Ni-Cd

Low-maintenance nickel-cadmium batteries for electric vehicles

STM MR - MRE series

Launched initially to satisfy the needs of electric vehicle manufacturers, SAFT nickel-cadmium has now become a standard for EV applications. SAFT nickel-cadmium batteries provide electric vehicles an autonomy of 60 miles (90 km), ideal for urban use. A complete battery system using nickel-cadmium modules also incorporates thermal management for increased efficiency.

Application
All-electric vehicles
(compact cars, minivans, shuttles, commuter vehicles, scooters)

Advantages
- Low-maintenance
- Life time of over 65,000 miles (>100,000 km)
- Adaptable to extreme temperatures: -20ºC to +40ºC
- Rapid recharge
- Fully recyclable

Technology
- Sintered positive electrodes
- Plastic-bonded negative electrodes

Electrical characteristics

<table>
<thead>
<tr>
<th></th>
<th>STM 5-100 MR*</th>
<th>STM 5-100 MRE**</th>
<th>STM 5-140 MR*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal voltage (V)</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Rated capacity at C/3 (Ah)</td>
<td>100</td>
<td>100</td>
<td>136</td>
</tr>
<tr>
<td>Typical specific energy at C/3 (Wh/kg)</td>
<td>55</td>
<td>54</td>
<td>54</td>
</tr>
<tr>
<td>Typical energy density at C/3 (Wh/dm³)</td>
<td>88</td>
<td>87</td>
<td>95</td>
</tr>
<tr>
<td>Typical specific power at 3/4 Uo at 80% DOD (W/kg)</td>
<td>122</td>
<td>120</td>
<td>108</td>
</tr>
</tbody>
</table>

Mechanical characteristics

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical weight (kg)</td>
<td>12.9</td>
<td>13.2</td>
<td>17.0</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td>248x120x260</td>
<td>246x123x260</td>
<td>244x153x260</td>
</tr>
<tr>
<td>Volume (cm³)</td>
<td>7.74</td>
<td>7.87</td>
<td>9.7</td>
</tr>
</tbody>
</table>

*MR: air-cooled - **MRE: integrated liquid cooling

SAFT
**Ni-Cd**

**High-power nickel-cadmium batteries for hybrid electric vehicles and automated guide vehicles**

**STH series**

These advanced Ni-Cd batteries provide an ideal balance of mass, power and energy for vehicles combining a conventional combustion engine in tandem with an electric motor to reduce the consumption of gasoline and minimize air pollution. They are also used as power backup batteries for trolley buses or light rail trains (LRT) when running without catenaries or skirting obstacles.

### STH RANGE

<table>
<thead>
<tr>
<th>Cell Type</th>
<th>Rated Capacity (Ah)</th>
<th>Cell Dimensions (W x H x L) (mm)</th>
<th>Approx Weight (kg)</th>
<th>Electrolyte Reserve (cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>STH 160B</td>
<td>16</td>
<td>196 x 86 x 46.5</td>
<td>1.1</td>
<td>60</td>
</tr>
<tr>
<td>STH 210B</td>
<td>21</td>
<td>196 x 86 x 46.5</td>
<td>1.1</td>
<td>60</td>
</tr>
<tr>
<td>STH 300B</td>
<td>29</td>
<td>196 x 86 x 61</td>
<td>1.5</td>
<td>95</td>
</tr>
<tr>
<td>STH 360B</td>
<td>36</td>
<td>196 x 86 x 86</td>
<td>1.9</td>
<td>130</td>
</tr>
<tr>
<td>STH 470B</td>
<td>47</td>
<td>196 x 86 x 86</td>
<td>2.0</td>
<td>130</td>
</tr>
<tr>
<td>STH 210</td>
<td>21</td>
<td>276 x 86 x 46.5</td>
<td>1.6</td>
<td>160</td>
</tr>
<tr>
<td>STH 240</td>
<td>24</td>
<td>276 x 86 x 46.5</td>
<td>1.7</td>
<td>160</td>
</tr>
<tr>
<td>STH 300</td>
<td>30</td>
<td>276 x 86 x 61</td>
<td>2.1</td>
<td>215</td>
</tr>
<tr>
<td>STH 340</td>
<td>34</td>
<td>276 x 86 x 61</td>
<td>2.1</td>
<td>215</td>
</tr>
<tr>
<td>STH 400</td>
<td>40</td>
<td>276 x 86 x 86</td>
<td>2.7</td>
<td>325</td>
</tr>
<tr>
<td>STH 450</td>
<td>45</td>
<td>276 x 86 x 86</td>
<td>2.9</td>
<td>315</td>
</tr>
</tbody>
</table>

