EU Reg. 2023/1542

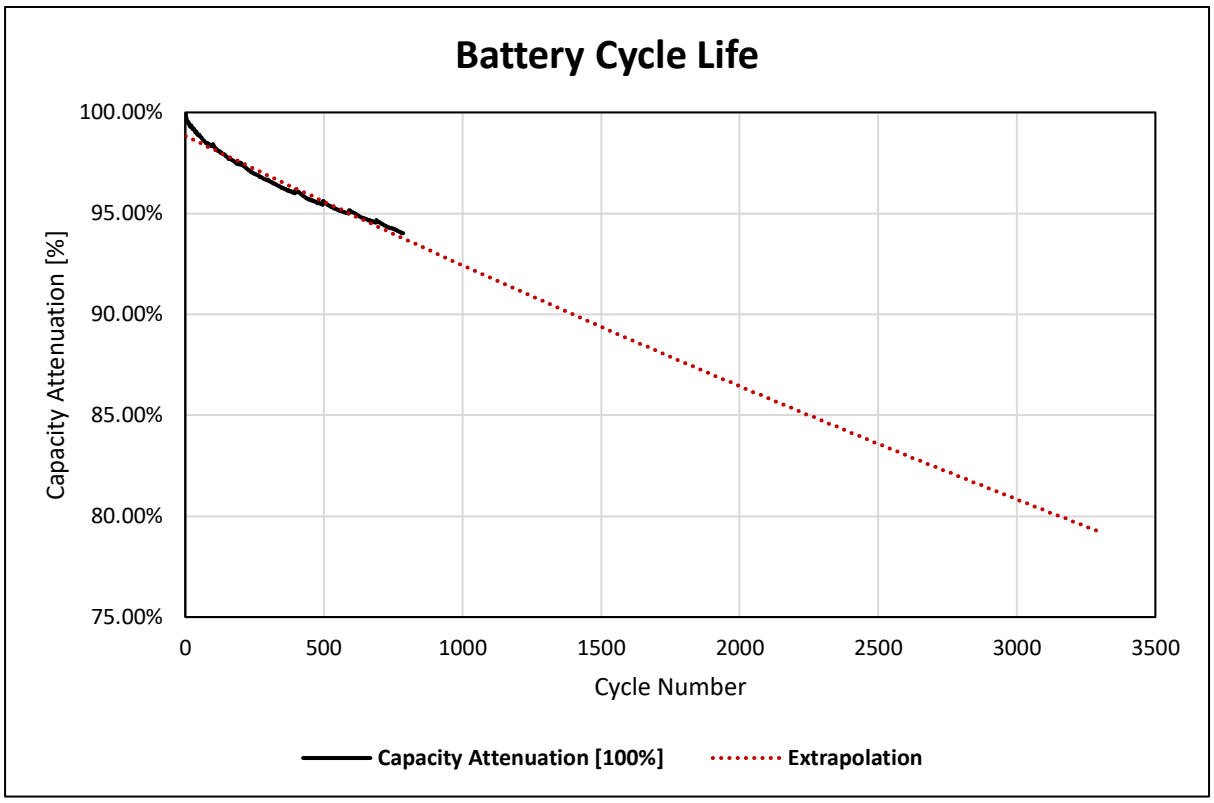
Electrochemical Performance and Durability Requirements of RELiON RB Batteries According to Article 10

Lifetime

The Relion RB batteries have a lifetime of 2,000 cycles at an ambient temperature 25°C, with a charge rate of 1C, a discharge rate of 1C, and a Depth of Discharge (DoD) of 100%, before its capacity decreases to 80% of its initial value.

