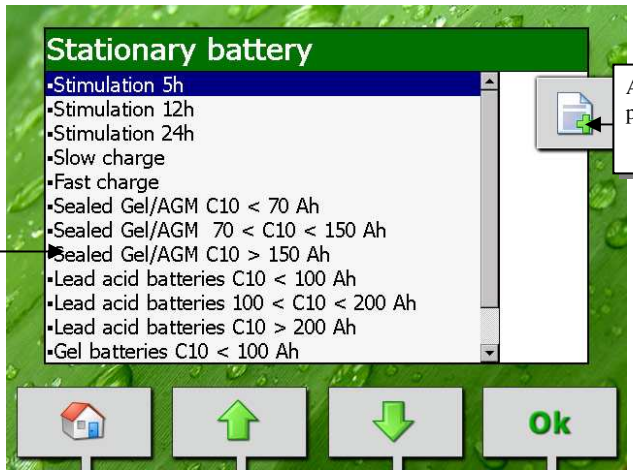
Thus, there are often always fully charged and must go on the discharger before being regenerated on the BRT.

The AGM monobloc or gel stationary batteries will be processed in series like as the starting batteries.

Considering the voltage memory effects that these batteries can present, it is often necessary to carry out preliminary discharge cycles.

The temperature sensor is fixed to battery side or sandwiched between two batteries in the case of a sealed battery (gel or AGM)

Stationary batteries program :



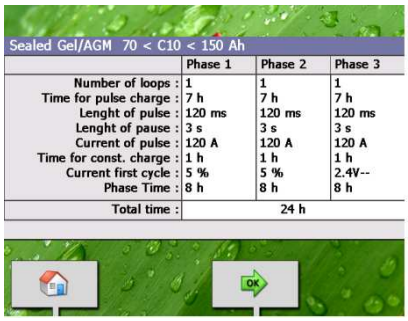
Program listing for starting batteries.
To ease the operator's task, 2 programs are already set for strating batteries regeneration

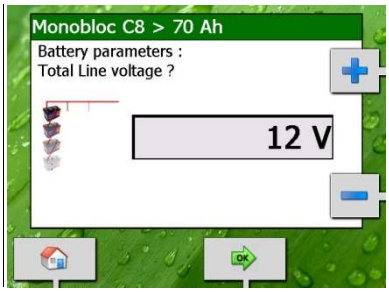
Allow the operator to add a new program for stationary batteries.

Press « Ok » and access to the selected program process.

Press to go back to main menu

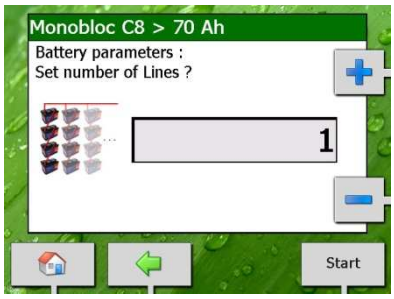
Press down or up to access to dedicated program.





Select global voltage of the line.

Select battery capacity



Set the number of parallel lines. It is mandatory that all lines have the same global current. Press « start » when ready to proceed.

During the process, amperage of the pulse highs can be adjusted. One shall simultaneously press on « I+ or I– » buttons and on the upper right button. The new order will smoothly be executed over the two minutes onwards.

After being regenerated, those batteries have to go on floating charge. Stabilization will be at 2.35V per cell, up to 0.5A residual flow.
Regeneration is adjusted in order to avoid quick increase of tension, meaning that at the end of the process the battery charge may not be completed.

TREATMENT PROCESS

- Reception of the battery and analysis (Shape of rack and connectors, voltage over or at the nominal value)
- Check and fill the cells with distilled water for lead batteries.
- Set up series line to discharge the batteries on 48v maximum voltage.
- Launch of possible discharges.
- Several parallel lines can be treated simultaneously. Check the current balance on each line setting up a short constant charge loop at 10A (Report to starting battery chapter)
- Set the requested standard loops.
- **CAUTION** for manual mode: IF YOU HAVE TWO LINES OF 48V IN PARALLEL AND YOU WANT TO TREAT THOSE AT 50A IN PULSATION, YOUR PROGRAM SHOULD BE ON 50 + 50 = 100A. Same calculation applies for constant charge to be set at twice the value of the requested treatment.
- Set up the floating charge stabilized at 0.5A and 2.34V per cell.
- Check on the discharger the results under C_1, C_3, C_8… as per the battery criteria.

