STM nickel-cadmium battery power for today’s electric vehicles
STM batteries - driving today's electric vehicle revolution

Potential electric-vehicle users need not wait until the next century for the right kind of battery. Saft can provide them with one today. Throughout the world, cars, vans, utility vehicles and bus fleets are already driving regularly and efficiently on high-performance electric power with Saft’s STM nickel-cadmium batteries.

The STM-powered Peugeot 106 E will be trialed in selected cities equipped with a network of recharging stations.

City cars for the clean generation

Edison’s century-old vision of electrically-powered city transport can now come true - especially for individual vehicle owners. With their 55 Wh/kg specific energy, Saft’s STM batteries offer the ideal performance, dimension and reliability profile for powering environmentally-friendly city cars and scooters. Saft is already at work on joint programmes with major carmakers, supplying STM batteries for the first generation of mass produced electric city cars and scooters.

1. Equipped with a 6.7 kWh STM battery, the electric Microcar Light weighs only 510 kg and can run for 80 km. The maximum speed is 80 km/h.
2. A fleet of Renault’s electric, compact Express, is used in Göteborg public services.
3. Chrysler’s electric-powered TaVan II recently broke the long distance record for electric vehicle, completing 1,67 km with 55 fast recharges.

Series production of the upcoming Peugeot 106 E, for example, will start in 1995, with a target of 50,000 cars by 1998.
Flexible hybrid and dual-mode solutions

STM batteries also work well in tandem with internal-combustion engines to drive heavier-duty payloads. Taxis, buses, trolleybuses and waste-disposal vehicles can gain added operating flexibility from both hybrid (parallel power) or dual-mode (alternating) designs to operate efficiently in urban settings, while benefiting from added diesel power for open road driving. The Italian assembly firm Macchi has equipped one refuse collection truck with Saft STM batteries. Silent electric power allows the fleet to operate efficiently in Modena at night. The truck then switches to diesel mode for the drive to the out-of-town dump, charging the batteries at the same time.

Saft’s programme for continuous improvement

Saft’s development programme has now delivered a fully industrialised source of high-performance batteries—the STM solution. So Saft is more than ready to help you adapt it to your specific battery needs, whatever your electric vehicles. Meanwhile, Saft’s research effort continues, targeting the next energy ceiling of 65 Wh/kg.

Proven all-electric service vehicles

Saft STM batteries have already proved their worth in the utility vehicle field. Local government services in Chatellerault, France are using Saft STM battery power in their fleet of all-electric Renault Master vans for their 60-90 km/day tasks. After four years of operation and a total of nearly 300,000 km, running costs show favourably against their gasoline-powered counterparts. In Oberstdorf, Germany, all-electric 41-seater Neoplan buses are in regular use, fitted with STM battery power to move people over 50 km ranges.

And Chrysler’s TeVan II recently broke the long-distance record for electric vehicles, completing 4,167 km with 55 fast recharges. Cleanly, quietly and efficiently.
STM nickel-cadmium batteries reliable all-round performance

Saft's STM batteries are built to supply a fully reliable, long-lasting power source that can sustain extensive cycling and fast charging, providing an excellent driving range. They feature an advanced electrode design evolved from Saft's aerospace technology, built into a compact industrial battery unit optimised for use in electric vehicles.

Test results* comparing different batteries (industrialised and under development)

