The life of a VRLA battery is dependent on the life of the electrolyte and the life of the electrolyte is dependent on the levels of water released during the gassing phase. Abertax researchers Klaus Dieter Merz, Joseph Pule, and George Schembri discuss the value of the valve that controls the gassing — it's a small part with a huge impact on the battery performance.

# Superior valve design for VRLA batteries

A high quality valve for VRLA batteries is essential to ensure quality battery performance. Research over a four year period has shown that most of the valves on the market tend to have a wide range of opening and closing pressures. Apart from that, they tend to degrade in performance rapidly affecting the cells concerned, resulting in unacceptable short cycle life of VRLA batteries. The goal of the reseach was to design a superior valve, suitable for all VRLA batteries. This superior valve has been in use for the past four years and has been proven by various battery manufacturers. This is becoming more important than ever given that the AGM battery is being used for all future stop and go applications.

## Valve construction

The standard valve basically consists of three main parts: the valve body, the diaphragm and the valve lid. The precision of the plastic and rubber parts is of utmost importance for the proper functionality of the valve during its operation.

A bottom cap is used at the lower end to protect the valve from the direct exposure of the diaphragm to the acid vapour. The o-ring, which should be of the appropriate dimensions depending on the type of battery lid, ensures that no gas leaks occur between the battery lid and the valve body.

The diaphragm and the length of the calibrating pin are the most important parts in the valve which determine the pressure settings of the valve. This patented technology uses a disk shape diaphragm design rather than the typical U-shape design as used in most of the safety valves for VRLA batteries.

The membrane material and design is the result of intensive research by Abertax R&D and has proved to stand the most harsh environments that some of the VRLA batteries might be exposed to.

This diaphragm in combination with the novel lid and body design of the valve outperforms any other valve on the market through a number of advantages namely by addressing the critical features as shown in figure 2.

Main valve features to ensure the expected cycle life of a VRLA battery

During their research work, the authors found out that the valve can have a huge impact on battery performance. They identified that the following characteristics are a must for a high quality valve:

- Low tolerances in opening — and closing pressure
- Calibration of the opening and closing pressure
- A good flow rate at excessive pres-

Figure 1: Exploded view of the Abertax valve

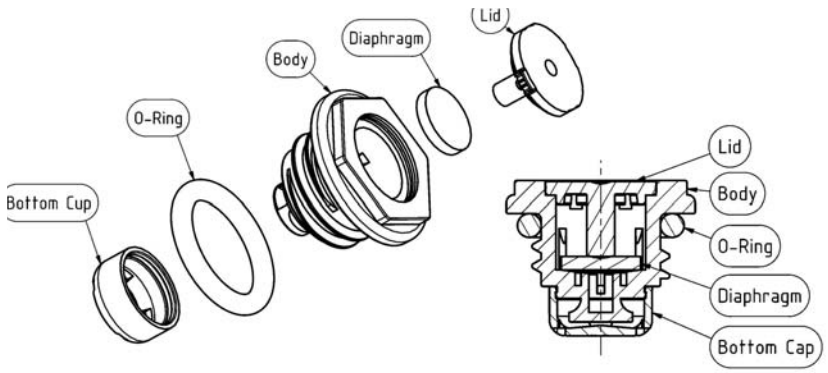
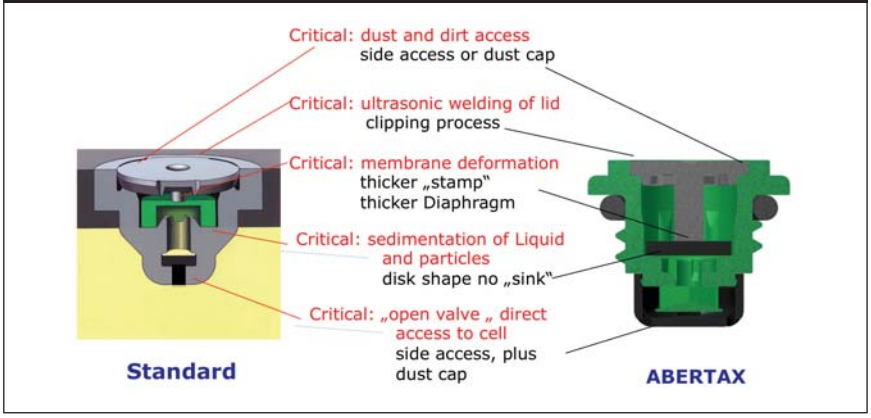



Figure 2: Comparison of critical features between the Abertax valve and a standard valve



sure to ensure safety
- Capability of a long cycle life without degradation in performance
- Acid resistance
- Protection against any form of dust particles
- Self-cleaning surface
- Has to fulfil the ignition test and meet IATA test requirements

The most important feature to guarantee the expected performance of a VRLA battery is the opening and closing pressure tolerance, the long cycle life and the appropriate pressure setting. Abertax patented valve technology is the only technology that allows the calibration of the opening and closing pressure to specific requirements which depend mainly on the design, construction and material of the battery box.