Caution : When batteries are set in series, tension will be added. Maximum tension shall not exceed 48v (ie 4 batteries of 12v each), because that's the limit fuction of BRT10.

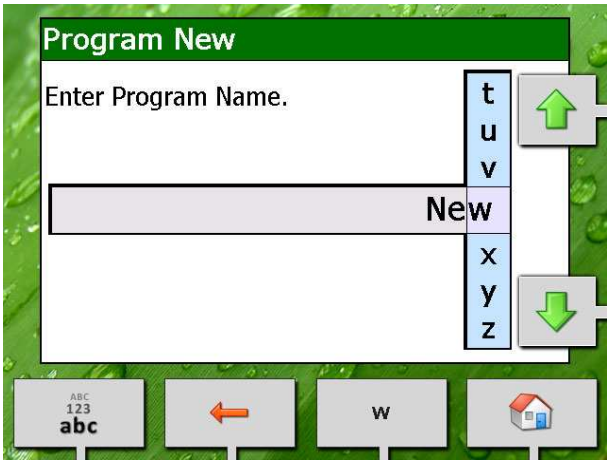
When connecting the batteries in series, take care not to close the pattern which may involve short circuits, thus explosion and fire risk may occur.

ISOLATED TOOLS SHALL BE USED BY THE OPERATOR AS PER STAFF SAFETY REGULATION

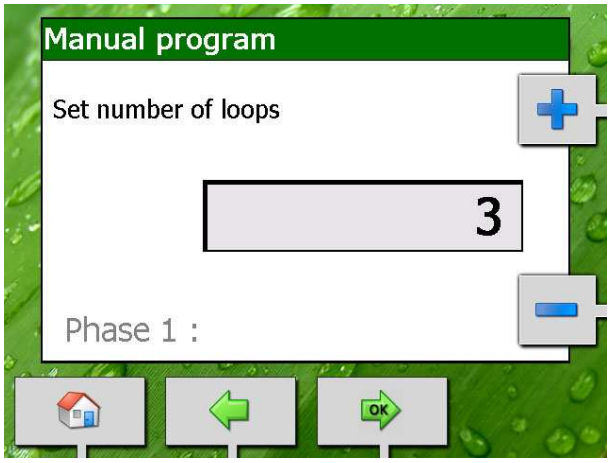
3.2.5 MODIFYING OR SETTING UP A NEW PROGRAM

Operator can set up and/or modify programs.

Add a new traction or starting battery program:



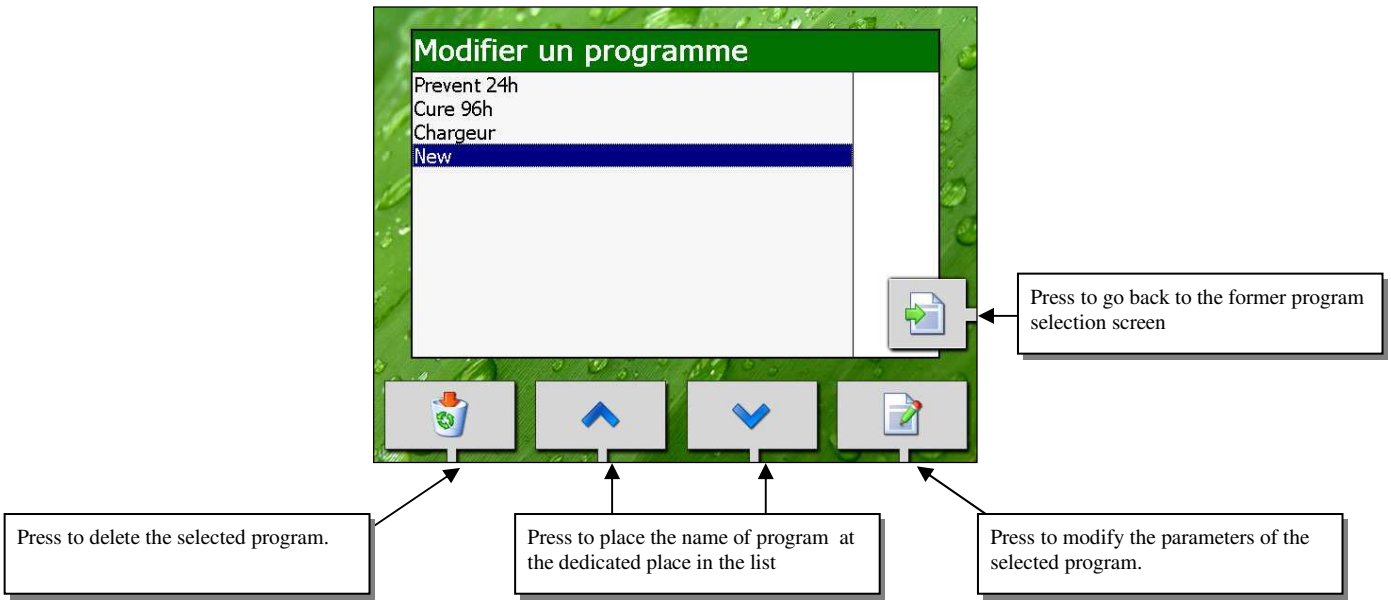
In the traction or starting program select then enter the name of the new program (minimum 3 letters)).