**S A F T**
Applications
Buses, trolley buses, trucks, light rail trains (LRT), automated guided vehicles (AGV), etc.

Advantages
- Low maintenance
- Reliability
- Permanent availability of power
- Low km/passenger cost ratio
- Adapted to extreme temperatures -20°C to +35°C
- Centralized water filling system
- Rapid recharge
- Fully recyclable

Technology
- Sintered positive electrode
- Plastic-bonded negative electrode

156, avenue de Metz
93230 Roissy-en-France (France)
Tel. +33 (0)1 49 15 36 00
Fax +33 (0)1 49 15 34 00
eva.saf@saft.alcatel-cls.com.fr

Published by the Communication Department

Data in this document is subject to change without notice and become contractual only after written confirmation by Saft.
Ni-Cd

STX 600

Extra high power nickel-cadmium batteries for hybrid electric vehicles

This advanced Ni-Cd battery provides incredible power with the advantage of compact size. Used in tandem with a conventional combustion engine, it reduces fuel consumption and minimizes air pollution. The STX 600 is designed to deliver high current during acceleration and accept high current during regenerative braking. In addition, it is light in weight and provides excellent thermal performance.

Applications
Transit buses, trolley buses, trucks, sanitation vehicles, and delivery vehicles.

Advantages
- Lightweight
- Ease of assembly
- Low maintenance
- Low life cycle cost
- Adapted to extreme temperatures -20°C to +55°C
- Single point water filling system
- Rapid recharge
- Fully recyclable

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Electrical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal voltage (V)</td>
<td>1.2</td>
</tr>
<tr>
<td>Rated capacity (C; Ah)</td>
<td>56</td>
</tr>
<tr>
<td>Specific energy (Wh/Kg)</td>
<td>35</td>
</tr>
<tr>
<td>Typical power at 50% state of charge and 0.8 V (W/kg)</td>
<td>350</td>
</tr>
<tr>
<td>Peak power at 100% state of charge and 0.8 V (W/kg)</td>
<td>500</td>
</tr>
</tbody>
</table>

Mechanical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical weight (kg)</td>
<td>2.0</td>
</tr>
<tr>
<td>Dimensions (mm)</td>
<td>63x86x218</td>
</tr>
<tr>
<td>Volume (dm³)</td>
<td>1.18</td>
</tr>
</tbody>
</table>
Technology

- Cell construction based on Saft aviation battery technology
- Sintered positive electrodes
- Plastic-bonded negative electrodes
- Interlocking ribbed case for efficient forced air cooling and to ensure proper installation
- Low resistance copper terminals
- Barbed cell vent integral to cover

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156, avenue de Metz
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Fax +33 (0)1 49 15 34 00
ev.saft@soft.acticel-shopom.fr

DOF: N° 209 988-1024-2
Published by the Communication Department

Data in this document is subject to change without notice and become contractual only after written confirmation by Saft
Ni-MH

Nickel metal hydride modules for electric vehicles

Saft is now shipping a new EV battery module using nickel-metal hydride (Ni-MH) technology. One of the nickel-base technologies, Ni-MH extends Saft's current nickel-cadmium range. The new technology offers higher energy density which, for EV users, means 25% greater range for a weight and a volume that are identical to what is currently available for EVs. The batteries are made up of 12-volt liquid cooled modules, featuring improved compactness and electrical performance at a lower cost. An operational EV weighing 1,300 kg with this type of Ni-MH battery (Saft 288-volt Ni-MH) will have a range mobility of more than 200 km.

<table>
<thead>
<tr>
<th>Electrical characteristics</th>
<th>Module 12V</th>
<th>Module 24V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity at C/3 rate (Ah)</td>
<td>93</td>
<td>93</td>
</tr>
<tr>
<td>Typical specific energy at C/3 (Wh/kg)</td>
<td>64</td>
<td>64</td>
</tr>
<tr>
<td>Typical energy density at C/3 (Wh/dm³)</td>
<td>133</td>
<td>135</td>
</tr>
<tr>
<td>Typical specific power at 7/8 Us at 80% DOD (W/kg)</td>
<td>150</td>
<td>150</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mechanical characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
</tr>
<tr>
<td>Dimensions: L x W x H (mm)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cycle life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cycles at 80% DOD</td>
</tr>
</tbody>
</table>
**Technology**
- Nickel foam positive electrode.
- ABs hydride on nickel foam negative electrode.

