AUTOMOTIVE BATTERIES
TECHNICAL INFORMATION

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A - Storage of “dry charged” batteries

Dry charged automotive batteries manufactured according to the newest, and most advanced technologies, can be stored for extended periods of time without suffering of any permanent alteration or degradation.

The plates of dry charged batteries are subject, within a certain time, to a modification of their initial features of full charge status, as well as their activation availability, since a progressive “oxidation” of the negative plates and a smooth “passivation” of the positive plates may take place.

These circumstances are leading basically only to a partial loss of the charge, without however compromise the performance and the durability of the batteries, provided they are properly activated and charged at the moment of putting them into service.

The oxidation of negative plates and the consequent loss of the battery charge, increases with an increase of the room temperature and humidity.

Following recommendations must be observed for proper storage of “Dry Charged” batteries:

- store the batteries in a dry place with temperatures between 15÷25 °C;
- store the batteries within the original closed packaging.
- follow the “ first in, first out “ rule so to use always those batteries put on stock first and therefore having “ older age “.

B - Activation of “dry charged” batteries.

1. Remove plugs and fill up each battery cell with electrolyte (diluted sulphuric acid) having density of 1,27 Kg/l (31Bè, 36%), up to a level of 10÷15 mm over the upper plate edge.
   The temperature of the electrolyte should not be lower than 15 °C.
2. Let the battery rest for about 20 minutes.
3. Shake the battery slightly and check the liquid level once more. If necessary adjust the correct level by adding acid until the liquid reaches the “max” mark on the battery container.
4. Charge the battery at current rate (Amps) equal to 1/10 of the battery capacity. (Example: a battery of 60 Ah must be charged with 6 A .)
5. Make sure that during the whole charging process the value of the current keeps its initial setting value.
6. Be aware that the electrolyte temperature does not exceed 50 °C (if so interrupt the charge in order to allow a temperature decrease.)
7. The charging operations are considered completed when the electrolyte is showing homogeneous “gassing” in all battery cells and the density value of 1,275÷1,280 Kg/l is reached.
8. It is advisable to check the voltage “under-charge” during the final charging period; the activation-charge is completed when a voltage of min. 16,5 Volt will be reached (2,75 Volt per cell).
9. Switch off the power supply, leave the battery without plugs for some minutes so to favour the escape of the explosive gas, disconnect the terminals, apply the plugs, clean and dry the battery cover.

N.B.: Dry charged batteries stored for more than 12 months as well as those kept on stock at temperatures lower than 15 °C, must be activated with particular attention, following with care a.m. descriptions.

C - Storage of "wet charged" batteries.

Wet charged batteries are subject to a "self-discharge" process in case they are kept inactive.

This spontaneous chemical process consists in a progressive transformation of the active material into lead sulphate.

The actual technologies used for the manufacturing of wet charged batteries do however minimise this phenomenon.

Should the batteries anyhow be kept on storage for a longer period (more than 5÷6 months), the charge level may drop more than 20 % and the sulphating of the plates will become irreversible, having as consequence a difficult recharge as well as the risk to definitively compromise the features and the durability of the batteries.

The "self-discharge" process increases with an increase of the room temperature.

On the other hand the crystallisation (hardening) of the sulphated plates (i.e. discharged due to self-discharge phenomenon) increases with a decrease of the room temperature.

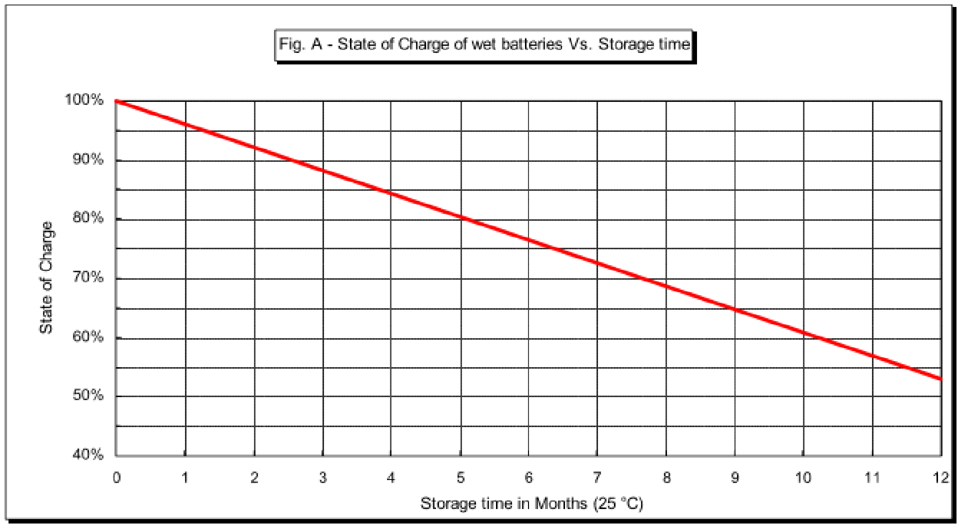
It is therefore very important to avoid that the batteries loose more than 20 % of their initial state of charge and further that they remain in such condition for long periods, in particular at low temperatures.