Rated Capacity Fade

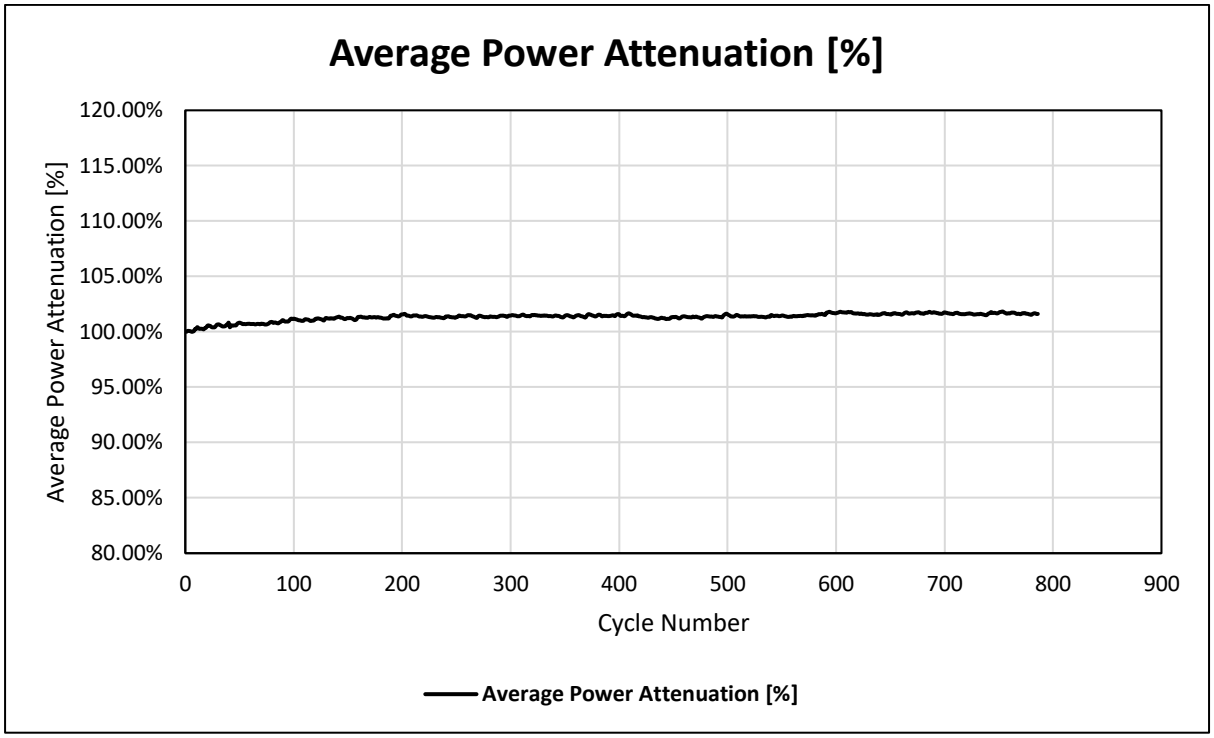
The graph below shows the capacity retention [%] when the battery is cycled with a 1C charge rate, a 1C discharge rate, and a DoD of 100% at ambient temperature of 25°C.



- *The graph above is based on data from internal testing conducted by Navico Group.*