<table>
<thead>
<tr>
<th>Cell type</th>
<th>Lead Tubular</th>
<th>Lead Maintenance-free</th>
<th>Ni-Cd</th>
<th>Ni-Zn</th>
<th>Zn-Ni</th>
<th>Ni-MH</th>
<th>Ni-Pb</th>
<th>Ni-Fe</th>
<th>Li-Ion</th>
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<tbody>
<tr>
<td>Type</td>
<td>T32705</td>
<td>6V160</td>
<td>STM 5 200</td>
<td>N5 200</td>
<td>H.CELL</td>
<td>ZEB/5/48</td>
<td>P11</td>
<td>M11</td>
<td>B11</td>
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<tr>
<td>Unit</td>
<td>Manufacturer</td>
<td>Chloride</td>
<td>Siemens</td>
<td>Saft</td>
<td>Eagle Power</td>
<td>Osmotic</td>
<td>SEA</td>
<td>Chloride</td>
<td>ABB</td>
</tr>
<tr>
<td>Wh/kg</td>
<td>Specific energy</td>
<td>50</td>
<td>54</td>
<td>55</td>
<td>51</td>
<td>55</td>
<td>79</td>
<td>79</td>
<td>81</td>
</tr>
<tr>
<td>Wh/dm³</td>
<td>Energy density</td>
<td>78</td>
<td>92</td>
<td>104</td>
<td>118</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
</tr>
<tr>
<td>h</td>
<td>Charge time</td>
<td>8</td>
<td>8</td>
<td>6.5</td>
<td>10</td>
<td>11</td>
<td>7</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>%</td>
<td>Overcharge coefficient</td>
<td>15</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>10</td>
<td>7</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>%</td>
<td>Energy efficiency</td>
<td>68</td>
<td>84</td>
<td>78</td>
<td>58</td>
<td>80</td>
<td>75</td>
<td>80</td>
<td>91</td>
</tr>
<tr>
<td>W/kg</td>
<td>Specific power (at 80°C, 300°C)</td>
<td>91</td>
<td>68</td>
<td>125</td>
<td>99</td>
<td>175</td>
<td>40</td>
<td>90</td>
<td>150</td>
</tr>
</tbody>
</table>

* Published by the US Argonne National Laboratory, 1991

Optimum payload and range

With a specific energy of 55 Wh/kg and 104 Wh/dm³, STM nickel-cadmium batteries represent a light, compact energy-to-power solution. While ensuring the best driving performance and a sufficiently wide range for daily needs, an STM battery leaves enough space and payload for passengers and goods.

Constant power availability

Nickel-cadmium battery technology means the reliability of 175 W/kg specific power available throughout battery discharge at any temperature. Whether starting, accelerating or climbing sudden inclines, STM-powered vehicles have the power surges needed to merge with complete safety into normal traffic flows.
Fast recharging

STM batteries also make recharging a rapid operation. Besides economical overnight charges, it is also possible to restore 75% of the battery's capacity with just one hour's charge at the charging station. Combined with minimum maintenance requirements and the high reliability of Ni-Cd batteries, this means that vehicles are ready for driving at almost any time under any conditions.

Unrivalled service life

Saft has developed STM batteries by combining the successful plastic bonded negative electrode solution (PBE) with sintered positive electrodes that have demonstrated their exceptional robustness in aerospace applications. Sinter/PBE technology easily accepts 2,000 cycles of charge and discharge; this means that one battery will suffice throughout the lifetime of a vehicle. Depending on operating conditions, a battery has an active life of 7-10 years, or 100,000-200,000 km.

Highly competitive running costs

The real work of STM batteries begins once they are fitted inside the vehicle. Saft's approach ensures that compared to other solutions STM batteries make significant overall running cost savings over lifetime by tonne-kilometre or by passenger-kilometre.

Examples of vehicle performance for STM-equipped EVs

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Performances</th>
<th>Characteristics</th>
<th>Performances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range</td>
<td>90-180 km</td>
<td>Range</td>
<td>124 km</td>
</tr>
<tr>
<td>Max. speed</td>
<td>90 km/h</td>
<td>Max. speed</td>
<td>50 km/h</td>
</tr>
<tr>
<td>Acceleration 0-50 km/h</td>
<td>&lt; 7 sec</td>
<td>Acceleration 0-50 km/h</td>
<td>10 sec</td>
</tr>
<tr>
<td>Payload</td>
<td>280 kg</td>
<td>Payload</td>
<td>659 kg</td>
</tr>
<tr>
<td>Service life</td>
<td>200,000 km</td>
<td>Service life</td>
<td>200,000 km</td>
</tr>
</tbody>
</table>

STM batteries ensure all-round driving performances largely compatible with typical urban conditions.

