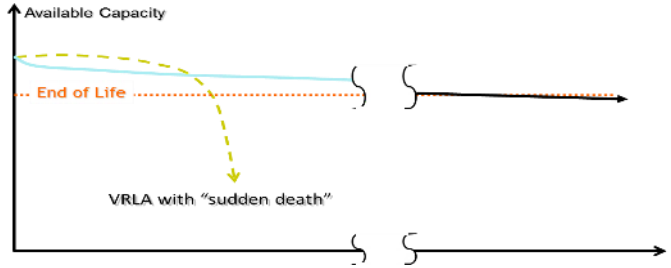
Webinar July 2020
Ni-Cd Technology

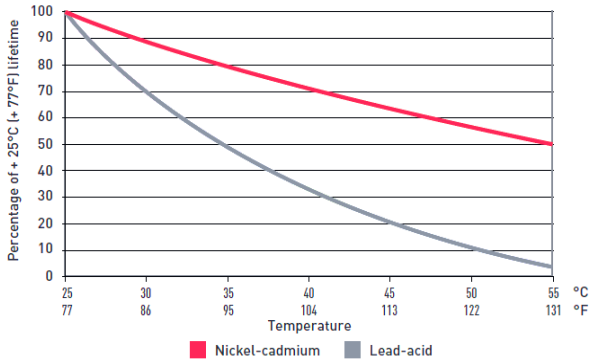
saft
a company of
TOTAL

WHY NICD?

The benefits of Ni-Cd

- Total reliability
  - No risk of sudden death
  - Long service life
  - Tolerant of extreme temperatures
  - Electrical and mechanical robustness





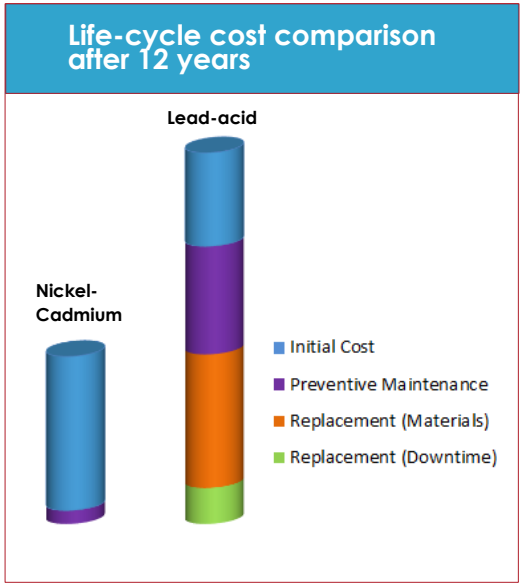
Low Total Cost of Ownership (TCO)

Saft Ni-Cd benefits versus Lead-acid

Lower TCO of Saft Nickel-Cadmium batteries

- No downtime cost
- No replacement cost
- Low maintenance cost
- Optimized performance

Lower cycle cost of Saft Nickel-Cadmium batteries versus lead-acid



BASICS OF TECHNOLOGY

Ni-Cd battery composition

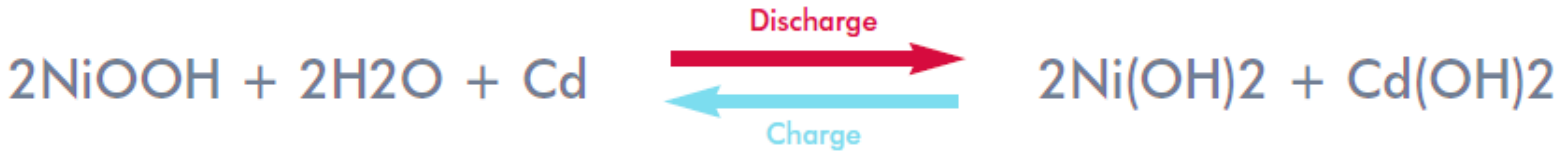
Active materials

Positive electrode

- Nickel Hydroxide (discharged)
- Nickel Oxyhydroxide (charged)

Negative electrode

- Cadmium Hydroxide (discharged)
- Cadmium (charged)



Ni-Cd battery composition

Separator

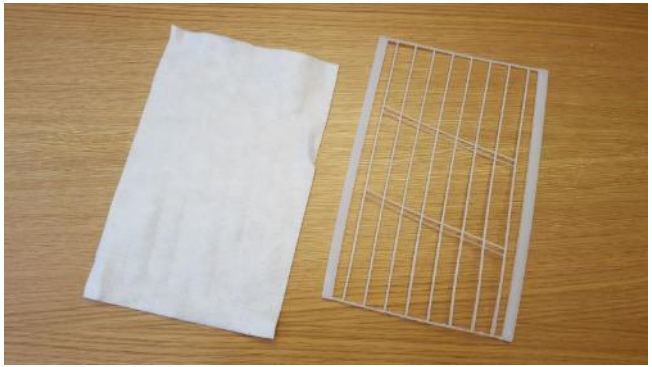
- Grid or Felt

Electrolyte

- Potassium Hydroxide (KOH), destilled or deionized water and small quantities of Litium Hydroxide (LiOH)

