Battery Regeneration – Pilot project

Site: Magyar Telekom NyRT, Local Telecom Center - Budapest, XI. ker. Nagyszeben u. 24.

Performed by: CTDI Ltd. – Budapest, XVIII. ker. Tóth Árpád u. 1/B.

Other participating subcontractors: Batterie Plus, Strabag

Used Equipment: BRT MAXI GOLD – Battery Regenerator
Discharger / Analyzer BDX 96-200 USB, 96V/200A.
Thermal Camera
Fluke Multimeter

Duration of the regeneration process: 2017.01.16-23

BRT MAXI GOLD

Process of the regeneration

1 Preliminary preparation of the site and the electrical network

Before starting the regeneration process had to perform a preliminary site survey in order to taking into account the existing environmental and electrical conditions.

1.1 Environmental conditions

The following environment conditions were fulfilled:

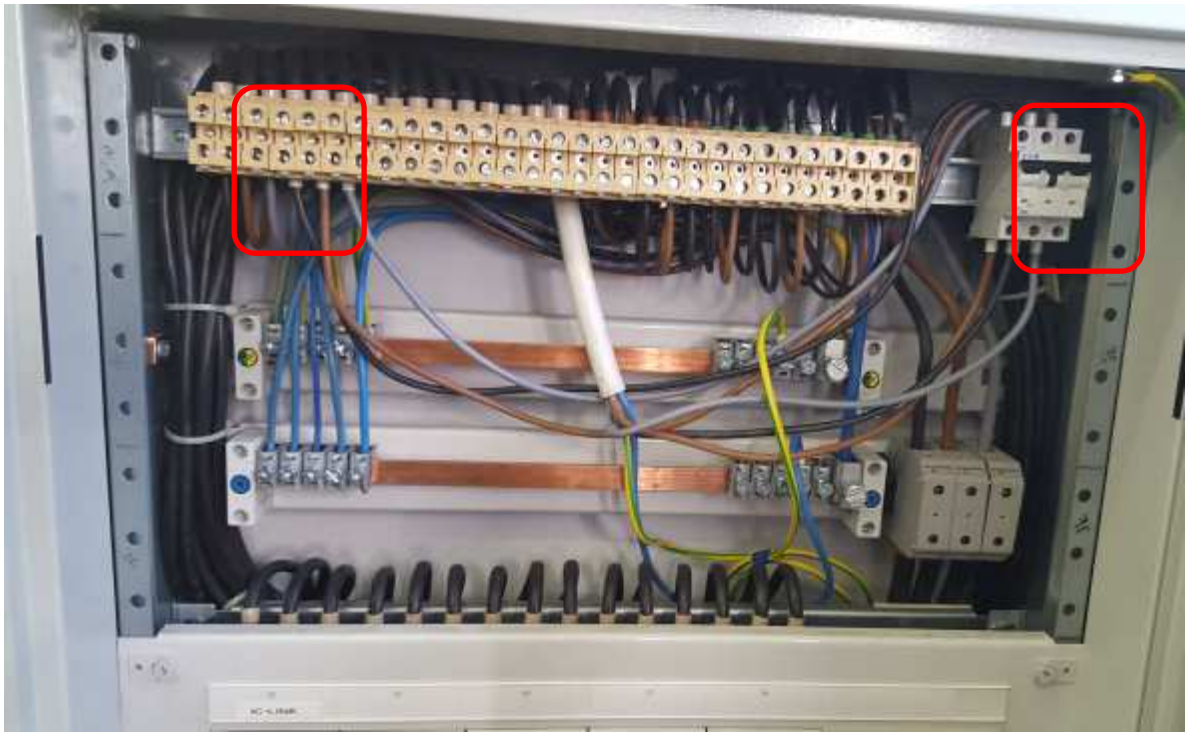
- The regenerator was used indoor only, in a dry and clean place. No liquid shall stand close to the regenerator and the batteries.
- The regenerator was placed in an air vent room.

Picture 1

- Regenerator was on a flat floor. Keep all electricity input and battery connectors accessible. Main switch was accessible in case of quick disconnection requirement.

1.2 Requirements for Electrical power input

After the site survey the electrical network were built accordance with the equipment requirements:



Picture 2

- The regenerator was connected to an approved dedicated plug in accordance with required voltage with appropriate phases.
- Equipment requirements were:
    - 380/ 400 V Three phases+ Ground
    - 50 A disruptor (D curve)

Picture 3

- The discharger was connected to a 220V single phase connector.

Picture 4

2 Preparation of the Regeneration

Right before starting the regeneration process the following equipment were installed in the accumulator room:

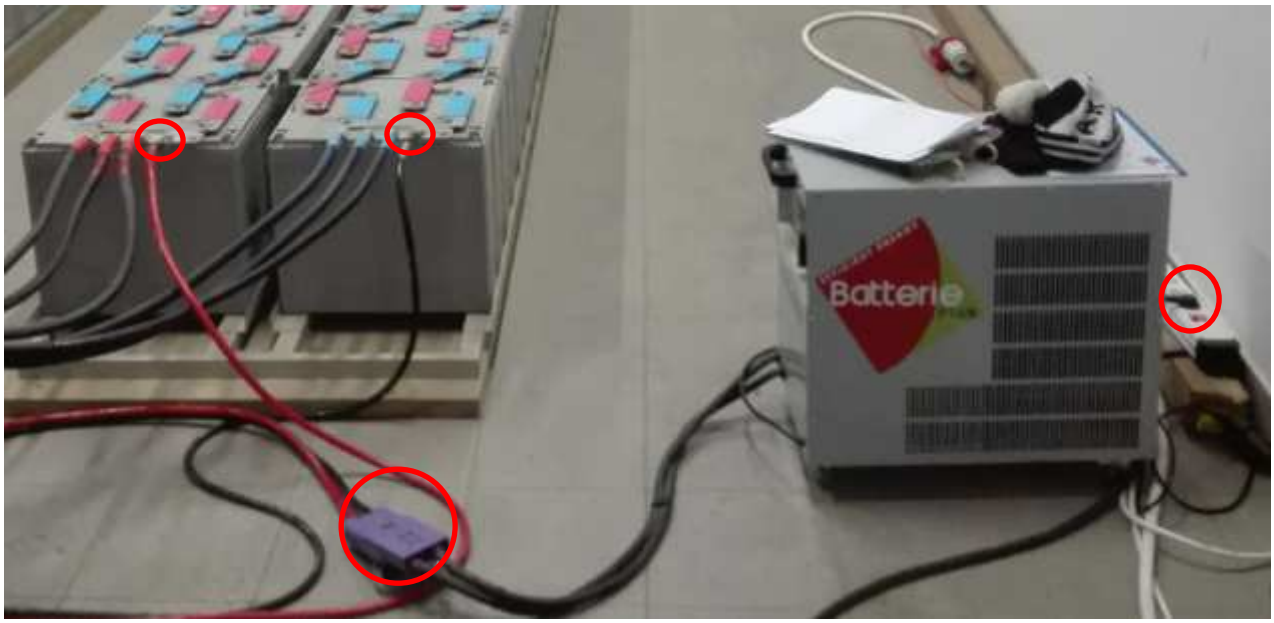
2.1 Thermal Camera

Picture 5

Picture 6

2.2 BDX Battery Discharger

The connections of the discharger can be seen on the picture 8. The battery was connected to the discharger and the discharger was connected to the main power.



Picture 7

2.1 BRT MAXI GOLD – Battery Regenerator

Picture 8

The battery regenerator was connected to the 3 phase main power through a 50 A disruptor (D curve) and the battery during the regeneration process. The order of the 3 phases were determined by the regenerator.

2.2 Preparing batteries

One of the two batteries packs were disconnected from the MT UPS backup network. It was perform by MT subcontractor (Strabag).

3 Pretest and condition survey

The following inspections will be performed before starting of the regeneration:

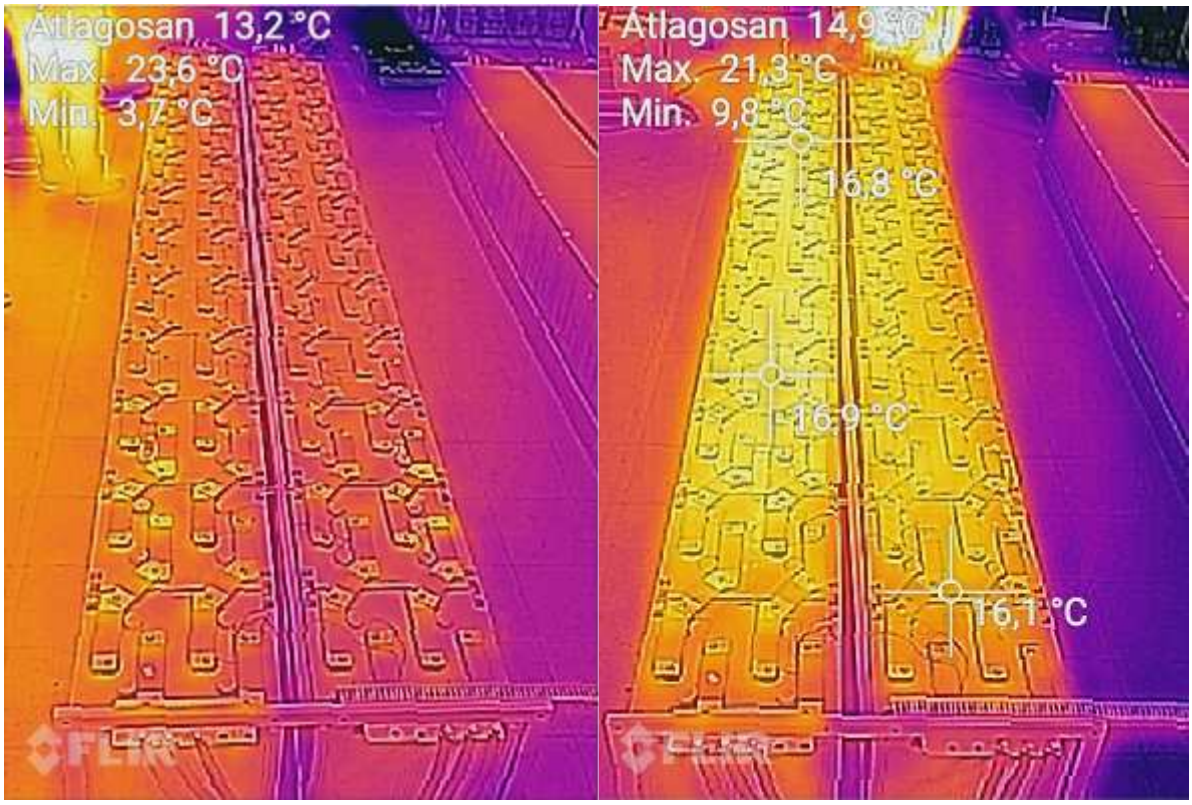
3.1 Battery cells tension measurement

Picture 9

There were not failed battery cells in the 48V battery pack.