City car (4 seats, 1,275 kg) powered with a STM battery (120 V, 100 Ah, 12 kWh, 260 kg, 180 km).

Van (3,180 kg) powered with a STM battery (220 V, 190 Ah, 41.8 kWh, 862 kg, 496 km).
STM nickel-cadmium batteries
A solution sized for every requirement

The STM family of batteries offers a full range of products designed to meet key needs on the electric vehicle market. They are manufactured to the highest standards in dedicated industrial facilities.

### Characteristics of the STM range

<table>
<thead>
<tr>
<th>Type</th>
<th>Nominal voltage (V)</th>
<th>Nominal capacity (Ah)</th>
<th>Dimensions (mm)</th>
<th>Weight (kg)</th>
<th>Electrolyte reserve (cm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single cells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STM 1.40 B</td>
<td>1.2</td>
<td>37</td>
<td>85</td>
<td>45.5</td>
<td>198</td>
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<tr>
<td>STM 1.60</td>
<td>1.2</td>
<td>61</td>
<td>85</td>
<td>45.5</td>
<td>278</td>
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<tr>
<td>STM 1.80 B</td>
<td>1.2</td>
<td>75</td>
<td>85</td>
<td>55</td>
<td>198</td>
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<tr>
<td>STM 1.130</td>
<td>1.2</td>
<td>125</td>
<td>85</td>
<td>55</td>
<td>278</td>
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<tr>
<td>STM 1.200</td>
<td>1.2</td>
<td>208</td>
<td>126</td>
<td>78</td>
<td>336</td>
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<tr>
<td>STM 1.230</td>
<td>1.2</td>
<td>234</td>
<td>126</td>
<td>87</td>
<td>336</td>
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<tr>
<td>STM 1.280</td>
<td>1.2</td>
<td>285</td>
<td>166</td>
<td>103</td>
<td>336</td>
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<tr>
<td>Monoblocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STM 5.100</td>
<td>5.0</td>
<td>100</td>
<td>244</td>
<td>123</td>
<td>260</td>
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<tr>
<td>STM 5.140</td>
<td>5.0</td>
<td>136</td>
<td>264</td>
<td>153</td>
<td>262</td>
</tr>
<tr>
<td>STM 5.180</td>
<td>5.0</td>
<td>180</td>
<td>260</td>
<td>190</td>
<td>260</td>
</tr>
</tbody>
</table>

### Constant current discharge at 25 °C after constant current charge and 1 hour rest

STM batteries provide excellent performance throughout continuous discharge. They are particularly suited to high-current peak discharge at any state of discharge between 0 and 100%.

### Variation in energy at a given nominal capacity for two main technologies at different discharge rates

STM batteries provide highly stable specific energy, making them particularly effective for highly intensive use.
Quality-driven manufacturing
At Saft's dedicated Bordeaux facility, production teams utilize ISO 9001-certified quality management techniques at every stage in the design and assembly process to ensure both the high performance and sustained delivery rate of STM batteries under environmentally sound conditions. And Saft is bringing on line a fully-automated pilot plant for the mass production of STM batteries, targeting 100,000 batteries by 2000.

A full service portfolio
Saft customers benefit from the company's international technical assistance network. Skilled engineering staff are on hand to provide a complete service package, from initial design through to after-sales requirements and the collection of used batteries.

A concentration of advanced capabilities
From design through after-sales service, mission-critical batteries depend on top-quality production resources.
As world leader in industrialised nickel-cadmium battery technology, Saft has the capability to integrate engineering and production skills from various disciplines to deliver STM batteries that match the specification of the vehicles they power.