Nominal voltage

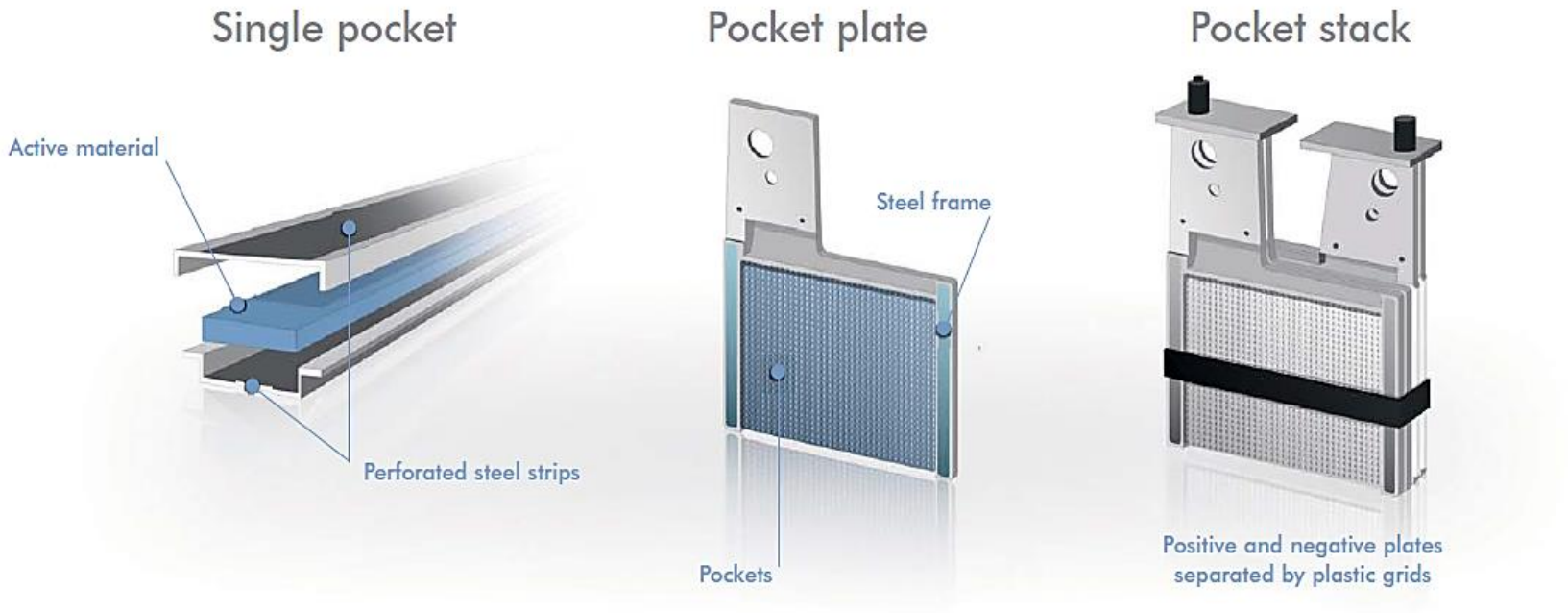
- 1.2 V/cell



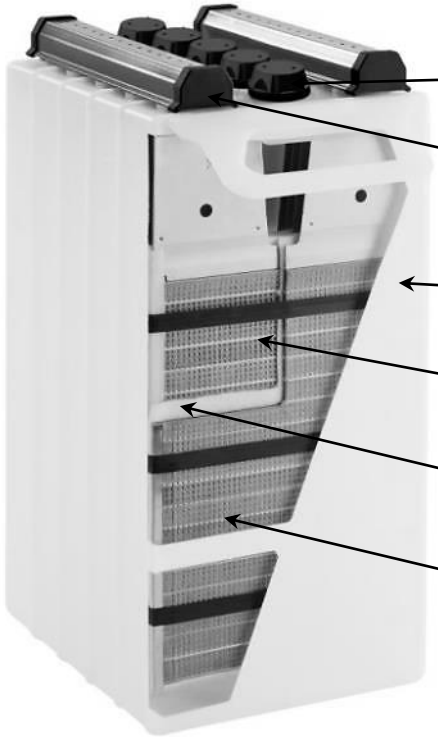
Rated capacity

- Quantity of current and duration of time that a cell can provide at a discharge rate of $0.2C_5A$ down to a voltage of 1.00 V at 20°C

Pocket Plate electrode



Ni-Cd Pocket Plate Battery



Low pressure flame arresting vent

Terminals beneath terminal covers

Polypropylene container

Ni positive electrode

Polypropylene fibrous separator

Cd negative electrode

Plate types with optimized performance

Performance is related to plate thickness

L type

- Thick plates
- Optimized performance for low discharges for long discharge times