Once named, proceed to the parameters setting starting from the set number of loops phase 1.

Modify a program:

In the Traction or starting menu, select the program to be modified pressing the display, the following display will show up :



3.2.6 Normal charge

The BRT 10 can also be used as a normal charger. 3 phases maximum can be programmed.

ATTENTION : THE CHARGE CALLED CONSTANT CORRESPOND TO THE CONTINUOUS PULSATION AND NOT TO CONSTANT CURRENT!

Usually, one should check the battery capacity in Ah stamped on the battery.
A first phase will be set in order to reach the stabilization or equalization of the cell tension at 2,4 Volt : the so called « gas tension »
In the second phase the BRT will choose freely the current.

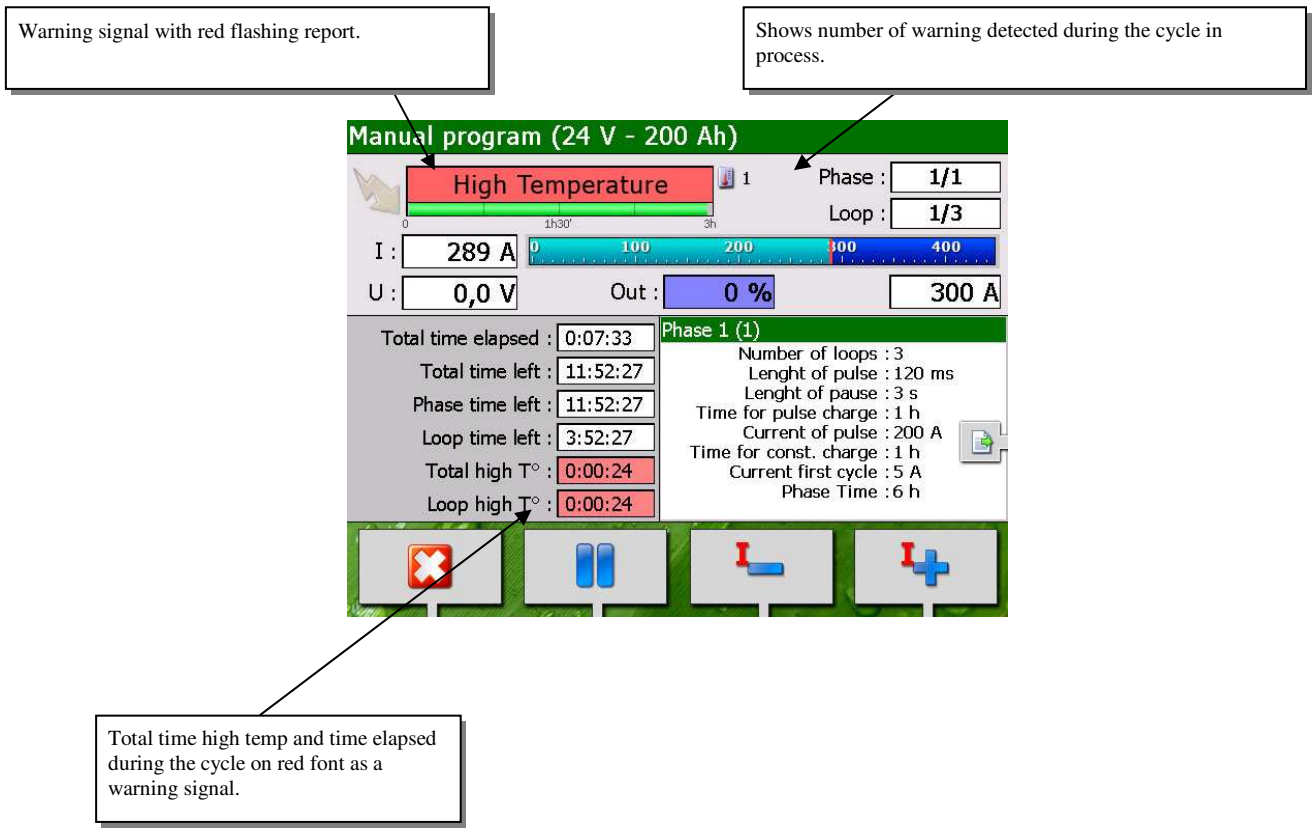
In phase 2, the amperage will slowly decrease automatically every 10 A till reaching 10 A which is the minimum maintenance charge level.
Charge will then be completed.