**Advanced Technologies Division**
Electric Vehicle Marketing
156, avenue de Metz
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Fax +33 (0)1 48 91 95 53
E-mail: evt@saft.alcatel-alsthom.fr

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High Energy

Nickel-Metal Hydride module for automotive industry
Ni-MH

Designed in partnership with the automotive industry, Saft's nickel-metal hydride (Ni-MH) module provides excellent performance for electric vehicle battery systems. Featuring a liquid cooling system, Saft nickel-metal hydride batteries are available in either 12 V or 24 V configurations. Thanks to their enhanced specific energy and energy density, Saft Ni-MH batteries enable EVs to extend their range above 100 miles per charge. Saft Ni-MH module is designed to allow fast charge.

Applications
• All-electric vehicles

Main advantages
• Maintenance-free operation
• High power/energy ratio
• Excellent safety and perfect resistance to abuse testing
• Easy fast charging
• Fully recyclable
• Liquid cooling
• More than 1,200 charge/discharge cycles
• Monoblock design

Technology
• Nickel foam positive electrode
• AB2 hydride on steel foil negative electrode

### Electrical characteristics

<table>
<thead>
<tr>
<th>Nominal voltage [V]</th>
<th>12</th>
<th>24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated capacity at C/3 rate [Ah]</td>
<td>109</td>
<td>109</td>
</tr>
<tr>
<td>Typical specific energy [Wh/kg at C/3]</td>
<td>73</td>
<td>73</td>
</tr>
<tr>
<td>Typical energy density [Wh/dm³ at C/3]</td>
<td>162</td>
<td>164</td>
</tr>
<tr>
<td>Typical specific power [W/kg at 80% DOD, 30 sec, 2/3 Uo]</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>Typical power density [W/dm²]</td>
<td>370</td>
<td>373</td>
</tr>
</tbody>
</table>

### Mechanical characteristics

<table>
<thead>
<tr>
<th>Maxi dimensions [mm]: L x W x H</th>
<th>390x120x195</th>
<th>767x120x195</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical weight [kg]</td>
<td>19.6</td>
<td>38.7</td>
</tr>
<tr>
<td>Typical volume [dm³]</td>
<td>8.8</td>
<td>17.4</td>
</tr>
</tbody>
</table>

### Operating conditions

<table>
<thead>
<tr>
<th>Operating temperature range [°C]</th>
<th>-20/+60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport or storage temperature range [°C]</td>
<td>-40/+65</td>
</tr>
</tbody>
</table>

* Liquid cooling included
109 Ah Ni-MH Module - Specific power during PPT at 23°C at various currents
Minimum voltage: 8V/module of 10 cells

109 Ah Ni-MH Module - Capacity at C/3 rate - Internal resistance
cycling at 80% DoD at RT: discharge at 1C rate/charge at C/3 x C/20 (k=1.10)

Fast charge
Soft Ni-MH modules are designed to allow fast charge through a
combination of features that include a high charge efficiency of the
positive electrode formulation, an effective liquid cooling integrated
in the module case and a specific advanced algorithm. Thanks to
these features, more than 350 miles in a 10-hour period have been
performed by a shuttle minivan powered by Soft Ni-MH battery.
For any information please contact Soft.

Soft
Automotive Sales
and Marketing Direction
12 rue Sadi Carnot
93170 Bagnolet - France
Tel: 33 [0] 49 93 19 18
Fax: 33 [0] 49 93 19 50
DOC. N° 0900.51033.2

www.softbatteries.com

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confirmation by Soft.
Li-Ion

Energy and power-efficient lithium-ion batteries for electric vehicles

Battery module

With over 30 years of R&D and experience in lithium technology behind it, Saft undertook in 1993 an ambitious research program on lithium-ion. As a result, the first 20 kWh EV battery is under various tests. A new module will improve vehicle range five times over lead-based technologies. It incorporates state-of-the-art control electronics and cooling technology for improved reliability and efficiency.