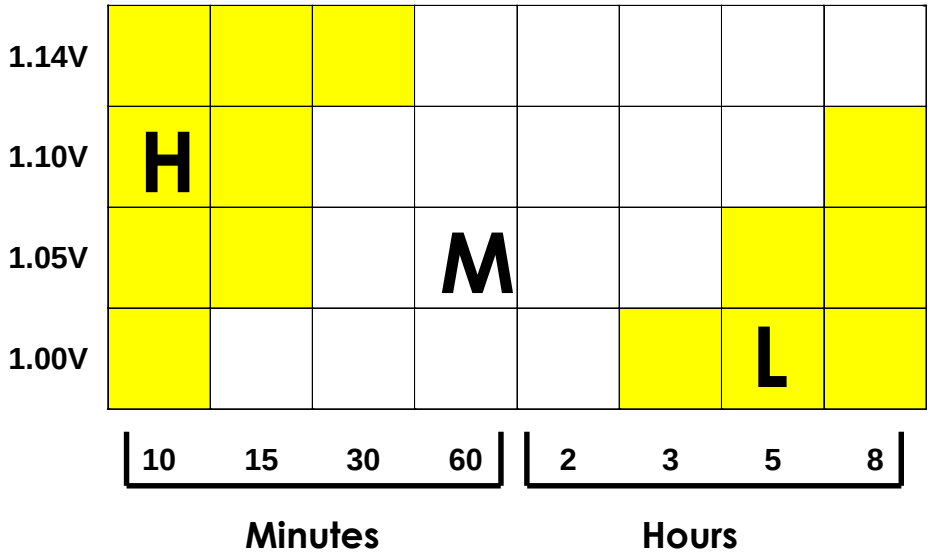
M type

- Plate thickness between L and H type
- Optimized performance between L and H

H type

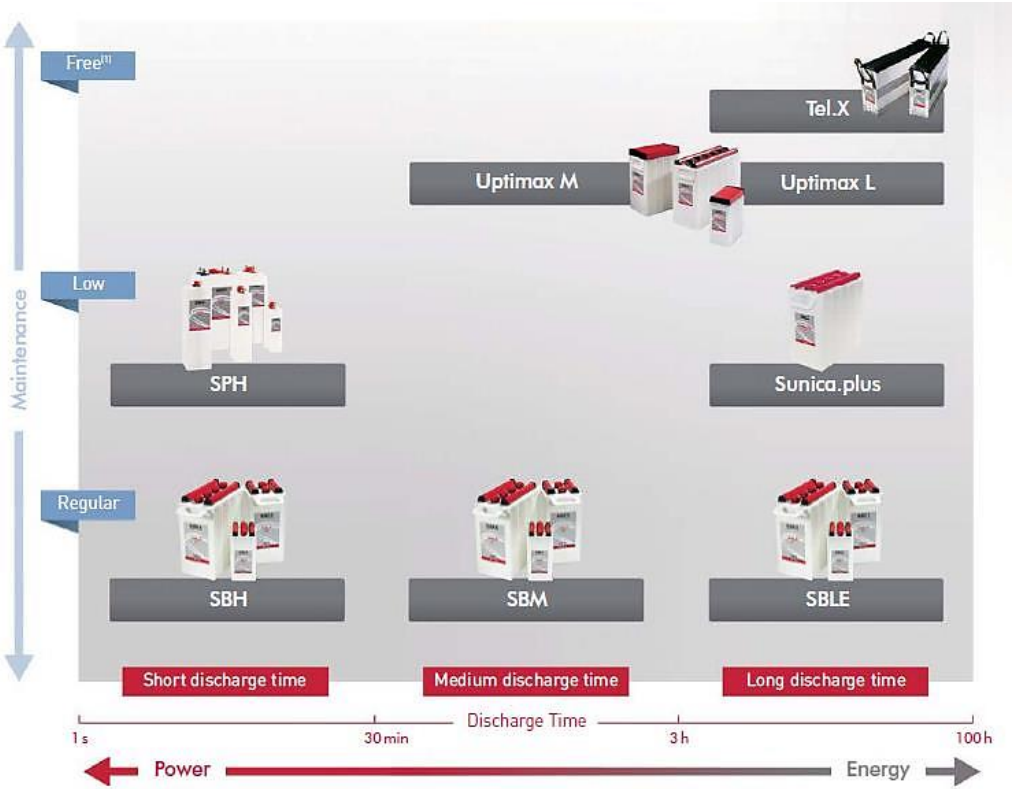
- Thin plates
- Optimized performance for high discharges for short discharge times