Power Fade

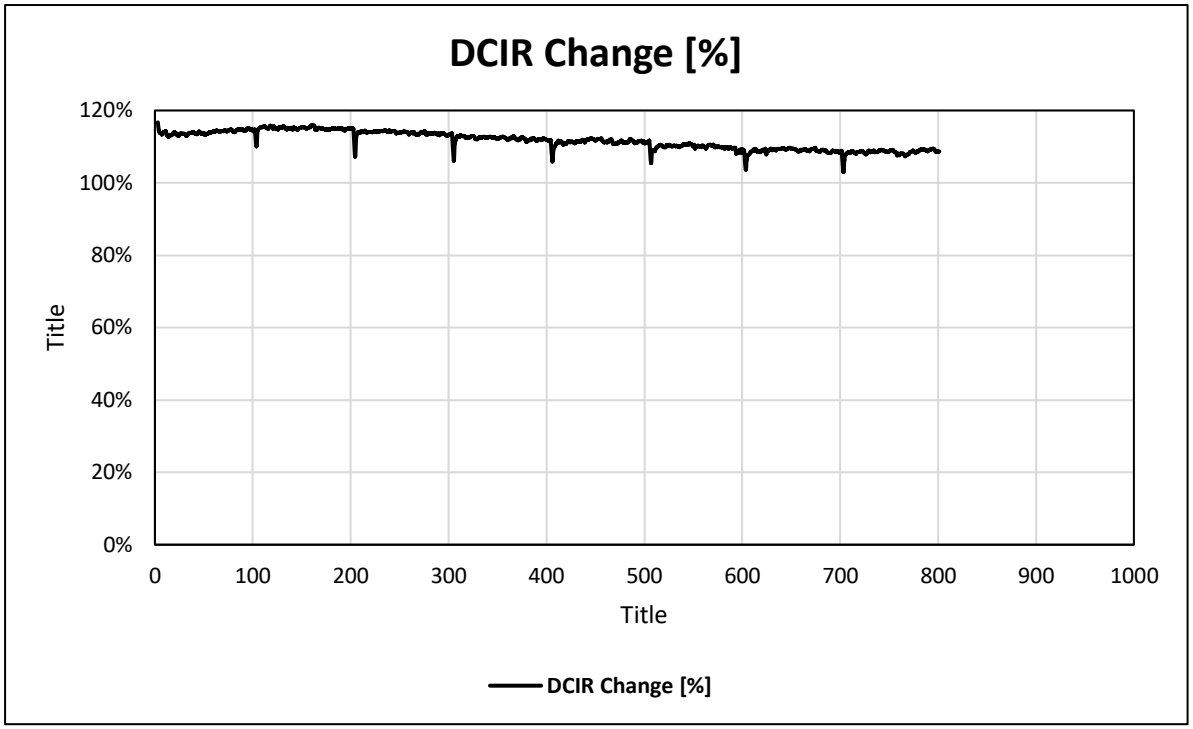
In the graph below the one cycle average power attenuation over lifetime is depicted. The average power [W] is calculated as the ratio of the energy [Wh] delivered by the battery during the discharge over the number of hours [h] the discharge process lasted. The graph below shows how the average power of the battery evolves over the lifetime of the battery if cycles with 1.5C charge, 1.5C discharge at 25oC with DoD=100%.



- *The graph above is based on data from internal testing conducted by Navico Group.*