Partners for the environment
Moreover, Saft's concern for environmentally-friendly products covers the batteries throughout their lifetime, from the manufacturing process to end-of-service life and recycling.
The battery components are chemically stable and risk-free. At the end of their useful life, Saft recovers almost 100% of the batteries' usable metals (especially cadmium). They are reclaimed in the USA and recycled in Sweden and France, closing the industrial loop.
SAFT NIFE INDUSTRIAL BATTERIES NETWORK

ARGENTINA
Nife SA de Argentina S.A.
Buenos Aires
Tel.: (54-1) 641 1995
Fax: (54-1) 641 1976

AUSTRALIA
Soft Nife Australia Pty Ltd
Bryans Park NSW
Tel.: 61 (2) 338 42 22
Fax: 61 (2) 738 47 47

AUSTRIA
Soft Nife Ges.m.b.H
Wien
Tel.: (43-1) 710 51 31
Fax: (43-1) 710 51 32

BELGIUM
Soft Nife
Bruxelles
Tel.: 32 (2) 556 44 00
Fax: 32 (2) 570 18 84

BRAZIL
Soft Nife Brasil Sistemas Eletronicos Ltda.
Sao Paulo
Tel.: 55 (11) 449 06 33
Fax: 55 (11) 390 63 80

BRITISH HONDURAS
Soft Nife Ltd
San Francisco
Fax: (506) 287 35 02

CANADA
Soft Nife Corp.
Terrebonne
Tel.: 1 (456) 345 23 45
Fax: 1 (456) 345 23 45

FRANCE
Soft Nife SA
Group
Tel.: 33 (1) 49 15 52 00
Fax: 33 (1) 49 15 52 00

GERMANY
Soft Nife GmbH
Mannheim
Tel.: 49 (0) 621 70 00
Fax: 49 (0) 621 70 00

HONG KONG
Soft Nife Ltd
Kowloon
Tel.: (852) 2870 26 28
Fax: (852) 2870 26 28

ITALY
Soft Nife SPA
Genova
Tel.: 39 (10) 27 47 91
Fax: 39 (10) 28 47 91

JAPAN
Soft Nife Japan
Tokyo
Tel.: (3) 3323 23 00
Fax: (3) 3323 23 00

KOREA
Soft Nife Korea
Industrial battery division
Soisul 190-8
Tel.: 82 (2) 758 13 00
Fax: 82 (2) 758 13 04

MALAYSIA
Soft Nife Power Systems Sdn Bhd
Kuala Lumpur
Tel.: 60 (3) 1985 29 96
Fax: 60 (3) 1985 29 96

MEXICO
Soft Nife SA de CV
Mexico City
Tel.: 55 (5) 25 00 00
Fax: 55 (5) 25 00 00

MIDDLE EAST
Soft Nife ME Ltd
Cairo
Tel.: (20) 320 25 50
Fax: (20) 320 25 50

NORWAY
Soft Nife AS
Oslo
Tel.: 47 (22) 55 00 00
Fax: 47 (22) 55 00 00

THE NETHERLANDS
Soft Nife BV
Hasselt
Tel.: 31 (32) 51 00 00
Fax: 31 (32) 51 00 00

SINGAPORE
Soft Nife Power Systems Pte Ltd
Singapore
Tel.: (65) 741 34 00
Fax: (65) 741 34 00

SWEDEN
Soft Nife AB
Stockholm
Tel.: (46) 8 675 67 00
Fax: (46) 8 675 67 00

UNITED KINGDOM
Soft Nife Ltd
Hampshire
Tel.: 081 720 12 34
Fax: 081 720 12 34

USA
Soft Nife Inc.
Waltham
Tel.: (781) 321 22 33
Fax: (781) 321 22 33

THE NETHERLANDS
Soft Nife BV
Hasselt
Tel.: 31 (32) 51 00 00
Fax: 31 (32) 51 00 00

SINGAPORE
Soft Nife Power Systems Pte Ltd
Singapore
Tel.: (65) 741 34 00
Fax: (65) 741 34 00

SWEDEN
Soft Nife AB
Stockholm
Tel.: (46) 8 675 67 00
Fax: (46) 8 675 67 00

Industrial battery group
156, avenue de Matis - 93320 Romainville - France
Tel.: 33 (1) 49 15 34 00 - Fax: 33 (1) 49 15 34 00

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