Deep discharged batteries, exposed to extremely low temperatures, may be subject to freezing of the electrolyte and consequent mechanical damage of the battery container.

The freezing point of electrolyte stands in relation with its density according to following table:

Electrolyte density Kg/l	1,120	1,140	1,160	1,180	1,200	1,220	1,240	1,260	1,280
Freezing temp.°C	-10	-13	-17	-21	-26	-35	-46	-59	-68

The state of charge of the automotive batteries decreases in relation to time according to **Fig. A.**



The variation of the **Open Circuit Voltage** and **electrolyte density** has an average trend as showed in **Fig. B** and **Fig. C.**

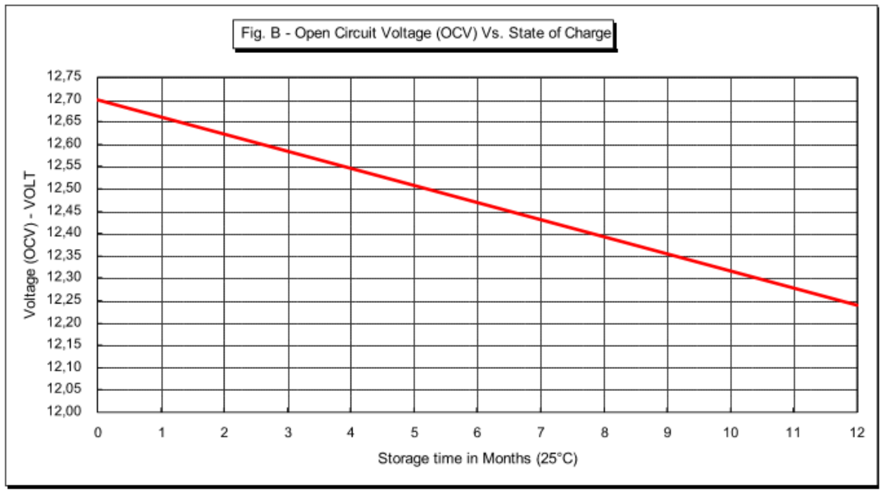


Fig. B - Open Circuit Voltage (OCV) Vs. State of Charge

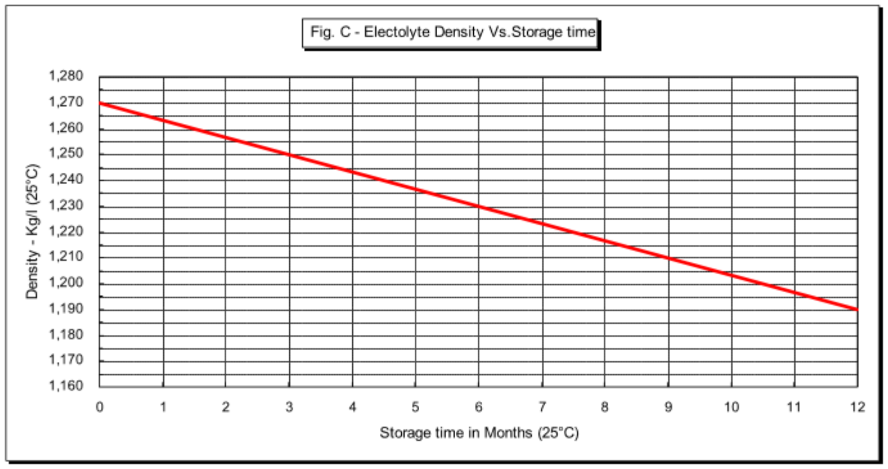


Fig. C - Electolyte Density Vs.Storage time

As mentioned before also the **room temperature** may considerably contribute to the loss of charge of the wet charged batteries.
Consequently the **maximum storage time**, without recharging operations, should never exceed that one stated on **Fig. D,** related to the room temperature.