Caution: As "2.4 V impose" has been chosen during the 2nd phase, constant charge current will determined by the machine during the process to reach 2.4 V per cell.
If duration or amperage of the 1st phase are too low, set up current may by very high involving high temperature and even disruption of the main fuse in the machine.
Special care is mandatory in the choice of the battery capacity input.

3.3 Control and regeneration acknowledgment

3.3.1 High temperature

High temperature warning :



If battery temperature is getting to high (over 55°C), The BRT will stop automatically for 30 minutes, to allow the battery to cool down.

« High temperature » will appear on screen. Once the temperature recovers normal level, the BRT will resume the process. BRT will set the requested parameters automatically in order to reduce high temperature pics again. Parameters will be as follows:

- During pulse session: pulse length reduced by 20% automatically, down to 80ms if needed. Below this figure, then the pause length will be increased by 1 second.
- In imposed constant charge phase: Current will be decreased by 30% down to 10A minimum.
- During free charge: As self regulation in current will apply; only stops of the charge shall occur during the process.

AFTER 4TH STOP THE MACHINE WILL NOT RESUME PROCESS

It is very important not to stop the process of the BRT; operator shall leave the machine to run the full program.

Values will automatically be set as initially requested for the following loops.
Temperature may also be reduced by setting up manually parameters: reduce length of pulsation, increase the pause lap.