Most cost effective product



Saft stationary Ni-Cd batteries

A large offer to find the right battery



New Products

Ni-Cd New Product Road Map

Ni-Cd

New Uptimax

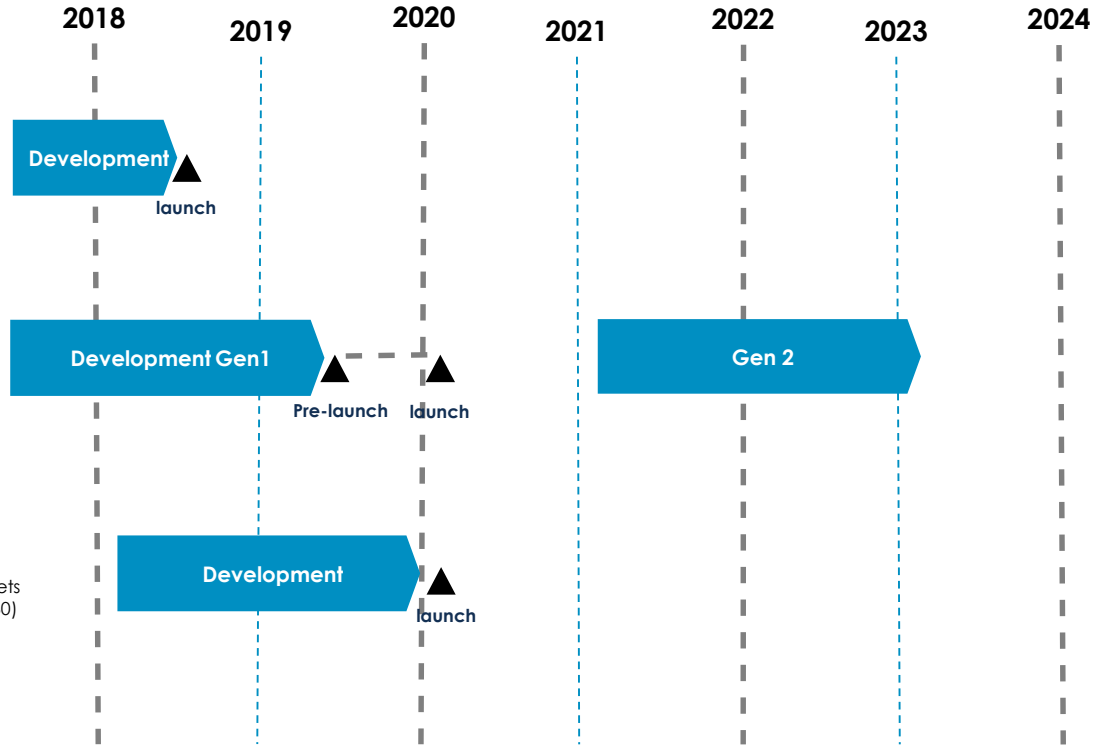
Perfect fit to replace lead-acid
- 1.39 V/cell single level charge
- Fast recharge capability

Intelligent Battery

UIT, electrolyte level & H2 indicator
SOC, SOH predictive calculation
Remote communication

Compact

Complement the existing L-range
Target compact installations in cabinets
Same capacity range (80/100/150/180)



New Uptimax Range
What's new?

The 1st Ni-Cd battery adapted to narrow DC voltage window

– **1.39 V/cell single level charge**

- Perfect fit to replace lead-acid batteries
- Adapted to narrow DC voltage window, without dropping diodes or DC/DC converters

– **Fast recharge capability**

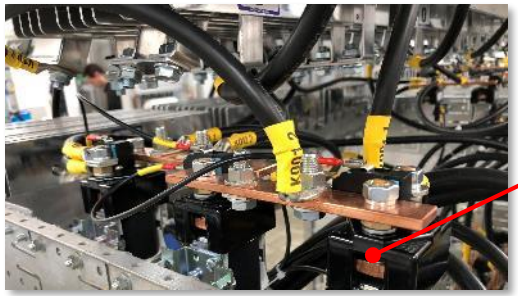
- 95% State-Of-Charge (SOC) achievable in 8h @1.45 V/cell
- For minimal downtime and optimal availability

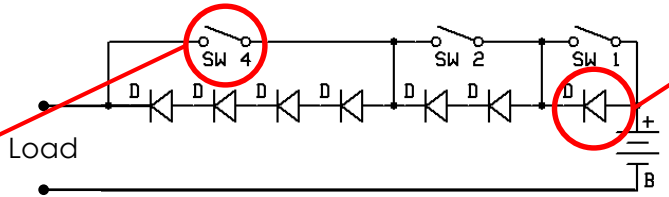
Uptimax Gen 3: More competitive solution to convert lead-acid

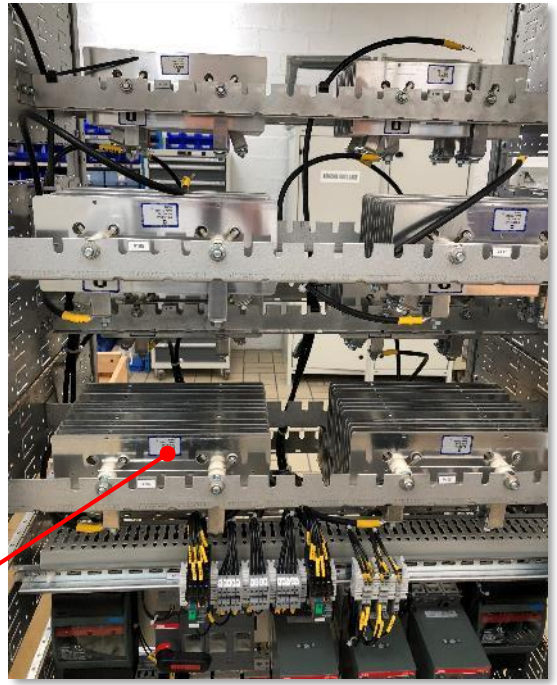
New Uptimax Range
Dropping diodes

No need for dropping diodes

- **Expensive component**
  - Size of diodes is depending on the system current
- **Lower voltage for the load**
  - Voltage is decreased by diodes connected in series
  - Not needed with new Uptimax (1,39V/cell)