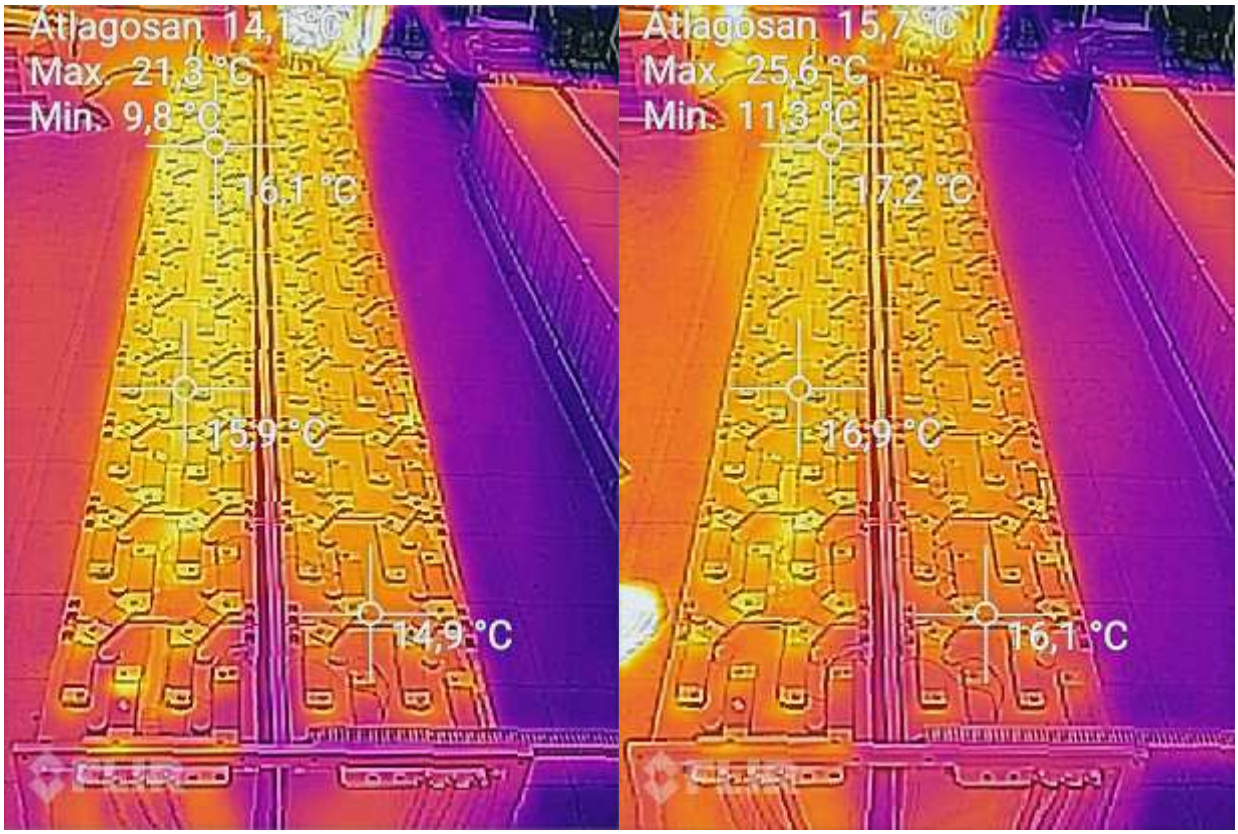
3.2 Checking of the temperature conditions of the battery cells

The temperature measurement was made by thermal camera. The measurement was repeated by 4-6 hours.
The thermal map of the battery cell can be seen on the picture 10 before and during the discharging.



Picture 10

During the regeneration:



Picture 11

Result: the thermal statuses of the battery cell were fairly stable, there were not any outlier battery cell during the whole regeneration process.
The few degree differences were caused by the environmental temperature and the heat was generated by discharger and battery regenerator.
All thermal picture are available in electronic form.

3.3 Measurement of the battery capacity – discharge process.

Before and after regeneration the accumulator have to be discharged in order to know the status of this battery and its capacity.

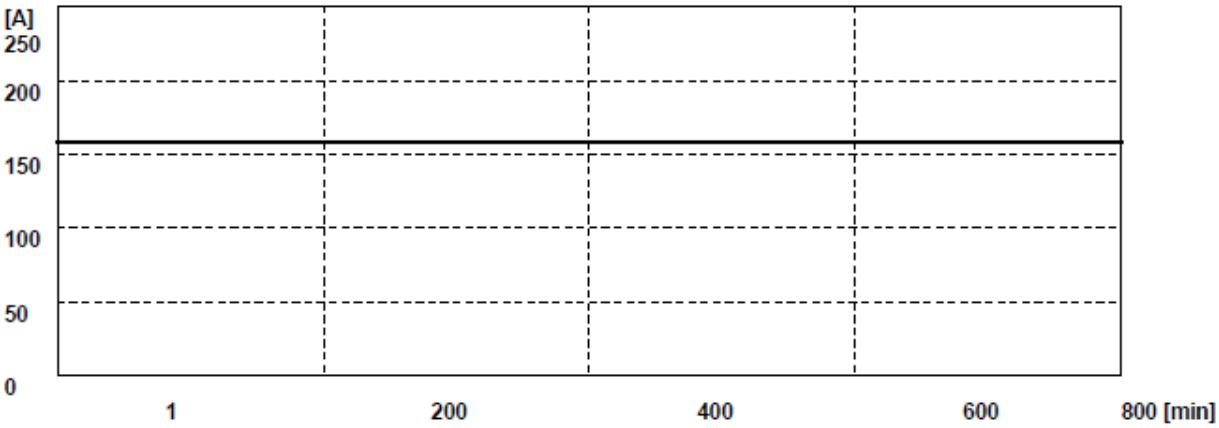
Picture 12

The input data were determined by calculation of the nominal capacity and tension values.
It was performed by Discharger / Analyzer BDX 96-200 USB, 96volt /200A. The duration of the discharge was 13 hours 20 minutes, battery end tension was set for 43,2V. At this value the discharger automatically stops the process.
The discharger current was set for 158 Amps. The measured capacity was 2106 Ah.
The discharging process consists of two parts. In the first 10 hours the battery is discharged for the set tension level. In the second part the battery is charged up for the nominal level, it takes approximately 3 hours.
Before regeneration: the set data and the generated results can be seen on the following sheet:

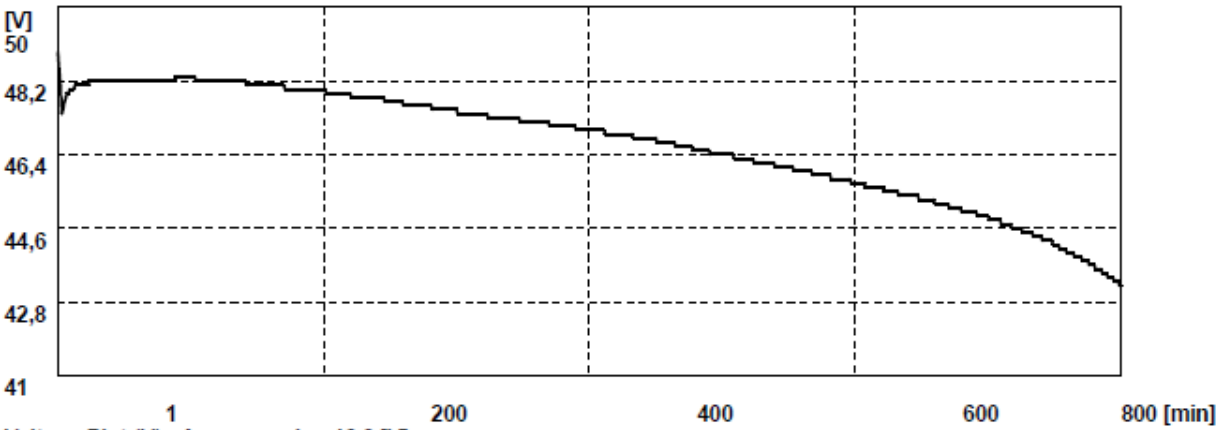
BDX BATTERY DISCHARGER

DISCHARGE TEST REPORT

DISCHARGE DATE :	17\01\2017 11:33:00 [Version 1.9]
OPERATOR :	IMRE GYENES
COMPANY :	CTDI Hungary
BATTERY TYPE :	Coslight GFM 2000Z
NOM. VOLTAGE :	48 volts
CAPACITY :	2000 [Ah] / CAPACITY OBTAINED 105,3 %
NOTES :	first trial of discharge after floating full charge



Current Plot (A) - Average value 158 [A]



Voltage Plot (V) - Average value 46,6 [V]

FINAL RESULTS

Discharge total time	13:20:00 [min]
Battery initial voltage	48,9 [V]
Battery final voltage	43,2 [V]
Discharge minimum current	158 [A]
Discharge average current	158 [A]
Discharge maximum current	158 [A]
Total amperehours discharged	2106 [Ah]
Total energy discharged	98342,3 [Wh]

Signature_____

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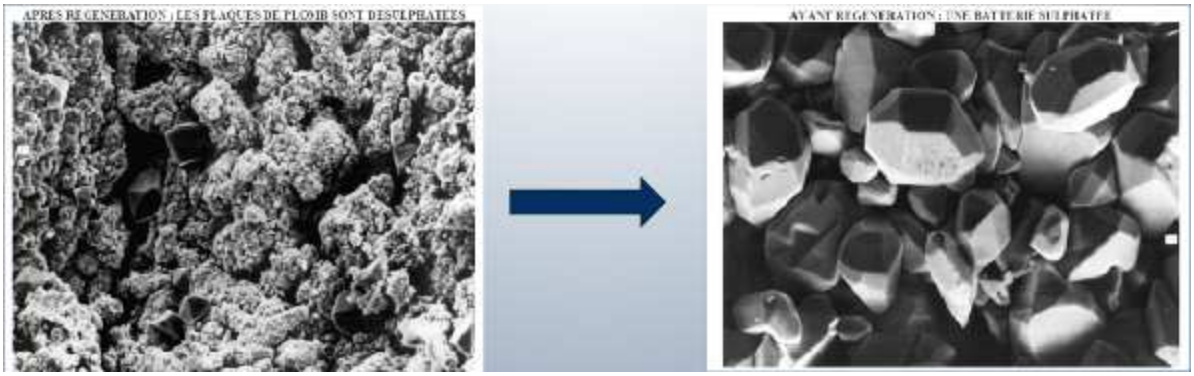
4 Regeneration

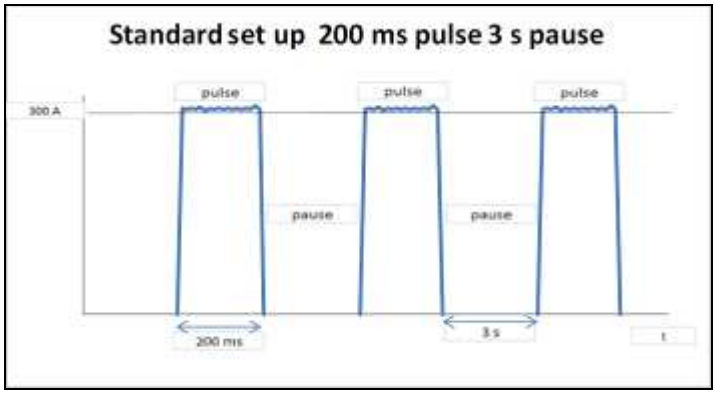
4.1 Brief theory of the regeneration

The regeneration process treats the batteries with an electric pulsation system using specific frequencies. This leads to the full recovery of the active agents in the battery, turning them from solid back to their original state. Regenerating the battery permits to recover the original capacity and to extend the life span.
We can see the plate of the cell before and after regeneration.