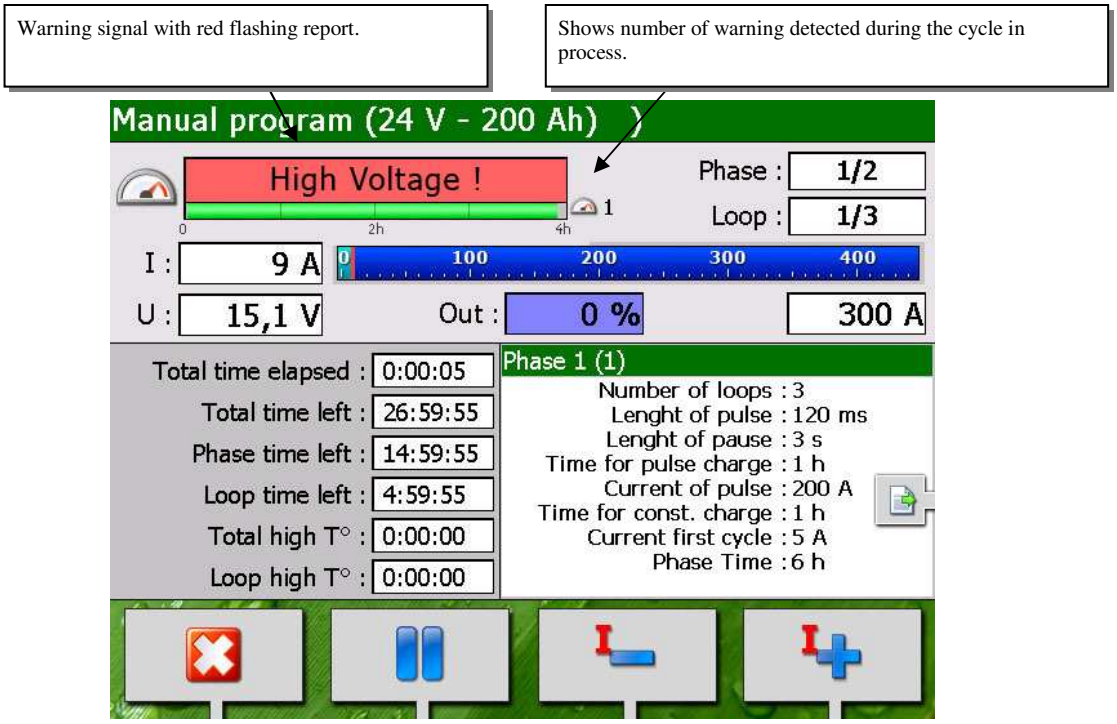
To keep temperature cool, air vent or cooling system shall be implemented.
When a temperature failure occurs, a temp gauge will be displayed on the screen.

Caution : Exceeding temperature may cause severe damages to the battery that may destroy it. It is important to check as follows that the temperature gauge is working well.

Once operator notice there is a rotten egg smell in the workshop, it means temperature reach 60 °C. At this stage battery produces Sulphuric hydrogen (H_2S). This gas is toxic and explodes.

3.3.2 « High voltage»

High voltage warning :



This warning appears when tension exceeds the maximum eligible tension (2, 4 Volts per cell), involving then gas production. This signal is a notice showing that regeneration process may be finished. Machine will then stop automatically for 10 minutes to get voltage decreased.

BRT will set the requested parameters automatically in order to reduce voltage in the battery. Parameters will be as follows:

- During pulse session: pulse length reduced by 20% automatically, down to 80ms if needed. Below this figure, then the pause length will be increased by 1 second.
- In imposed constant charge phase: Current will be decreased by 30% down to 10A minimum.
- During free charge: As self regulation in current will apply; only stops of the charge shall occur during the process.

AFTER 4TH STOP THE MACHINE WILL NOT RESUME PROCESS

That can also mean that a cell may be damaged. Some lead particles may then be floating in the cell generating short circuits.
If so, operator will notice an excess of tension in the other cells and current will increase. Sometime the damage cell may produce gas and some noise will come out from this cell.
To cure this, check that all other cells are in good state taking tension measures during constant charge and looking for high voltage. It is recommended to regularly check cell tension during the regeneration process.

3.3.3 End of regeneration loops

When regeneration is over, « finished » appears on the screen. Operator should check the battery and upon result it should be decided whether a new phase is needed or not.

During constant charge, Regeneration will stop if the BRT notice that the battery global tension doesn't need more charge. « STOP High voltage » appears on the screen (report to previous chapter).
Operator will give a quick check on the battery.

3.3.4 Control on the discharger analyzer for acknowledgment

Mainly for traction batteries, the discharging test is mandatory to validate the C5 (5hours test).
This is part of the final quality control of the whole process.

For other batteries operator shall refer to manufacturers charts.

Stationary batteries are usually tested in the C_1, C_3 or C_8 table charts.

Discharging test shall also be adapted to the use of the battery the owner is supposed to do.

For Traction batteries :

The five hours test shall be conducted :
This is an international chart requesting that battery should hold a discharge during 5 hours with a discharged down limit of 1.7 Volt per cell.

As a statement, because we are working on used batteries, test shall be conducted aver 5 hours at 80% of the nominal capacity of the battery.