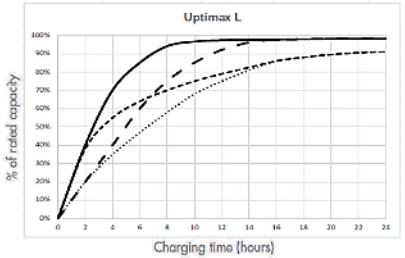
New Uptimax Range
The 1st Ni-Cd battery adapted to narrow DC voltage window

Technical Specifications

	UP1 L energy range (L type)	UP1 M medium power range (M type)
	For low-rate discharges over long periods between 1 and 100 hours	For mixed loads with low and high discharge rates, between 30 minutes and 3 hours
Capacity range (C5 rate)	15 to 1700 Ah	8 to 1330 Ah
Range of:	34 cells	38 cells
Charge voltage	Single level: 1,39 V/cell Two level: 1,39 V/cell float, 1,45 V/cell boost Temperature compensation: -2 mV/°C	
Recharge	95% SOC in 8 hours @ 1,45 V/cell, 0,2 C5A	
Topping up interval	No topping up needed when charged according to specification	

Figure 3(a): Available capacity after constant voltage charge

Available charge current 0.1 C_5A or 0.2 C_5A at +20°C (+68°F)

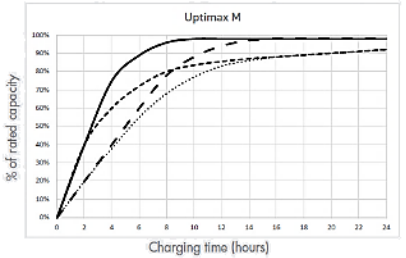


- 1.45 Vpc at + 20°C (+ 68°F), 0.2 C_5A
- 1.45 Vpc at + 20°C (+ 68°F), 0.1 C_5A
- 1.39 Vpc at + 20°C (+ 68°F), 0.2 C_5A
- 1.39 Vpc at + 20°C (+ 68°F), 0.1 C_5A

*For charging voltages higher than 1.45 V/cell, a current limit of 0.1 C_5A is recommended

Figure 3(b): Available capacity after constant voltage charge

Available charge current 0.1 C_5A or 0.2 C_5A at +20°C (+68°F)



- 1.45 Vpc at + 20°C (+ 68°F), 0.2 C_5A
- 1.45 Vpc at + 20°C (+ 68°F), 0.1 C_5A
- 1.39 Vpc at + 20°C (+ 68°F), 0.2 C_5A
- 1.39 Vpc at + 20°C (+ 68°F), 0.1 C_5A

*For charging voltages higher than 1.45 V/cell, a current limit of 0.1 C_5A is recommended

New Uptimax Range
Your choice

New Uptimax can be

- Charged with 1,42 V/cell or 1,39V/cell
- Charged with single and two level charge method
- Installed together with previous generation in case cell replacement is needed

How new Uptimax creates new business?

Make sizing possible with narrow voltage window, increase your revenue base !

Ex: 110V +/-10%

	Uptimax	New Uptimax
System voltage window:	99 – 121 V	99 – 121 V
Single level charge voltage:	1.42 V/cell	1.39 V/cell
Max No of cells (max system voltage / charge voltage/cell):	85	87
End of Discharge (min system voltage / No of cells):	1.165 V/cell	1.137 V/cell

Max 85 cells possible EOD is too high ✗

EOD is OK ✓

Intelligent Battery
Customer wish to our new product

Target

Upgrade our product offering through digitalization

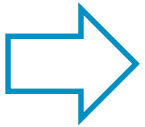
A battery monitoring system measuring key battery parameters

- Running time, State Of Charge calculation by advanced algorithm
- Remote monitoring capability
- Battery history: voltage, current, temperature (U, I, T) storage
- Cell voltage measurement
- Electrolyte level detection
- Hydrogen gas detection

Intelligent Battery
Business Approach

Features

1. State of Health
2. State of Charge
3. UIT logging
4. Electrolyte level
5. Cell voltage measurement
6. Hydrogen detection



Benefits

1. Capex planning
2. Battery availability
3. Battery history
4. Fewer site visits
5. Fewer site visits
6. Increased safety

Product launch target

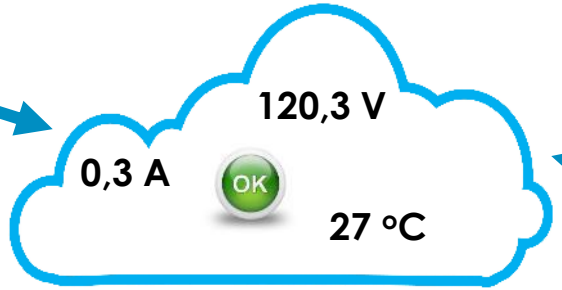
Q3-2020

Always connected to your backup – piace of mind

Intelligent Battery
Overview

Collect data | **Store & Process** | **Present & Manage**

Measurement module



Cloud connection via
- Mobile network
- LAN
- Satellite

Point-to-point (P2P)
- Local Connection

Data storage

Battery algorithm
- Calculation

Visualization
- Laptop
- Smartphone
- Tablet

Intelligent Battery
Live status updates

Questions

Why using it for Ni-Cd?