Picture 13

The figure shows current of the regeneration as function of the time.



Picture 14

The table contains the parameters of the “Curative regeneration”
The BRT has safety device that will stop the process if some parameters are getting to high:

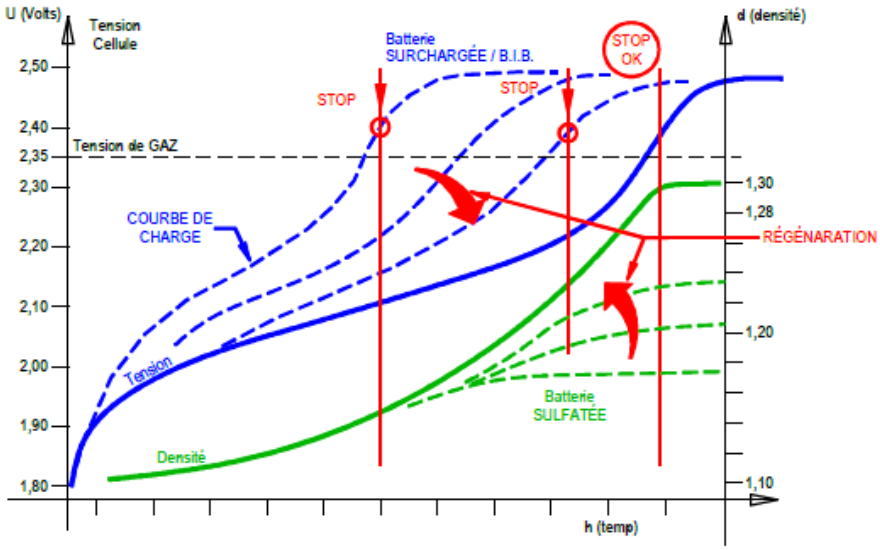


Figure 1

Temp > 45°C
Voltage > 2,4V per cell
The regenerator continuously monitors these parameters during the process.
At the end of the program the regeneration will stop automatically.

4.2 The specification of BRT Maxi Gold equipment

The BRT Maxi Gold equiment was choosen accordance with the property of the battery intended to regenerate. The main specifications of the regenerator are summarized in the chart can be seen on the picture 15.

Pics	Use	Client profile	Battery treated	Software	In and Out put
	Global Starting, traction and ups batteries. **Till 120 Volts / 2500 Ah**	Global maintenance facilities, regeneration center operators	• Starting bat 60u daily • Traction 80 to 200u yearly • UPS 4 packs 48v daily • UPS 10000 cells yearly	**26 automatic pgms** -11 pgms fr BRT medium -11 pgms from BRT UPS (6 gel-agm and 5 lab*) -4 pgms fr BRT start -capacity for manual settings by operator.	IN 400v Three phases OUT 120v/400A

Picture 15

Important specification data regarding the pilot.

- Capacity of the Regenerator 120V/2500Ah maximum
- Yearly capacity of the regenerator: 80-200 accumulators, depend on the status of them.
- 26 differend regeneration programs
- Input power requirement: 400V tri phases, 40A/phase
- Output voltage/current: max 120V/400A.

4.3 Switch on the BRT MAX Gold regenerator

Connection of the tested and prepared accumulator and the regenerator follow these steps:

- First we had to place the one end of the connection special cable to the accumulator (we took care with the right polarity).

Picture 16

- Then the other end of the cable was connected to the regenerator.

Picture 17

- At the end the regenerator was connected to main power connector. Then the regenerator was switched on by main power switch.

Picture 18

The regeneration process could be started.

4.4 Start of regeneration

The regenerator has two different operation modes:

- Charge by pulse – regeneration
- Constant charge – normal continous charge

We used both operation mode during the regeneration.