If battery capacity is 150 Ah, the discharge shall be conducted as follows (150x80%)/5 = 24A.
Battery shall deliver 24A during 5 hours.
After 5 hours of discharge, the cut off voltage on each cell shall be over 1,7 V.
For a 48 V battery, it means 24 x 1,7 = 40,8 V.
A well regenerated battery would be qualified if it can hold 4,5 hours on the discharger. Indeed, once in operation again the battery will gain value after several charge cycles.

Operator shall take into account how the battery is operated by the client.

3.3.5 Regeneration control on electrolyte and voltage

In order to get correct values, measurements shall be conducted when the battery is disconnected, at least 30 minutes after the regeneration process is over.

Tension on connectors can be check during the pause along the regeneration process.

At the end of the regeneration process it is recommended to check tension and electrolyte density in each cell. Sometime it may be necessary to change some parameters of the BRT as the battery sulphation is reducing.

With the electrolyte, if the density fell below the standard level, it is required to add some distilled water in the cell.
Measure shall be conducted before adding the water; otherwise the density value will be false as dissolution of acid will occur when adding water. If operator misses this part, it would then be recommended to do a quick constant charge in order to mix electrolyte.

A battery which is not in a good shape will often loose steam during regeneration process. So it is important to check electrolyte level after the process..

All measurement shall be conducted or converts at the standard temperature: 30°C.

Above 30 °C operator should decrease voltage by 0,005 Volt every degree exceeding 30° C. The greater the temperature the higher voltage is showed on ammeter.

Ex: Voltage red at 42° C ➔ V= 2,18V
Tension corrigée à 30°C ➔ V=2,12V

Above 30 °C operator should increase density by 0,0007 every degree exceeding 30° C. The greater the temperature the lower the density is showed on densitometer.

Ex: Density at 45° C ➔ 1,175
Density after correction adjusted to 30° C➔ 1,185

At a usual continental temperature (20 °C), battery regeneration is over when the electrolyte density is between 1,27 and 1,3 per cell and when tension is between 2,1 et 2,3 volts per cell. Those values are reached almost everytime.

To check whether the battery is completed, those values are important but not enough, and the 5 hours discharge test shall be conducted. As a statement, because we are working on used batteries, test shall be conducted aver 5 hours at 80 % of the nominal capacity of the battery.

A well regenerated battery will be noticed when during the first two hours of discharge both tension and electrolyte density values are not changing. Every hour operator shall check global tension and cell tension. Doing this allow the operator to see if one cell is weaker than the other and can proceed to its removal and replacement.

If new regeneration is needed, then disconnect the cable from the discharge and connect it to the BRT for a new adapted regeneration process.

Record in the « regeneration test » worksheet the final value for the electrolyte density and the battery tension.

3.3.6 Disconnecting the battery

Before disconnecting the battery, the process shall be terminated and the BRT switch off on zero position.

If regeneration process is finished, main BRT switch will be on zero.

Remove the main cable connector from the BRT (Main PSU cable).
Disconnect the battery cable plug (purple plug).