Application
All-electric vehicles

Electrical characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum voltage (V)</td>
<td>2.5</td>
</tr>
<tr>
<td>Maximum current (A)</td>
<td>330</td>
</tr>
<tr>
<td>Specific energy (Wh/kg)</td>
<td>150</td>
</tr>
<tr>
<td>Energy density (Wh/dm³)</td>
<td>250</td>
</tr>
<tr>
<td>Specific power (W/kg)</td>
<td>300</td>
</tr>
</tbody>
</table>

Operating conditions

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature range</td>
<td>-10° to +50°C</td>
</tr>
<tr>
<td>Charging method</td>
<td>Constant current and constant voltage</td>
</tr>
</tbody>
</table>

Advantages
- Maintenance-free
- Substantial specific power
- High energy density
- Light and compact
- Adaptable to a wide range of batteries

Technology
- Plastified carbon anode
- Plastified nickel oxide cathode
Specific power at various depth of discharge

Discharge curves of 100 Ah battery
at various rates, ambient temperature +20°C
In response to environmental concerns, Saft has developed a simple, practical procedure for recovering and recycling spent nickel-cadmium, nickel-iron and air depolarized cells and batteries for the North American market. By decreasing the number of used batteries discarded into the waste stream, Saft maintains its commitment to the protection of nature.

**Recoverable products**

Saft's recycling facility, located in Valdosta, Georgia is permitted by U.S. law to receive, store, treat, and recycle three types of batteries. These three battery types are:

1. Nickel-cadmium batteries.
2. Nickel-iron batteries.
3. Air depolarized batteries.

**Important note:** Saft's Valdosta facility is prohibited by law from receiving or processing batteries containing mercury, lithium or lead. Batteries containing these (and/or any other hazardous material not specified in the permit document) will be returned to the sender at the sender’s expense.

Saft’s environmental commitment is embodied in three major actions:

- Through recycling, Saft takes care of the third phase in the life cycle of batteries after manufacture and use;
- Currently, Saft is involved in designing fully-recyclable products; and
- Saft is an active participant among various consulting bodies involved in defining U.S. and International standards. Presently, a number of states have passed legislation to control the disposal of batteries used in business and industry. Experts believe it's only a matter of time before all states consider battery recycling laws for household consumers as well. Saft's involvement in these agencies helps to guide this process.
Battery returns

Eventually, all batteries will lose their ability to perform and must be repaired, scrapped or recycled. Spent batteries may be returned to Saft for recycling as follows:

Nickel-cadmium and nickel-iron batteries:
1. Federal legislation (H.R. 2024, Public Law 104-142) became effective on May 13, 1996 and exempts spent rechargeable batteries from regulation as hazardous waste. Manifesting these batteries as hazardous waste and shipping by permitted hazardous waste transporter is no longer required. Call Saft's Recycle Facility at 912-245-2918 for details concerning the labeling, manifesting, and transportation of air depolarized batteries destined for reclamation.

Here's the step-by-step procedure for utilizing Saft's services.
1. Check the batteries for content.
   A. Nickel-cadmium
   B. Nickel-iron
   C. Air depolarized (No batteries containing mercury will be accepted - they will be returned.)
2. Check the quantity - count and record.
   A. Nickel-cadmium
      Type Qty. Wt.
   B. Nickel-iron
      Type Qty. Wt.
   C. Air depolarized
      Type Qty. Wt.
3. Decide the type of contract desired.
   A. Customer Purchase Order:
      • Nickel-cadmium or nickel-iron batteries, evaluate, return or recycle.
   B. Battery Service Agreement for:
      • Nickel-cadmium or nickel-iron batteries, recondition, return or replace.

   4. Notify Saft's Recycle Facility of intent to ship and receive a Return Material Authorization (RMA) number by telephone (912-245-2918) or by FAX (912-245-2928). If applicable, receive a contract, fill it out and return to Saft.
5. Package the material securely to assure safe transportation.
6. Complete a hazardous waste manifest when required.
7. Ship by permitted waste hauler when shipping by hazardous waste manifest.
8. Expect to receive the return copy of the hazardous waste manifest within 30 days of receipt of the shipment by Saft.
9. Expect to receive your certificate of reclamation within 180 days.

Air depolarized batteries:
Air depolarized batteries become a hazardous waste once they have been declared spent. Primary batteries are not exempted by the federal legislation and must be shipped as hazardous waste unless all states through which the shipment will be transported have individually adopted EPA's 273 Rule, also known as the "Universal Waste Rule."

C. Hazardous Waste Agreement for:
   Primary (air depolarized) batteries, hazardous manifest required.
Proper packaging

CAUTION! THE SHIPPER IS LIABLE! All batteries, bare cells or battery packs must be fully discharged before shipping. They must be packaged to conform to all transportation regulations and ensure safe handling.