- We have always used the need for BMS systems as an argument against Lead Acid

Answers

Today everything is connected

- Customers expect connectivity
- Trend for asset monitoring

Fewer site visits is a requirement

- Especially in remote locations

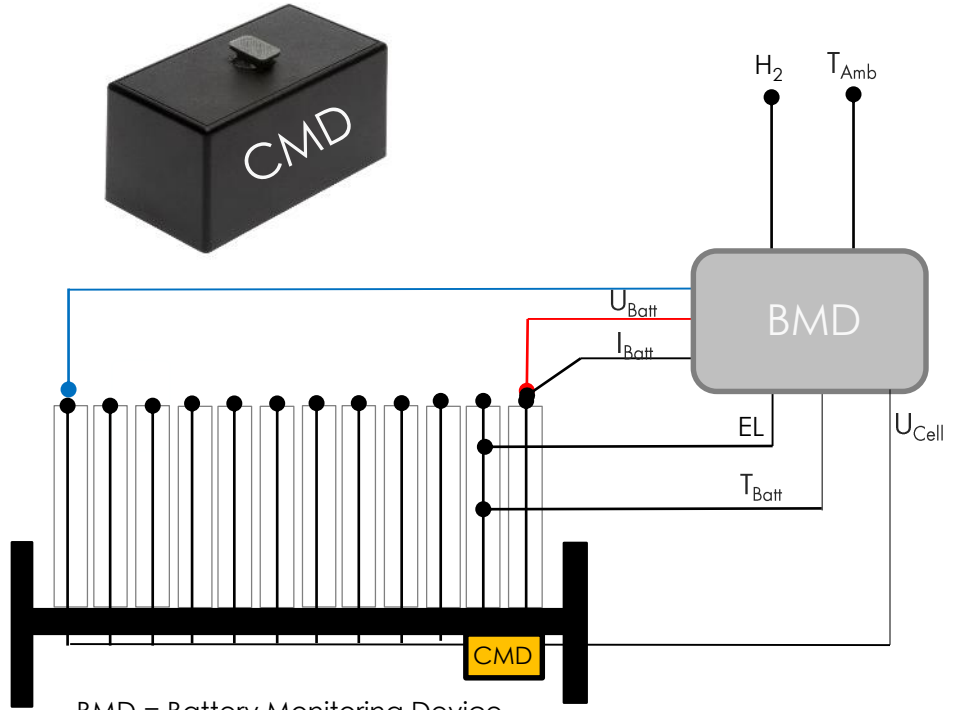
Used as complement to site visits

- Not as replacement of manual service

Intelli-Connect
How does that work?

Measures battery data

- By default parameters:
  - Battery voltage (UBatt)
  - Battery current (IBatt)
  - Battery temperature (TBatt)
  - Ambient temperature (TAmb)
- Optional parameters:
  - Electrolyte Level detection (EL)
  - Hydrogen gas detection (H2)
  - Cell voltage measurement (UCell)



BMD = Battery Monitoring Device

CMD = Cell Monitoring Device (12-cells max per CMD)

Intelli-Connect
How data is transferred

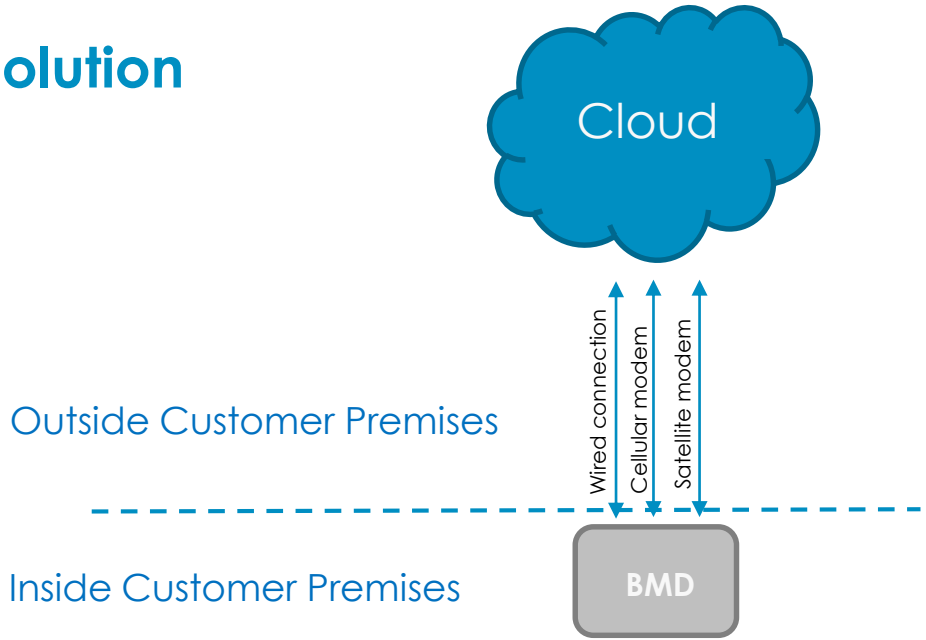
Answer data communication solution between BMD & Cloud

Baseline connectivity

- Wired connection

Connectivity options

- 2G/3G modem (e-SIM card in BMD)
- Satellite modem



Intelli-Connect
Data management

SECURITY

Data encryption:
Communication between BMD and Cloud is encrypted (TLS protocol)