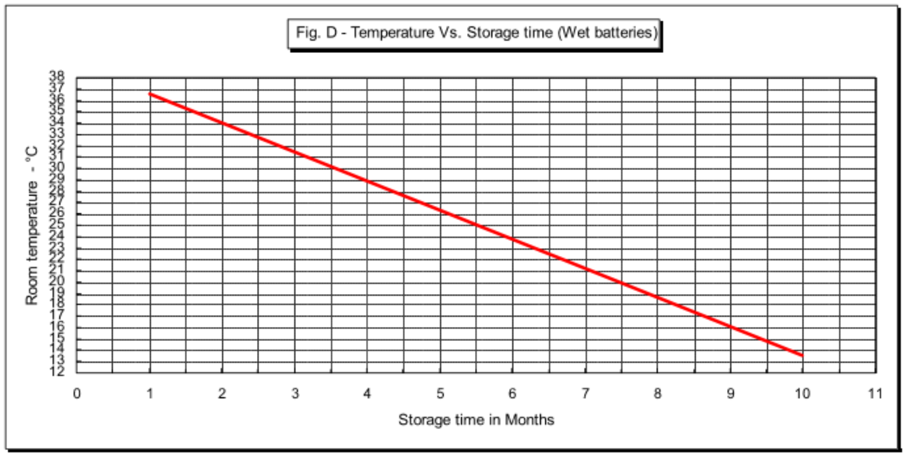


Fig. D - Temperature Vs. Storage time (Wet batteries)

Following recommendations must be observed for proper storage of “Wet Charged” batteries:

- store batteries in a cool dry place in upright position.
- follow the “first-in, first-out” procedure.
- check periodically the state of charge of the batteries, by means of voltage and density measurements as described below.

It is advisable to mark the “groups of batteries” according to the stock “entering” and their last charging date.

In this way it will become easier rotating the stock and perform the periodical controls as mentioned in the following chapter.

D - Determination of the state of charge.

In order to provide a correct and proper stock management of wet charged batteries, following basic instruments should be available:

- **Hydrometer** (in good conditions and of proper quality, with well readable range from 1,100 to 1,300 Kg/);
- **Digital Voltmeter** (of good quality, well adjusted, able to read 0,01 Volt);
- **Battery charger** (model with constant current and timer is suggested, capable to supply min. 15 A);
- **Thermometer** for liquids (range 0 ÷ 80 °C).

In order to keep the state of charge of the batteries under control, check **every month** the **open circuit voltage**, by means of the digital voltmeter, on at least two batteries of the same model for every group, identified by the “stock entering” date.

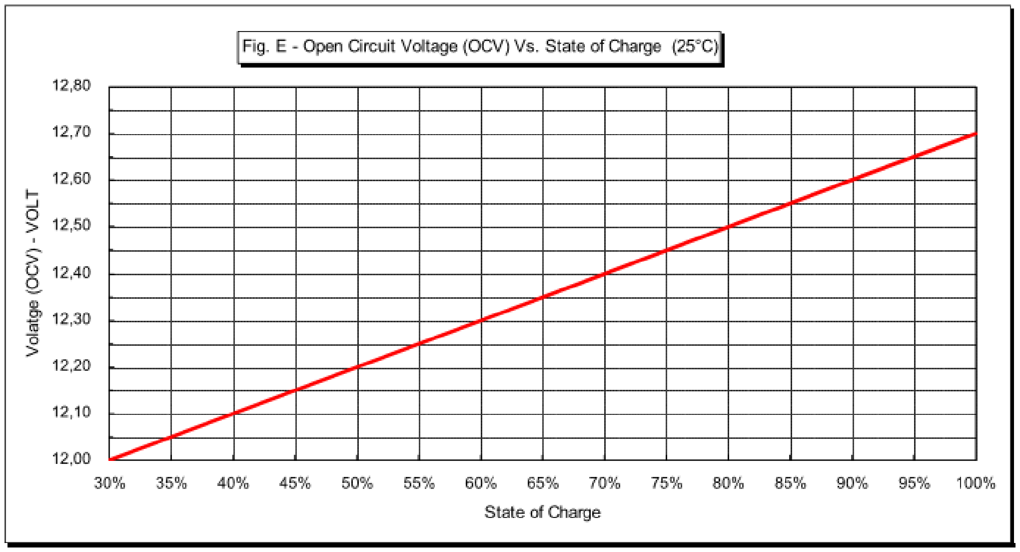
Batteries showing voltage higher than 12,60 Volts may be installed without any problem and can be kept furthermore on stock.