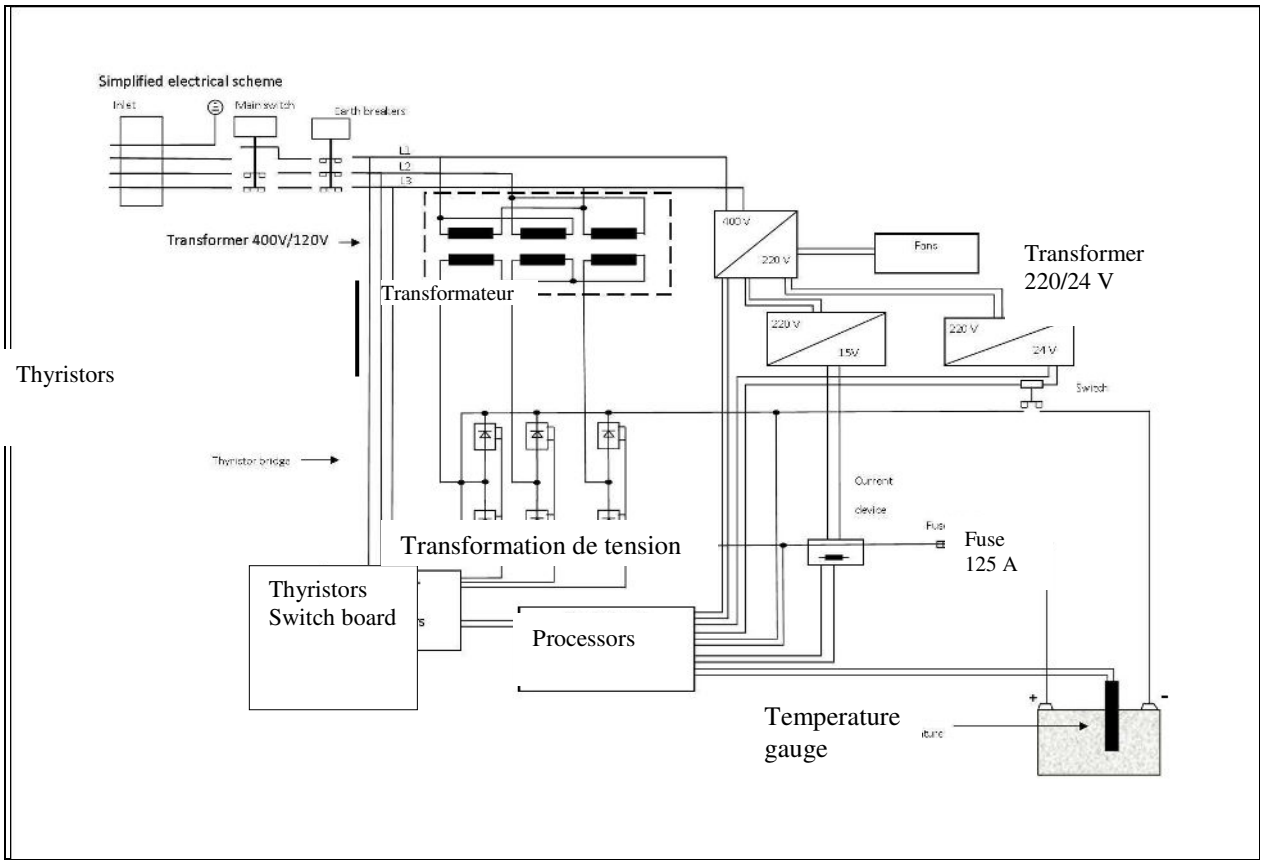
Disconnect the red + battery cable.
Disconnect the blue – battery cable.

4 Technical appendices

4.1 Equipment scheme description

Below, here is the wiring diagram of the BRT. However, it is a simplified diagram as some components are intentionally missing.

Main switch
Ground disruptor



Scheme, S = Current sensor.

4.2 Installation

The BRT is simple to set up. There is anyhow some minimum requirements:
Power supply shall be on three phases 230VAC, disruptor 20A on a D curve. The BRT requires a lot of energy during very short moment and disruptor shall be strong enough to keep current flow during those peak period.
To keep things moving without any trouble, we recommend to increase disrupter capacity to 20 Amps.

As for the plug, we use a Europian plug with earth.
This machine is equipped with a CEM filter requiring earth connection of 5mA. It is mandatory to connect this machine on a disruptor equipped with 300 mA differential (fire protection) or 500mA (machine protection on a dedicated connection).

The machine is equipped itself with a 30mA disruptor complying with the human body protection.

If the regenerator has been in a long transport please check that all screws are sufficiently screwed, especially those around the transformer.

4.3 Maintenance and equipment check list

The BRT is almost maintenance free equipment. Nevertheless, a special care is recommended on the following components:

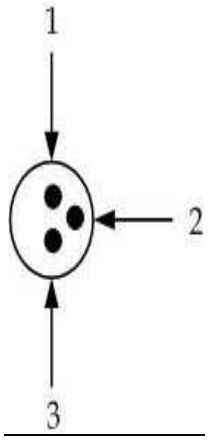
- -Control the air vent grill on the right hand side of the BRT is dust free,
- -Once switch off and disconnected from the main psu, check all cables connection, mainly if the BRT is often move place to place.,
- -Check the temperature gauge and test if it works when reaching temperature over 55°C.

  Double check with a classic thermometer that will be placed temporarily in a cell next to the original gauge.