Saat only assumes liability for spent batteries ONCE THEY HAVE BEEN RECEIVED. The Saat Valdosta facility is prohibited by law from receiving or processing batteries containing mercury, lithium or lead. These or any other material not specified in the permit document will be returned to the sender at the sender’s expense.

How to package your cells and batteries for return:
- All packages should be properly marked to include the RMA number and sender’s name and address.
- Mark each pallet in sequence with reference to the total number of pallets being shipped. Example: Pallet _ of _ pallets.
- Separate cells and batteries. Ship only cells with cells; only batteries with batteries.
- Small quantities of cells and batteries to be returned should be packed in individual cartons not to exceed 50 lbs.
- Customers returning sealed cell products should separate single cells from battery packs prior to shipping. Single cells and battery packs are processed differently and are therefore separate waste streams.

Battery returns:
- Batteries containing free electrolyte must be packaged with the battery in the upright position to prevent electrolyte leakage through the cell vent.
- Larger quantities of battery returns should be palletized for ease of handling and safety during shipment.
- Secure palletized shipments with metal banding. Strap around the batteries. Place plywood or chipboard on top of the batteries. Strap around the board and through the pallet in two directions to tie the batteries to the pallet. Two straps in each direction should secure the package.
- Four feet is the limit on stacking height.
- Place larger containers on the bottom, and/or use containers of uniform size and shape. Stand batteries on a pallet with vent caps installed and with shorter batteries surrounded by taller batteries.
- Nail furring strips (1”x2” or larger) around the outer edge of the batteries on the pallet.

Single cell returns:
- Cells containing free electrolyte must be packaged with the cell in the upright position to prevent electrolyte leakage through the cell vent.

- Recycle your original packaging for return of cells. Segregate cells to prevent accidental shorting.
- Place cells with free electrolyte upright, in head to base position for multiple layers. Place insulation between layers.
- Place covers on the battery contacts where feasible.
- Pack empty space to prevent shifting contents.
- Mark with Corrosive Labels.
- For Repair and Return, ship as Hazardous Material with the following description: Batteries, Wet, Filled with Alkali, 8, UN2795, PG III.
- To dispose, scrap or recycle, ship as Universal Waste with the following description: Used Batteries, Wet, Filled with Alkali, 8, UN2795, PG III.
- To dispose of Electrolyte liquid ship as Hazardous Waste with the following description: Waste, Environmentally Hazardous Substance, Liquid, N.O.S., 9, UN3082, PG III (Potassium Hydroxide Solution)
- Put RMA# on outside of all cartons, packing slips and bill of lading.
- Ship to: Saat America, Inc.
  Attn: Recycling Facility
  Dock #4
  711 Industrial Blvd.
  Valdosta, GA 31601

Batteries packaged unsafely are subject to refusal by Saat.
HAZARDOUS WASTE FACILITY PERMIT

Permit No. HW-0015577 2  Facility I.D. No. GAD063152573

In accordance with the provisions of the Georgia Hazardous Waste Management Act and the Rules, Chapter 391-3-11, (as amended through April 5, 1993), adopted pursuant to that Act,

is issued a Permit for the following:

- Storage of a maximum of 200,000 gallons of hazardous waste in containers
- Treatment of D006 and D002 waste in tanks

at the following location:

SAFT America, Inc.
711 Industrial Boulevard
Valdosta, Georgia 31601

This Permit is conditioned upon compliance with all provisions of the Georgia Hazardous Waste Management Act, the Rules, Chapter 391-3-11 (as amended through April 5, 1993) adopted pursuant to that Act, and any other condition of this Permit.

This Permit is subject to revocation, suspension, modification or amendment by the Director for cause including evidence of noncompliance with any of the above; or for any misrepresentation made in the application(s) dated August 6, 1993; supporting data entered therein or attached thereto, or any subsequent submittals or supporting data; or for failure to disclose fully all relevant facts; or when the facility poses a threat to the environment or the health of humans.

This Permit is further subject to and conditioned upon the terms, conditions, limitations, standards, or schedules contained in or specified on the attached 13 page(s), which page(s) are a part of this Permit.

Permit Issuance Date: December 23, 1993
Permit Termination Date: December 23, 2003

Director
Environmental Protection Division

SAFT

Saft Americo Inc.
711 Industrial Blvd. • Valdosta, Georgia
Tel.: (912) 247-2331  Fax: (912) 245-2880
website: www.saft.alcatel.com