Access protection:
All incoming connections to BMD on Internet interfaces are rejected. Communication with the Cloud is initiated by BMD

Cyber security audit:
Performed by third party according to ISO 27005

PRIVACY

Data ownership:
Data are owned by customer
Customer can only access their own data

Saft usage of data:
Upon approval of customer

CLOUD

Cloud solution:
Microsoft Azure

Cloud doesn't belong to Saft
Saft is paying a monthly fee to use Cloud functionalities for data storage and usage

Companies using Azure
Total, Airbus, Ericsson, Schneider Electric, Rolls Royce

Comparison
Ni-Cd vs Lead Acid

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AGENDA

1. Electrochemistry
2. Construction
3. Failure modes
4. Total Cost of Ownership

New mention

Electrochemistry

Electrochemical Reactions

Lead-Acid

PbO_2 (pos plate) + Pb (neg plate) + $2H_2SO_4$ (electrolyte) $\underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}}$ $2PbSO_4 + 2H_2O$

1. *Plates/Electrodes react continuously with Acidic electrolyte*
2. *Corrosion of Grids and components. Evolution of highly corrosive SO_3 acidic fumes.*

Ni-Cd

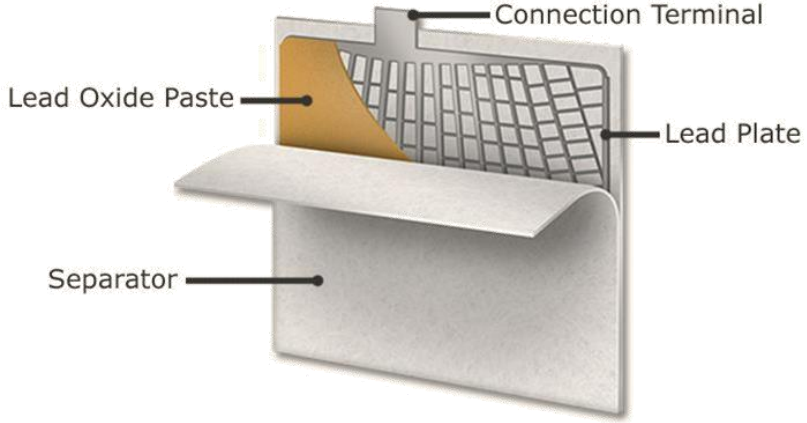
$2NiO.OH$ (pos plate) + Cd (neg plate) + $2H_2O$ $\underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}}$ $2NiOH_2 + CdOH_2$

1. *Plates/Electrodes do not react with Alkaline electrolyte*
2. *No presence of KOH solution in the chemical reaction.*
3. *The electrolyte is only acts as an ion carrier, NO Corrosion!*

Construction

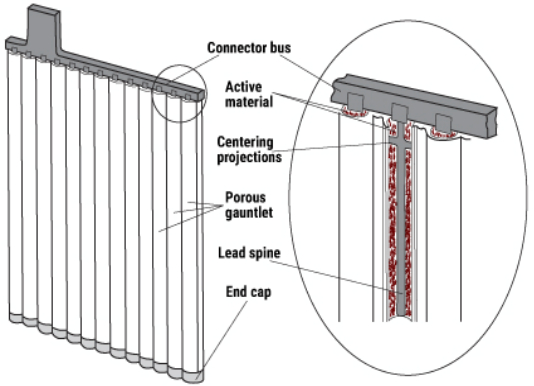
Electrode Structure – Pasted Plates

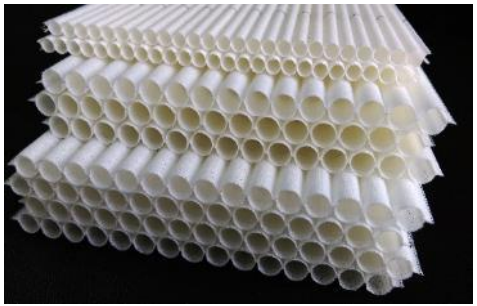
- No enveloping of active materials in Pasted plates (Vented & VRLA) lead acid.
- Tendency of electrodes to swell and shedding of active mass. Which cause internal shorting.



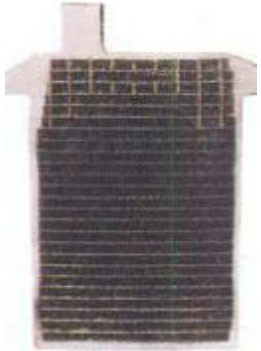
Electrode Structure - Tubular Plates

- Tubular plates have soft and non-conducting woven fabric enveloping to hold the active mass
- Tubular Spines are thin to maintain active mass ratio.
- If a spine cracks in between of a tube due to corrosion. Rest of the A/mass has no part to play in electrochemistry