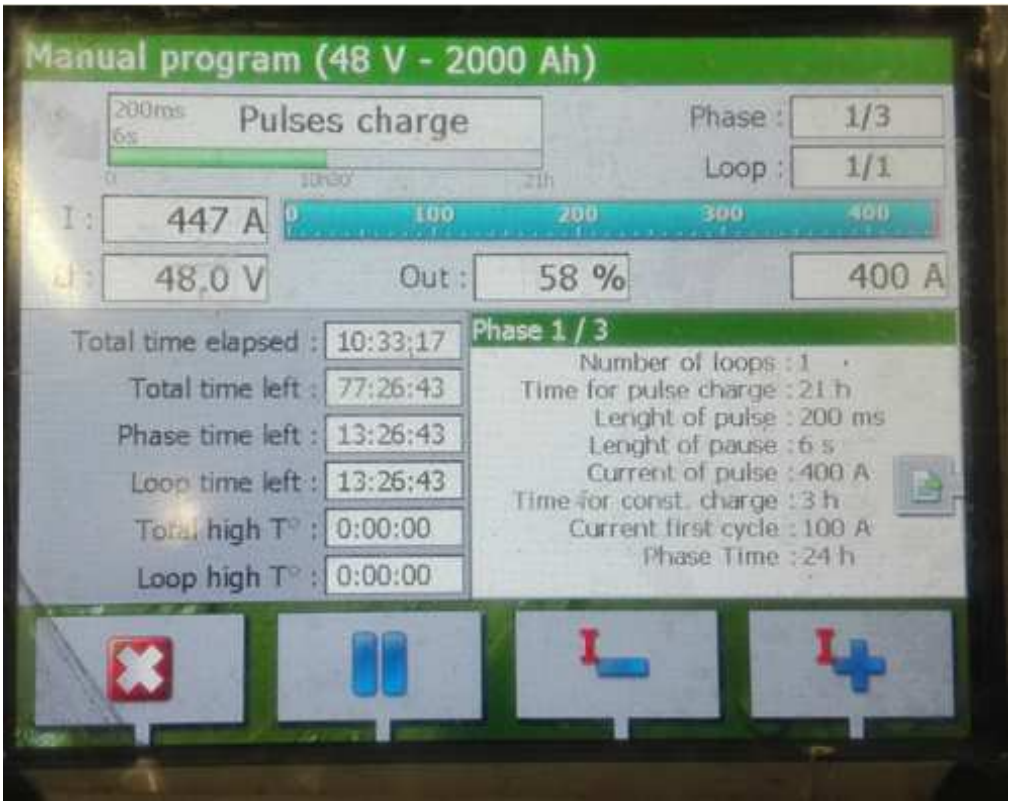
After switching on the equipment the following picture can be seen on the screen.

Picture 19

It offered four possibilities:

- Manual: Manual program
- Automatic: Pre set program for traction batteries
- Parameters : To access the parameters of the program in use
- Process

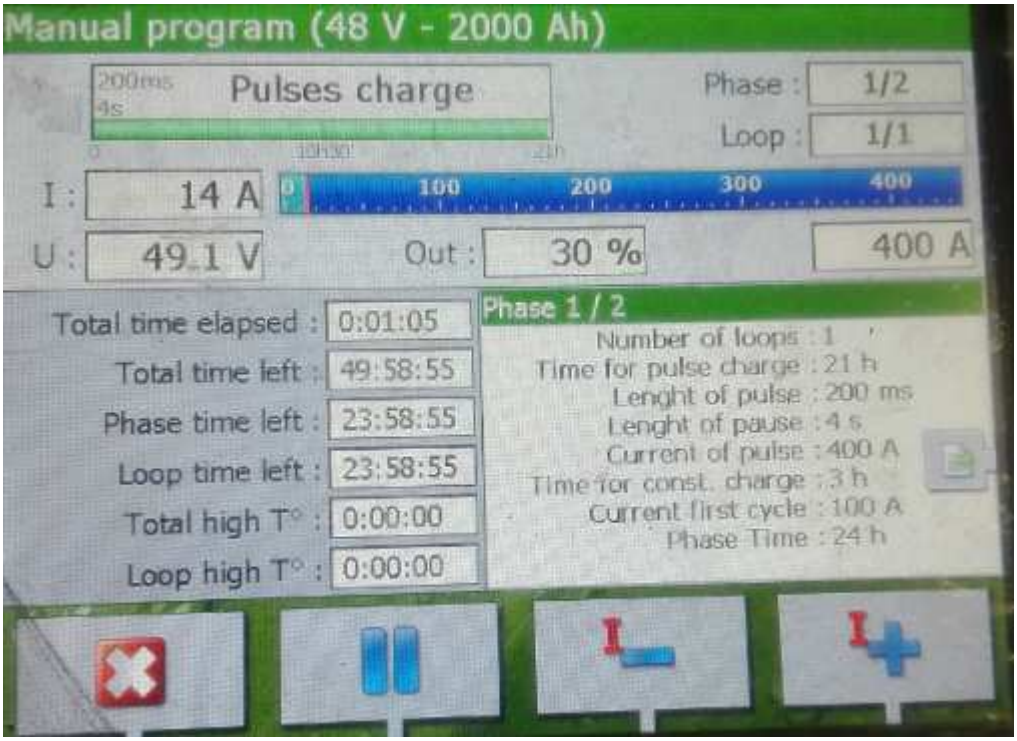
In our case the Manual mode was used, because there was not suitable program for this battery type.
The process consisted of 3 phases with diffent parameters and timings. The first phase can be seen on the picture 20 during the regeneration.