  Another way could also by heating water up to 60 °C and place the temperature gauge in order to see if the BRT stop processing displaying « High temperature ».

4.4 Checking the temperature gauge connection

Checking this device is quite simple as it is a closed circuit. With a ammeter, check position 1 and 3 without touching the ground which is in the metallic frame. Current should flow between 1 and 3. Pin position as below.



4.5 Breakdown analysis

No problem shall disturb the BRT operation. However here are some advices to cope with potential failures.

4.5.1 Electric interruption

If there is an electric disruption when BRT is started, operator should check the phases order.

If disruption occurs from time to time, check that the BRT is working correctly.

First thing to do : check the card which is right below the BRT top cover where operator can read

4.5.2 Regenerator gets overheated

If high temperature of the BRT is noticed check that the air vent system of the thyristors is working.

If not working, the BRT shall not be used and operator should contact the nearest distributor.

4.5.3 Temperature gauge

Sometime sulphuric acid attacks the temperature gauge.

If there is a doubt about it, refer to chapter 4.4 to test the gauge.

Gauge shall be connected to the BRT. If BRT stops and “high temperature” is on the screen display the gauge is working. If nothing happens, then the temperature gauge should be replaced.

If the gage is not connected, then « high temperature » message appears on the screen display.

4.5.4 Output displays 100 %

This failure may occur while the BRT is in pulsation mode. If power is 100 % it means the circuit is not closed for the following reasons:

- Main BRT interior fuse is dead,
- No battery connected to the BRT
- The battery or one of the battery line is in short circuit

The main reason would be the fuse of the BRT. Its resistance should be checked

CAUTION/ NEVER OPERATE MAINTENANCE ON THE BRT IF IT IS NOT DISCONNECTED FROM MAIN PSU – ELECTRIC HAZARD MAY OCCUR .

If needed, the fuse shall be replaced. Once the fuse changed, check up the connection line and the battery in process looking for short circuits.

Indeed, when output is 100% it is possible that a battery cell might be in short circuit.

To check this, set a constant charge loop without pulsation. If after a few minutes amperage doesn't increase and voltage of the battery is over nominal value, operator will have to cope with a battery short circuit.

BY SECURITY MEASURE AGAINST THE RISK OF SHORT CIRCUIT, THE BATTERY REGENERATOR IS STOPPED AFTER 1 MN WHEN THE DISPLAY IS A 100%.

4.5.5 Regeneration doesn't start

The BRT doesn't start even though the menu appears on the screen display.
Check if the temperature gauge is well connected.

4.5.6 No electric flow on screen

1- no electric flow on screen, 2- the BRT accumulate a lot of energy till the main fuse burns out.
Strange sounds will come out of the BRT, showing it is not under control.
Stop the BRT immediately and check if the current sensor is still working.

4.5.7 Worksheet "regeneration test"

Hereafter exemples of regeneration test worksheets for traction, stationnary and starting batteries.

TESTS DE REGENERATION

Désignation utilisateur:		**Désignation porteur**	

Marque batterie			**Age**		**Type**	

VOLT		**AH**		**N°**	

	VOLT			**DENSITE**		
Dates						
Cellule * 1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
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31						
32						
33						
34						
35						
36						
37						
38						
39						
40						

Dates							
Tension générale							

* Par convention les cellules sont numérotées par ordre croissant en partant de la borne positive de la batterie

Observations:

Opérateur: Qualification batterie: Signature

TESTS DE REGENERATION

Désignation utilisateur:		**Désignation porteur**	

Marque batterie		**Age**		**Type**	

VOLT		**AH**		**N°**	

BATTERIES STATIONNAIRES 2 LIGNES PARALLELES

	VOLT				**PASSAGES AU BANC DECHARGE**		
Dates							
BATTERIE 1				LIGNE A			
2							
3							
4							
5							
6							
7							
8							
total ligne				temp cum.			
	cycle 1	cycle 2	cycle 3	WATT			
BATTERIE 1				LIGNE B			
2							
3							
4							
5							
6							
7							
8							

Dates							
Tension générale							

* Par convention les cellules sont numérotées par ordre croissant en partant de la borne positive de la batterie

Observations:

Opérateur:
Qualification batterie:
Signature