Those batteries having a voltage between 12,50 and 12,60 Volts are still sufficiently charged if installed or put in service within a short period, but they may also need a “boost charge” if they remain on stock for further time.

In the same way, the charge level of a battery can be determined by checking the electrolyte **density** by means of the hydrometer.

Batteries having voltage lower than 12,50 Volt, or electrolyte density below 1,240 Kg/l, must be recharged according to the procedures mentioned hereinafter.

The relation between the battery **state of charge** and its **open circuit voltage** is shown in **Fig. E.**



The relation between the battery **state of charge** and the **electrolyte density** is shown in **Fig. F.**

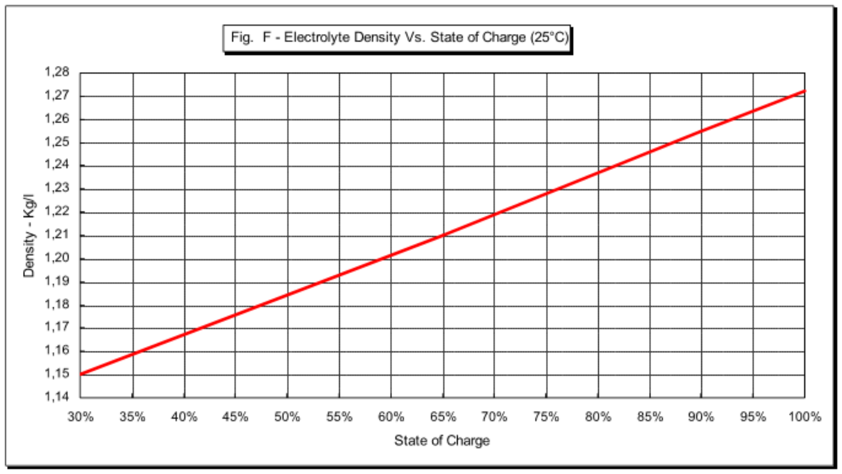


Fig. F - Electrolyte Density Vs. State of Charge (25°C)

The relation between the **open circuit voltage** and the **electrolyte density** as shown in **Fig. G.**

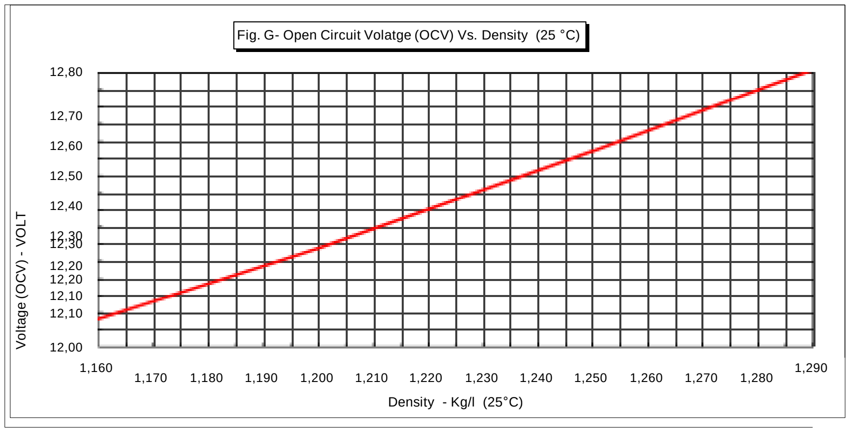


Fig. G- Open Circuit Volatge (OCV) Vs. Density (25 °C)

To each charge level of the battery plates corresponds a different concentration (density) of the electrolyte (acid). According to these relations the battery provides a voltage (at open circuit), which stands primarily in relation with the electrolyte density and secondarily with its temperature.

Summarising on can state that the values of the battery voltage (at open circuit) and those of the acid density, give precise information concerning the state of charge of the battery.

All value measurements of battery voltage and electrolyte density must be performed at temperatures between 18 and 25 °C.

Before measuring the density it is advisable to shake the battery firmly in order to mix up the electrolyte which may have become stratified due to a possible extended storage period.