Picture 20

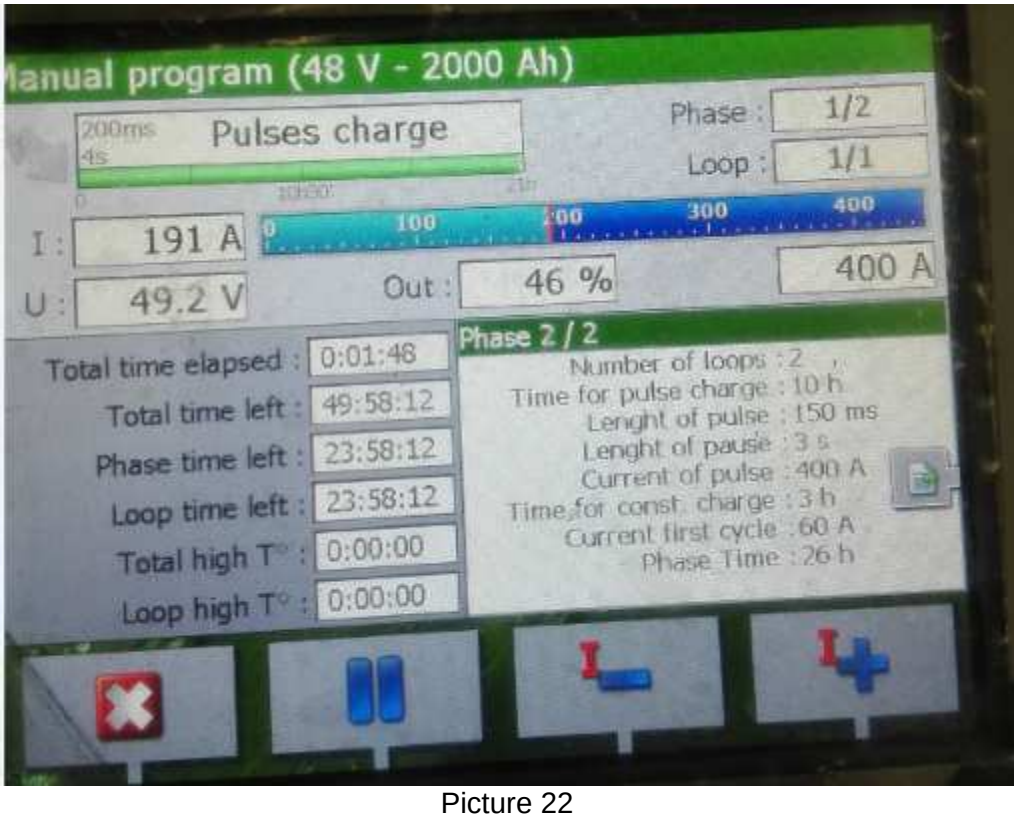
After the end of the first phase the regenerator was started again, was programmed only the remaining two phase.

Parameters in the second phase:



Picture 21

Parameters in the third phase:



Picture 22

At the end of the last phase there was a 3 hours constant charging term.

5 Final checking and results

At the end of the regeneration process we had to check the statuses of the accumulator.

5.1 Final discharge, capacity measurement

The discharge process was the same as described previously in the chapter 3.
The comparison of the initial and final measured battery capacities are the follows:

Initial capacity: 2106 Ah
Final capacity (after regeneration): 2233 Ah.

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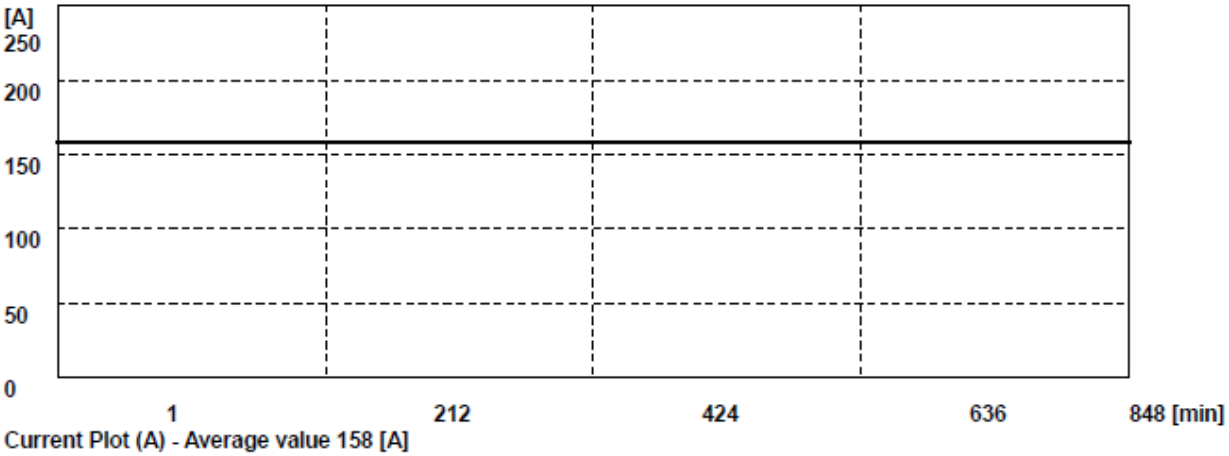
BDX BATTERY DISCHARGER