Internal Resistance Increase

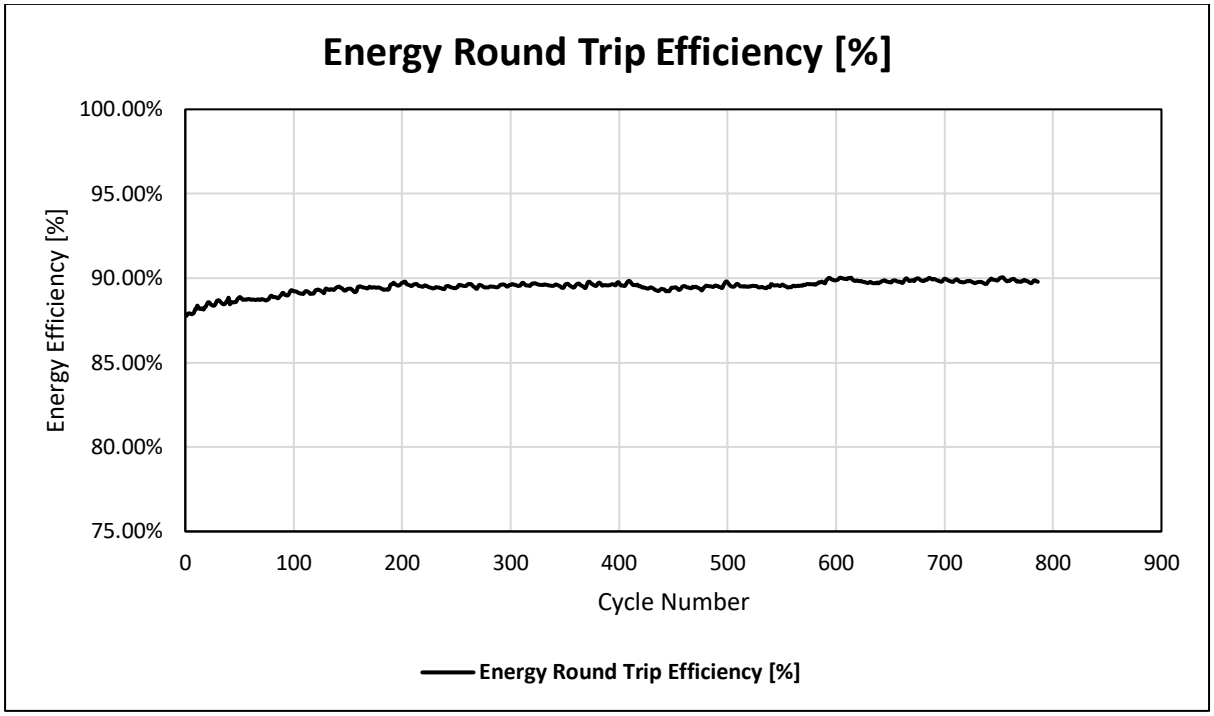
The graph below shows the increase of the internal resistance as percentage of its initial value [%] when the battery is cycled with a 1.5C charge rate, a 1.5C discharge rate, and a DoD of 100% at an ambient temperature of 25oC.



- *The graph above is based on data from internal testing conducted by Navico Group.*

Energy Round Trip Efficiency

The graph below shows the Energy Round Trip Efficiency [%] when the battery is cycled with a 1C charge rate, a 1C discharge rate, and a DoD of 100% at ambient temperature of 25°C.



- *The graph above is based on data from internal testing conducted by Navico Group.*

Battery Power Capability

The nominal power per battery along with other parameters are stated in the table below.

Battery Model	Nominal Voltage [V]	Cont. Discharge Current [A]	Nominal Capacity [Ah]	Battery Energy [Wh]	Nominal Power [W]	Nominal Power / Battery Energy	Initial Internal Resistance [mΩ]
RB100	12.8	100	100	1280	1280	1.00	6
RB24V100	25.6	100	100	2560	2560	1.00	11
RB24V52-D	25.6	50	52	1331.2	1280	0.96	22
RB20-LT	12.8	20	20	256	256	1.00	28
RB48V300	51.2	200	300	15360	10240	0.67	7
RB24V200-D	25.6	200	200	5120	5120	1.00	6
RB40	12.8	40	40	512	512	1	14.4

- *The battery can maintain the nominal power over the whole SoC range, but its duration for which is different based on the SoC.*

Formulas & Definitions

The internal resistance of the battery presented above is the equivalent DCIR [Ω] of the battery as measured during the cell cycling and calculated as follows:

$$DCIR[m\Omega] = \frac{\Delta V[Volt]}{\Delta I[Ampere]} = \frac{V_{discharge}[Volt] - V_{rest}[Volt]}{I_{discharge}}$$

The round-trip efficiency is defined as shown in the following equation:

$$Energy\ Round\ Trip\ Efficiency[\%] = \left(\frac{Energy_{Discharge}[Wh]}{Energy_{Charge}[Wh]}\right) * 100\%$$

- *The losses and resistance due to BMS and connections are ignored as they remain constant and are considerably smaller.*

The nominal power definition can be seen in the equation below:

$$Nominal\ Power[W] = Nominal\ Voltage[V] * Discharge\ Current^{maximum}_{Continuous}[A]$$

Battery energy is defined as follows:

$$Battery\ Energy[Wh] = Nominal\ Voltage[V] * Battery\ Capacity[Ah]$$