# HITACHI

## LL series AVRLA  Battery
Setting the industry standard for storage batteries

## BATTERY RELIABILITY

### Field failure rate

### Mean time  between  failures (MTBF)

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## Foreward

Hitachi Chemical has delivered the LL series battery in many different applications around the world since 1999 including (1) PV off-grid, (2) PV on-grid, (3) Wind power stabilization, (4) Micro-Grid, (5) Peak shaving on-grid.

Already up to March 2014 there were more than 83 different installations ranging from 11kWh to 10.3MWh installed during this time with a total of 105MWh installed accross the above mentioned application areas. The total aggregated operating hours across all installations combined with field return (failures) statistics allows for an estimated field failure rate (FFR) and Mean Time between failures (MTBF) to be calculated for any size bank with a high level of confidence.

Conversely with new battery technologies and chemistries that are now appearing on almost a daily basis, no such statistical field data exists as these installations are very recent so have not accrued any significant operating hours under diverse operating conditions of charge/discharge and temperature. This presents a higher level of risk of reduced system availability and system downtime.

Requirements of renewable energy sources such as wind and PV, or grid stabilization demand a frequent change of current flow direction in the battery. Therefore the batteries are often operated in a partial state of charge. The HITACHI LL batteries have been specifically designed and tested for these types of application. Also the batteries can operate safely in an environment with an ambient temperature of 25°C to 30°C average with not degradation on throughput energy.

## Definitions

**Failure rate**
Is the frequency with which the engineered system or component fails, expressed in failures per unit time.
The term FIT (failures in time) is used in industry and is defined as 1 failure per billion hours or $1 \times 10^{-9}$ failures per hour = 1 FIT

**Field failure rate (FFR)**
Is calculated by the formula:

$$\frac{\text{Sum of all component field operating hours}}{\text{quantity of failed components}}$$

**Mean time between failures (MTBF)**
Is a measure of how reliable a system or component is, expressed in number of hours between failures where;

MTBF (hrs) = 1 / FIT

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## Example Calculation

The field failure rate for Hitachi LL series is:

FFR = $0.5 \times 10^{-9}$ failures per hour = 0.5 FIT

This is for one (1) 2V cell.

**Application example**
Battery Energy Storage System rating = 4 clusters x 2.36MVA = 9.44MVA
Configuration = 4 clusters x 8 parallel x 76 series connected Hitachi LL1500AS8 modules
Module Voltage nom. = 8V (4 x 2V cells in series)
Module gross capacity = 12kWh [100% DoD]
Module net capacity = 7.2kWh [60% DoD, 30% to 90% SoC]
Bank net capacity = 7.2kWh x 4 x 8 x 76 = 17.5MWh

1 cluster = 8 parallel x 304 series x 2V cells = 2343 cells (608 x Hitachi LL1500AS8 modules)



590kVA    590kVA    590kVA    590kVA

2.36MVA
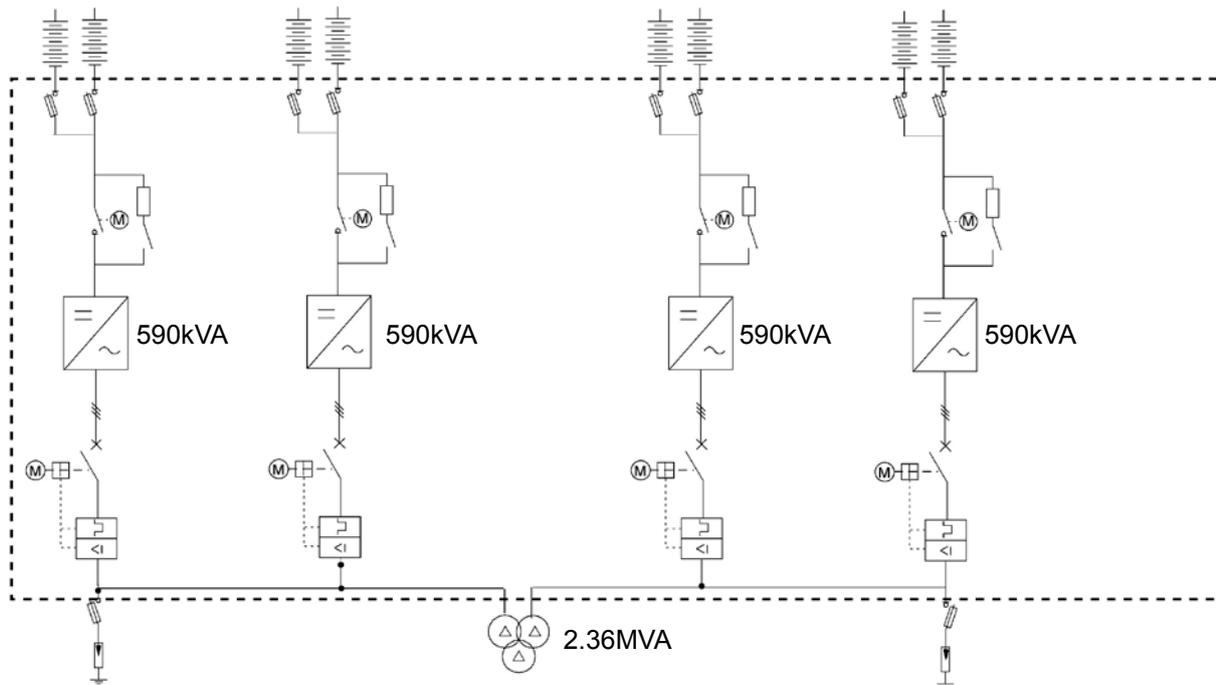
| Bank failure rate = | | Qty 2V cells | x | cell field failure rate (FFR) |
|---|---|---|---|---|
| | = | 4 clusters x 2343 cells | x | 0.5 FIT |
| | = | 4,686 FIT  or  $4{,}686 \times 10^{-9}$ failures per hour | | |
| | | | | |
| MTBF (Bank) | = | $1 / 4{,}686 \times 10^{-9}$ = 213,400 hours or 24years | | |

**If you have any further technical questions, please do not hesitate to contact us:**

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**Disclaimer**
Above technical specifications has been established on the basis of extended life tests which simulated actual working conditions as realistic as possible. Investigations that have been caried out with batteries that have been retrieved from the field after 3.5 and 7 years. These investigations have substantiated that the discharge capability and cycle life are also achieved in pratical applications. However, the above mentioned values do not construct any guaranteed features in the legal sense.

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