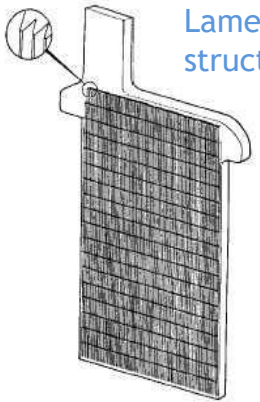


Electrode Structure - Planté

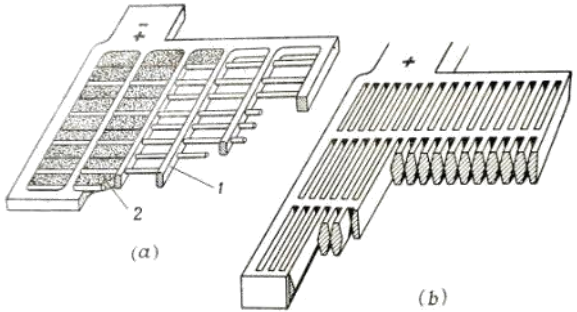


Planté plate

Neg plate



Lamella structure



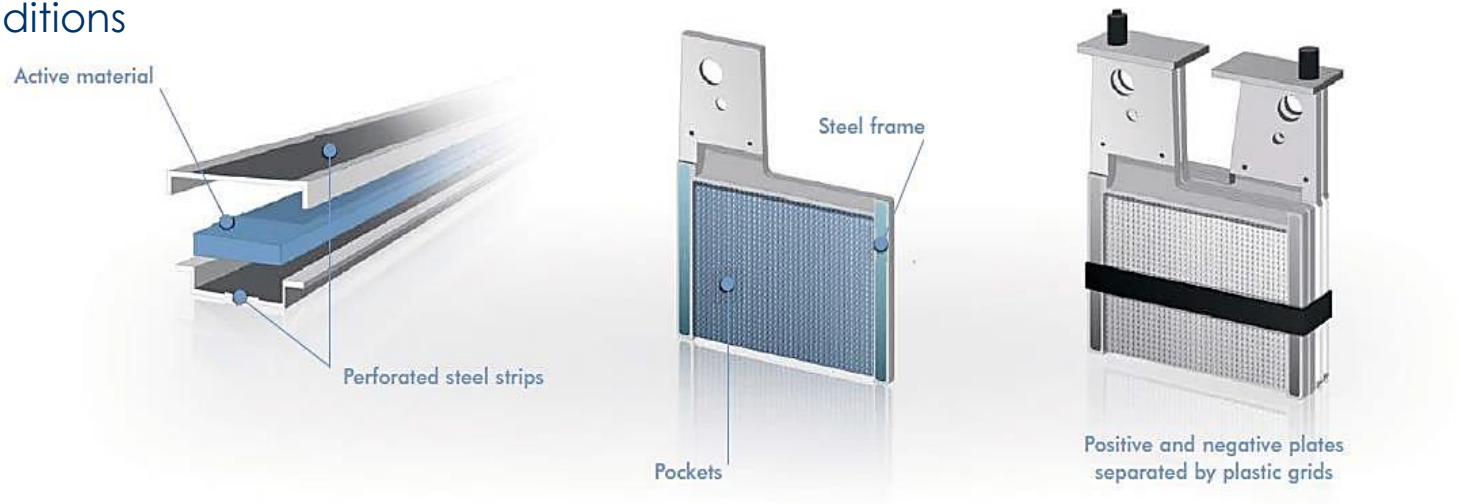
Thicker plates are used for active mass corrosion, mechanical strength and life

- Planté plates are designed to shred and generate active material mass by its own during electrolysis.
- 99.99% pure Soft-Lead used which has very low mechanical strength

- Planté plates has high plate thickness. Heavy weight. Very low Energy Density
- Deposition of active mass creates short circuit and premature death
- Hanging plate structure deforms easily

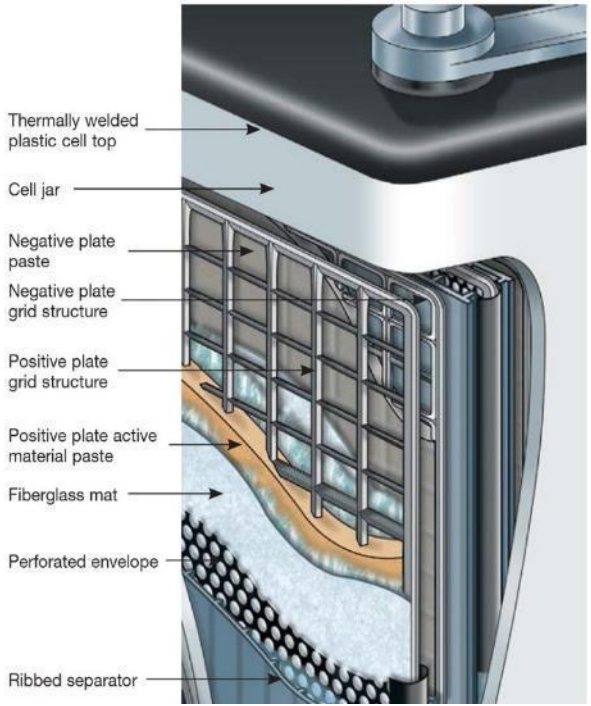
Electrode Structure - Pocket Plate

- Pocket plate construction enables to produce very thin plates for high performance without losing mechanical strength
- Electrodes are strong to withstand shock/vibrations in severe seismic conditions
- Different dimension of thickness pocket plate can be constructed. Many steps of capacity for a type of plate, providing flexibility and optimum capacity selection for an application



Cell construction

Lead Acid



Ni-Cd