It shall be reminded that any measurement of the battery voltage is reliable only if performed with a well adjusted voltmeter. A rather small variation of the voltage, may lead to a quite larger difference of the sate of charge (example: 12,20 Volt correspond to 50% state of charge, whereas 12,70 Volt correspond to 100%).

The **state of charge** of batteries, checked at temperatures between 15°C and 30°C, can be determined with sufficient precision by measuring the values of **stabilised open circuit voltage** or **electrolyte density** (better if both parameters) and consequently related to the following table :

Voltage (open circuit voltage) **Volt**	Electrolyte **Density Kg/l**	**Battery State of Charge %**
lower than 12,20	lower than 1,180	Lower than 50 %
12,25	1,190	55 %
12,30	1,200	60 %
12,35	1,210	65 %
12,40	1,220	70 %
12,45	1,230	75 %
12,50	1,240	80 %
12,55	1,250	85 %
12,60	1,255	90 %
12,65	1,265	95 %
12,70	1,270	100 %

The values of this table correspond to those which can be found on **Fig. E** and **Fig. F**.

The use of this table, with regard to the voltage values only, is recommended merely to check the charge level of "new" batteries.

In case these mentioned measurements are to be performed on "used " batteries, it is advisable to determine also the electrolyte density possibly of all the battery cells. (see flow chart for battery control operations).

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E - Suggestions for charging operations

According to the previous statements, wet charged batteries showing "open circuit voltage" equal or lower than 12,50 Volt and electrolyte density equal or lower than 1,240 Kg/ must be absolutely and properly charged, in order to re-establish the full state of charge.

This operation is very important and must be done following with care the table shown below.

The rate of charging (Amps) shall never be higher than 1/10 of the batteries nominal capacity (Ah).

On recommends **to adjust and lead the charge** with a current value between minimum 1/20 and maximum 1/10 of the capacity value.

The charging operation requires an adequate **survey**, thus to verify that it properly follows all settings.

It is necessary to carry out the foreseen measurements of the electrolyte density and voltage during the final step of the charge.

During the charging operations, the **electrolyte temperature** shall possibly **never exceed 50 °C.** If this may happen, make sure that the charging current was not set up too high. In order to lower the electrolyte temperature it is advisable to suspend temporarily the charge or to reduce the current.

Charging current (A) = 1/20 ÷ 1/10 of capacity value (Ah)

State of Charge	Charging Time
lower than 50 %	min. 12 hours (*)
60 %	10 hours
70 %	8 hours
80 %	5 hours
90 %	3 hours

(*) Batteries showing state of charge of 50 % or even lower,
must be charged with particular attention.
The battery is fully charged when the cells are gassing freely and no change in acid density occurs over a two hour period.

N.B: Considering the self-discharge phenomenon of " **wet charged batteries** " at normal ambient conditions (see Fig. A), it is possible to follow a simple rule for their " **recharge** " according to the passed storage time:

- constant current equal to approx. **1/10** of the capacity (A=1/10Ah);
- charging time **in hours** equal approx. to the **number of months** elapsed since the last charge (hours = months).

The proper handling of "wet charged batteries" does not foresee the need of charging for those showing a state of charge level higher than 80 %; the above shown table is however generally helpful to determine the correct charge settings for batteries to be controlled (ex.: guarantee claims) in relation to their effective state of charge.