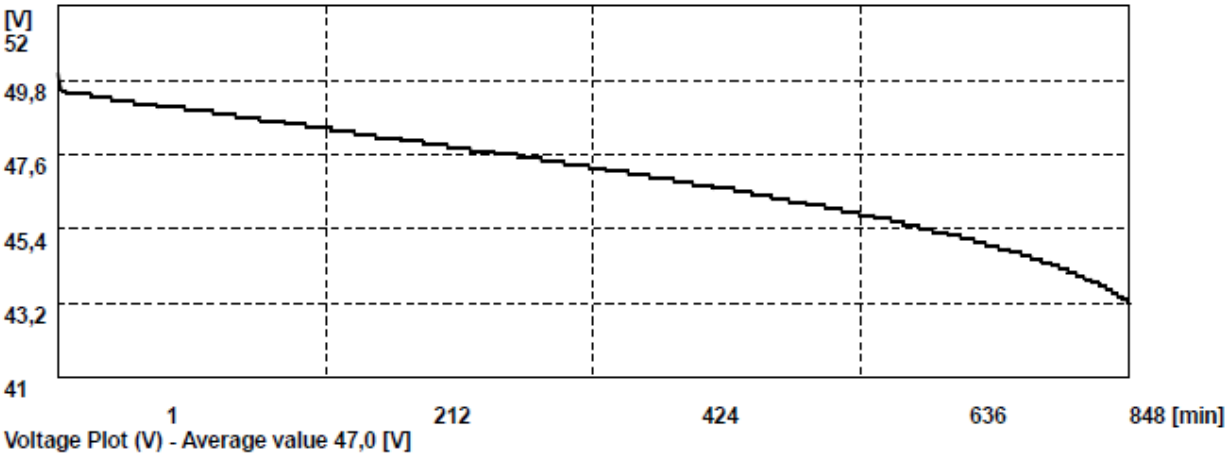
BDX

DISCHARGE TEST REPORT

DISCHARGE DATE :	23\01\2017 08:57:00 [Version 1.9]
OPERATOR :	Imre GYENES
COMPANY :	CTDI
BATTERY TYPE :	Coslight GFM 2000Z
NOM. VOLTAGE :	48 volts
CAPACITY :	2000 [Ah] / CAPACITY OBTAINED 111,65 %
NOTES :	discharge after regeneration --- but without floating charge



Current Plot (A) - Average value 158 [A]



Voltage Plot (V) - Average value 47,0 [V]

FINAL RESULTS

Discharge total time	14:08:00 [min]
Battery initial voltage	50,0 [V]
Battery final voltage	43,2 [V]
Discharge minimum current	158 [A]
Discharge average current	158 [A]
Discharge maximum current	158 [A]
Total amperehours discharged	2233 [Ah]
Total energy discharged	104978,0 [Wh]

Signature_____

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These two value shows us that the battery is in very good condition.

5.2 Battery cell - tension checking

The chart contained the measured cell tensions during the regeneration process.

	13II.	14II.	15II.	16II.	17II.	18II.	19II.	20II.	21II.	22II.	23II.	24II.
Before discharging	2.237 V	2.232 V	2.238 V	2.231 V	2.232 V	2.234 V	2.234 V	2.235 V	2.233 V	2.235 V	2.241 V	2.233 V
After charging	2.235 V	2.231 V	2.235 V	2.235 V	2.23 V	2.23 V	2.229 V	2.232 V	2.231 V	2.237 V	2.233 V	2.24 V
During first phase	2.013 V	2.014 V	2.009 V	2.01 V	2.004 V	2.011 V	2.004 V	2.207 V	2.014 V	2.004 V	2.008 V	2.013 V
After first phase	2.028 V	2.024 V	2.019 V	2.029 V	2.022 V	2.021 V	2.025 V	2.02 V	2.025 V	2.025 V	2.029 V	2.028 V
During second phase	2.091 V	2.092 V	2.081 V	2.089 V	2.083 V	2.088 V	2.083 V	2.084 V	2.093 V	2.084 V	2.087 V	2.093 V
During second phase	2.104 V	2.105 V	2.1 V	2.102 V	2.096 V	2.101 V	2.097 V	2.097 V	2.107 V	2.097 V	2.1 V	2.107 V
After second phase	2.21 V	2.211 V	2.209 V	2.206 V	2.203 V	2.208 V	2.205 V	2.2 V	2.213 V	2.205 V	2.21 V	2.211 V
During third phase	2.159 V	2.16 V	2.157 V	2.157 V	2.153 V	2.157 V	2.154 V	2.153 V	2.163 V	2.153 V	2.157 V	2.163 V
During third phase	2.172 V	2.174 V	2.169 V	2.171 V	2.165 V	2.169 V	2.166 V	2.166 V	2.176 V	2.166 V	2.17 V	2.176 V
After third phase	2.232 V	2.234 V	2.224 V	2.23 V	2.219 V	2.225 V	2.221 V	2.22 V	2.231 V	2.222 V	2.226 V	2.243 V

	12II.	11II.	10II.	9II.	8II.	7II.	6II.	5II.	4II.	3II.	2II.	1II.
Before discharging	1.983 V	1.983 V	1.974 V	1.981 V	1.968 V	1.977 V	1.968 V	1.975 V	1.979 V	1.97 V	1.968 V	1.978 V
After charging	1.984 V	1.98 V	1.982 V	1.977 V	1.963 V	1.979 V	1.976 V	1.971 V	1.973 V	1.971 V	1.965 V	1.982 V
During first phase	2.013 V	2.011 V	2.014 V	2.01 V	2.015 V	2.01 V	2.006 V	2.004 V	2.207 V	2.008 V	2.009 V	2.014 V
After first phase	2.028 V	2.026 V	2.028 V	2.025 V	2.017 V	2.025 V	2.021 V	2.021 V	2.022 V	2.023 V	2.026 V	2.028 V
During second phase	2.093 V	2.09 V	2.032 V	2.086 V	2.081 V	2.087 V	2.083 V	2.083 V	2.086 V	2.086 V	2.09 V	2.091 V
During second phase	2.107 V	2.104 V	2.206 V	2.1 V	2.095 V	2.1 V	2.097 V	2.097 V	2.093 V	2.099 V	2.103 V	2.105 V
After second phase	2.217 V	2.212 V	2.207 V	2.205 V	2.202 V	2.202 V	2.201 V	2.2 V	2.205 V	2.207 V	2.215 V	2.212 V
During third phase	2.162 V	2.16 V	2.16 V	2.155 V	2.151 V	2.156 V	2.152 V	2.152 V	2.155 V	2.156 V	2.16 V	2.16 V
During third phase	2.175 V	2.172 V	2.173 V	2.167 V	2.164 V	2.168 V	2.165 V	2.165 V	2.168 V	2.16 V	2.171 V	2.172 V
After third phase	2.238 V	2.231 V	2.23 V	2.22 V	2.219 V	2.22 V	2.218 V	2.219 V	2.222 V	2.222 V	2.229 V	2.237 V