The most important feature to guarantee the expected performance of a VRLA battery is the opening and closing pressure tolerance, the long cycle life and the appropriate pressure setting.

Figure 3a: Opening /closing pressure of 100 Abertax valves
Figure 3b: Opening /closing pressure of 100 valves of a selected example

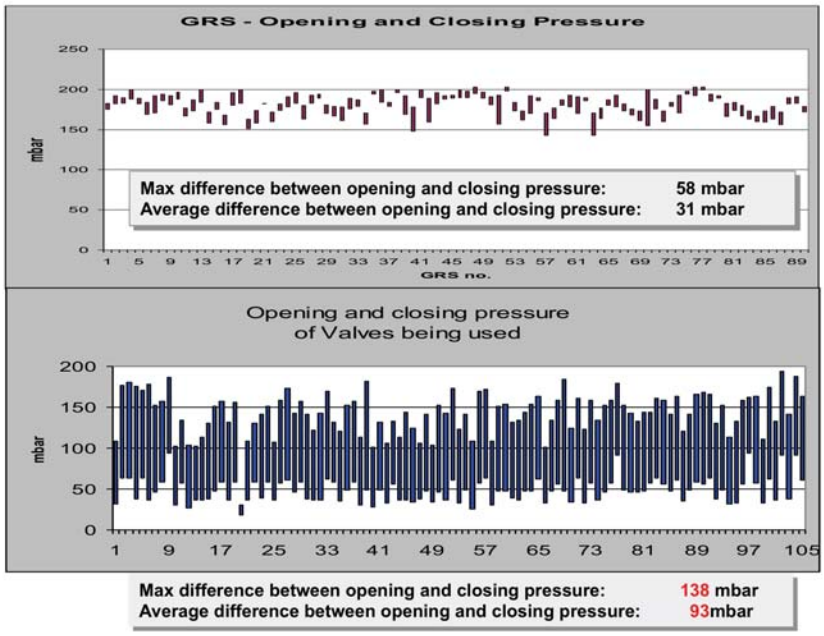
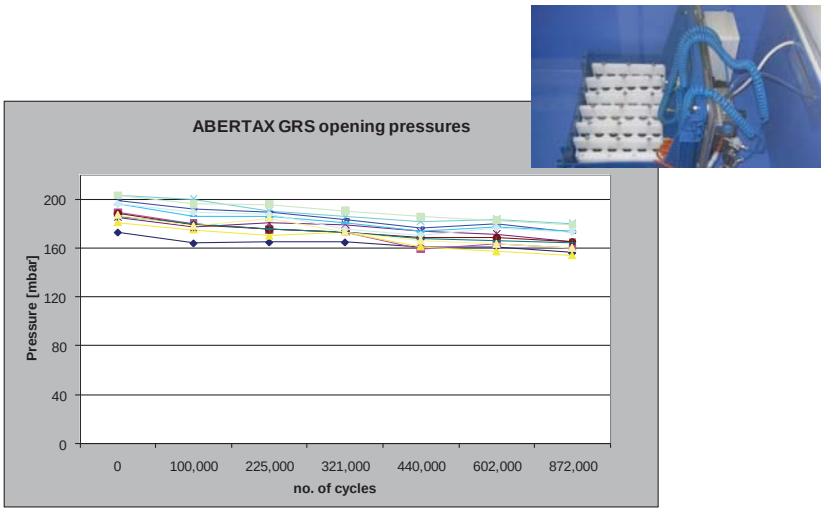



Figure 4: The Abertax GRS performance during the cycle test




In particular, the closing pressure and the difference in the operating pressure of each individual valve are important to guarantee the expected cycle life of a VRLA battery.

These specifications are not so critical for a low cost AGM block batteries. These are used in standby operations such as UPS applications where the standby voltage of the battery is always below the voltage that causes the battery to gas, ie 2.35V.

However it is extremely important for a good gel or AGM battery used in cyclic applications, where the battery is exposed to discharge and charging profiles that will cause gassing regularly.

The authors delved into this problem and present their results (below ) showing the huge effect that a valve can have on the performance of the battery.

## Opening and closing pressure

The patented Abertax GRS was designed to ensure that the opening and closing tolerances are at their lowest possible values. This, and the very low pressure differences of each individual valve, are considered to be the most important specifications to guarantee a quality VRLA battery.

A number of valves that are available on the market were selected and tested for their opening and closing performance and the best of these was then selected and compared with the Abertax GRS which was calibrated to open at 175mbar.

Figure 3a shows the performance of the Abertax GRS while figure 3b shows the performance of the other valves selected. It can be clearly observed that the Abertax GRS outperforms the others.