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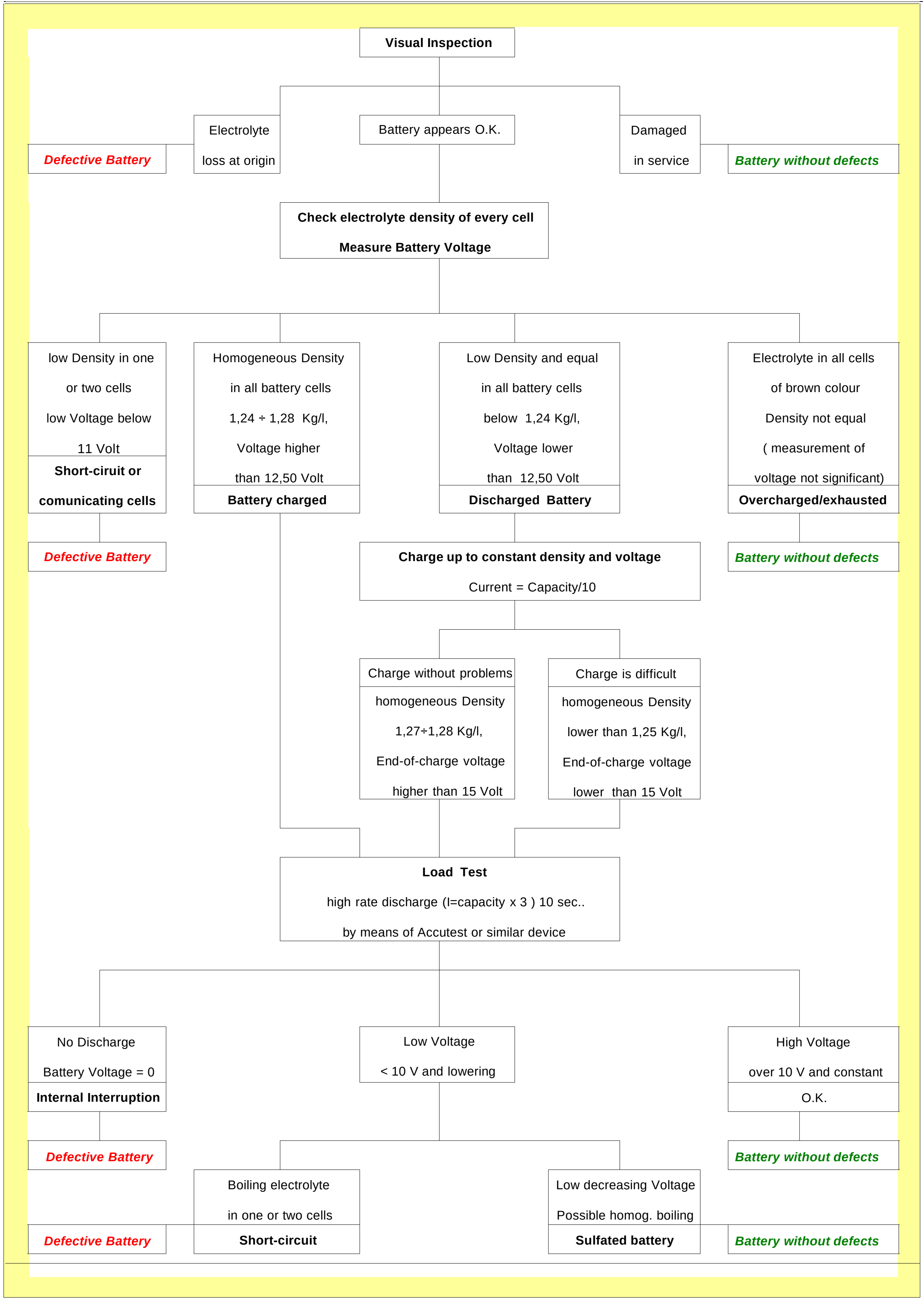
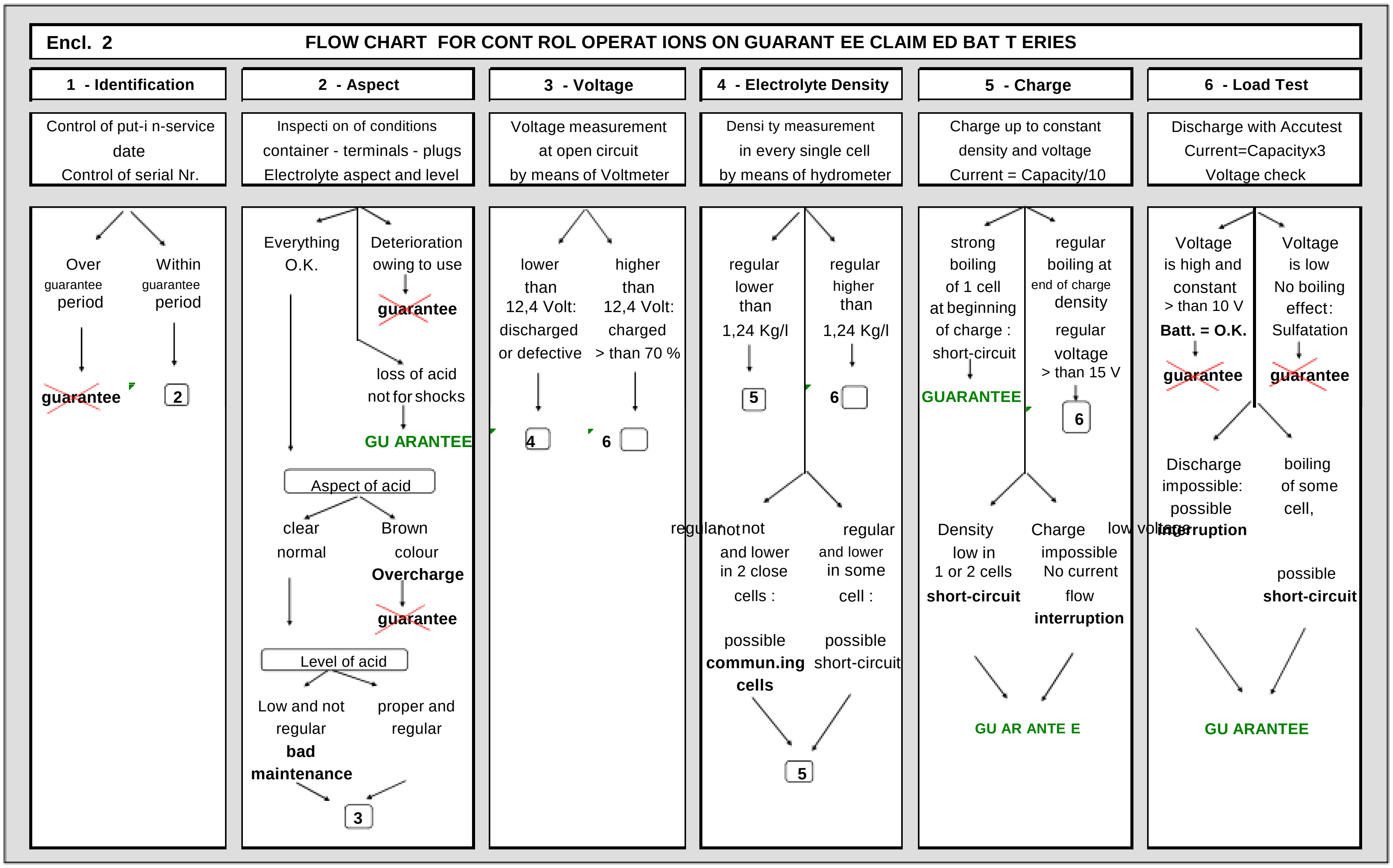
Encl. 1 **FLOW CHART FOR GENERAL CONTROL OPERATIONS OF AUTOMOTIVE BATTERIES**





Encl. 2
FLOW CHART FOR CONT ROL OPERAT IONS ON GUARANT EE CLAIM ED BAT T ERIES
1 - Identification
Control of put-i n-service date
Control of serial Nr.
Over guarantee period
Within guarantee period
guarantee
2
2 - Aspect
Inspecti on of conditions
container - terminals - plugs
Electrolyte aspect and level
Everything O.K.
Deterioration owing to use
guarantee
loss of acid not for shocks
GU ARANTEE
Aspect of acid
clear normal
Brown colour
Overcharge
guarantee
Level of acid
Low and not regular
bad maintenance
proper and regular
3
3 - Voltage
Voltage measurement
at open circuit
by means of Voltmeter
lower than 12,4 Volt: discharged or defective
higher than 12,4 Volt: charged > than 70 %
4
6
4 - Electrolyte Density
Densi ty measurement
in every single cell
by means of hydrometer
regular lower than 1,24 Kg/l
regular higher than 1,24 Kg/l
5
6
regular not and lower in 2 close cells :
regular and lower in some cell :
possible commun.ing cells
possible short-circuit
5
5 - Charge
Charge up to constant
density and voltage
Current = Capacity/10
strong boiling of 1 cell at beginning of charge : short-circuit
GUARANTEE
regular boiling at end of charge density
regular voltage > than 15 V
6
Density low in 1 or 2 cells
short-circuit
Charge impossible No current flow
interruption
GU AR ANTE E
6 - Load Test
Discharge with Accutest
Current=Capacityx3
Voltage check
Voltage is high and constant > than 10 V
Batt. = O.K.
guarantee
Voltage is low No boiling effect: Sulfatation
guarantee
Discharge impossible: low voltage possible interruption
boiling of some cell,
possible short-circuit
GU ARANTEE