The opening and closing pressure range of the Abertax valves is within a range of +/- 25 mbar and can be calibrated to the required pressure.

## Cycle life

During the recharging process gas is generated in the battery cell. The amount of gas generated during the charging cycle depends mainly on battery design, charging regime and temperature. The valve opens during this process between 50 and 250 times.

The cycle life of a good quality battery is of around 1,000 cycles, implying that the valve cycles could go up to more than 250,000 cycles.

The Abertax valve easily reaches

over 1 million cycles keeping within the calibrated pressure specifications.

## Effect of valve on battery performance

The impact of a high quality valve on the life time and performance of the battery has been demonstrated with the numerous tests conducted. The experience of the authors clearly identifies that the end of life of a good designed VRLA battery is usually a lack of electrolyte.

This is mostly attributed due to the gassing during the charging phase. Gassing results from the decomposition of water and this generated gas is released through the safety valve when the internal cell pressure exceeds the opening pressure of the valve. Therefore the battery will be losing the gas that would otherwise be available again for recombination into water.

Hence this results in a water loss of the very limited amount that exists in all VRLA batteries. The consistency of the opening and closing pressure between the valves on the same battery is also extremely important as otherwise the cell with a higher pressure valve tends to press on the cell with the lower pressure valve causing it to release even a higher amount of gas with every cycle.

## Water loss test on GEL block batteries

Several 12V gel block batteries were fitted with three 30 mbar valves and three 170 mbar valves respectively. These batteries were then continuously cycled and the water loss was calculated after 100 and 200 cycles. This was done through an experimental setup which the authors designed to measure the volume of gas released by each cell.

As expected, the cells fitted with the low pressure valves (30 mbar opening pressure) had a much higher water loss in comparison to the cells fitted with the 170 mbar valves.

This high water loss has a significant impact on the acid concentration inside the cells resulting in much higher corrosion and higher voltage level during recharge. Such "unbalanced cells" lead to premature failure of the battery.

## Test results on OPzV cells

This section demonstrates the performance of a high quality valve in reducing the gassing and eventually water loss in products such as OPzV cells which are expected to give a long life. The block and lid material is usually made of very strong plastic material and would therefore allow the use of a valve with high opening and closing pressure.

Standard valves currently used in VR cells have an opening pressure of around 80 mbar. Such OPzV cells fitted with 80 mbar valves have been taken in a C3 to C10 cycles test with continuous internal cell pressure measurement.

The graph (left) shows clearly that the cell pressure of 80 mbar inside the cell is always exceeded. This means a loss of hydrogen and oxygen out of the cells which results in water loss during each and every cycle

As can be seen in figure 6, the cell pressure does not exceed the 80mbar

Figure 5: Water loss test

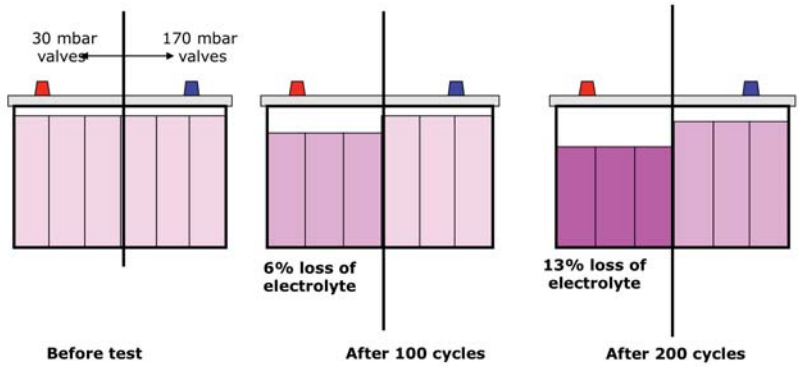



Figure 6: Internal cell pressure of an OPzV cell while being cycled with a valve opening at 80mbar

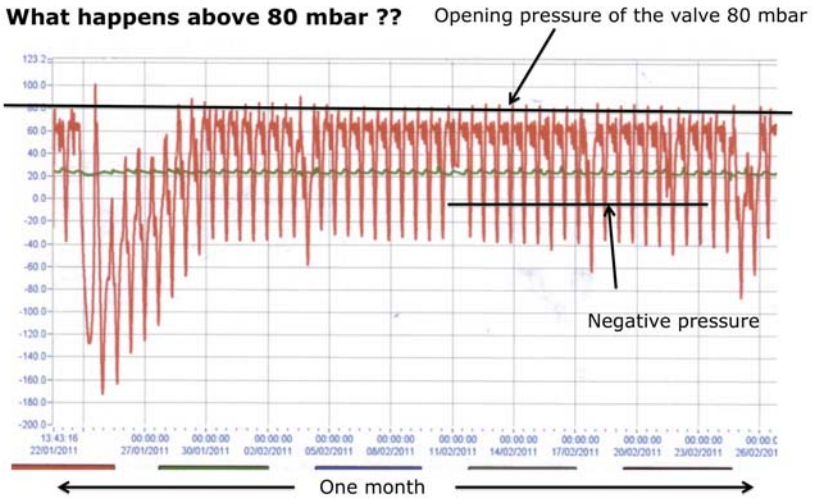
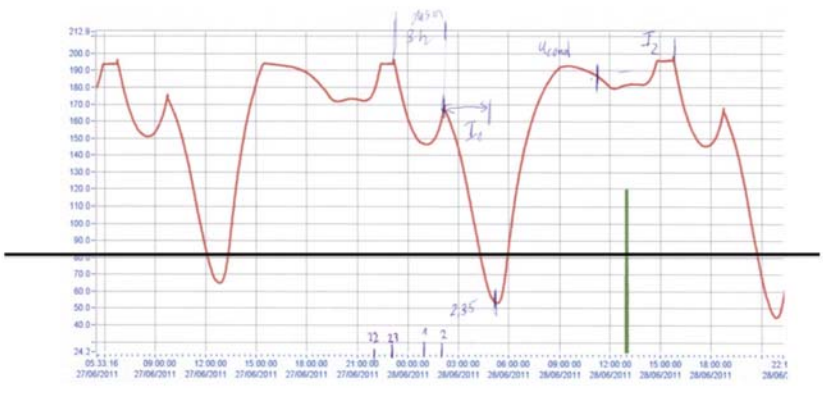



Figure 7: Internal cell pressure of an OPzV cell while being cycled with a valve opening at 200mbar



because the valve is releasing internal generated gas. The gassing phase lasts about 60% of the whole recharging time and therefore results in a critical amount of water loss.

Interesting to note is the cell internal pressure curve characteristics during the discharging and recharging process. To investigate the effect of the valve on this characteristic the authors carried out test with valves set to open at different pressure.

Figure 8: Comparison of pressure inside cell during recharge using valves of different pressures

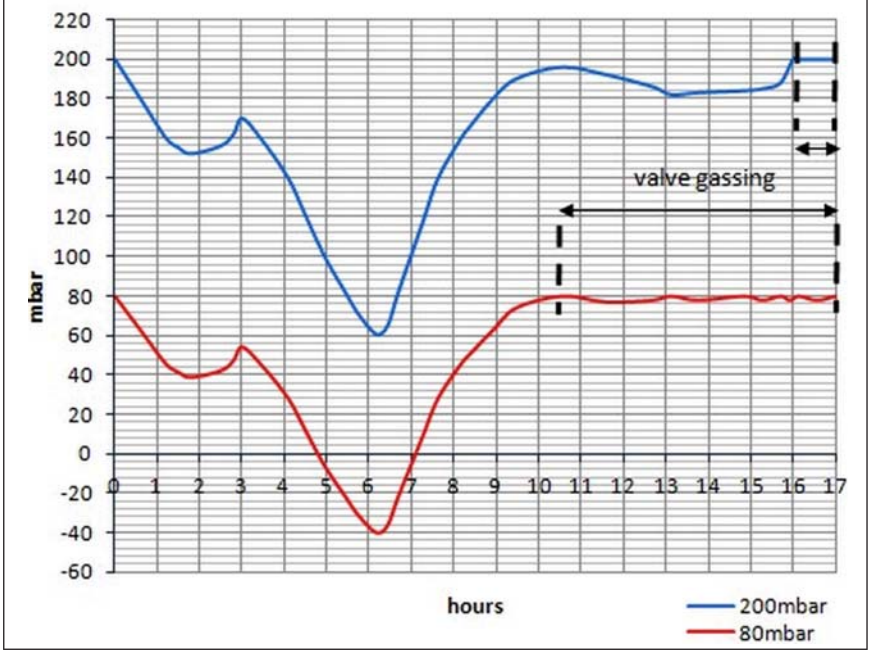



Figure 7 shows this characteristic for a cell equipped with an Abertax GRS valve calibrated to open at 200mbar. It was concluded that while the shape of the characteristics does not vary with pressure, the pressure operating levels inside the cell vary drastically.

In fact while the pressure inside the cell fitted with a 200mbar valve is always positive, the cell with the 80mbar valve goes into negative pressure while discharging.

It is important to note that in the case of the cell with a 200mbar valve there is only a very short period of gassing at the end of the charging phase.

Figure 8 shows one cycle and one can observe that in the case of the 200mbar valve, the duration of gassing was only one hour out of 14 hours, while in the case of the 80mbar, the gassing was 6½ hours.

This means that with a high pressure setting of the valve, the gassing time is drastically reduced and thus the water loss is very low.