

**STM nickel-cadmium battery power
for today's electric vehicles**



S A F T

NIFE

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 trialled 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

Series production of the upcoming Peugeot 106 E, for example, will start in 1995, with a target of 50 000 cars by 1998.

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.



1

2. A fleet of Renault's electric, compact Express, is used in Göteborg public services.



2

3. Chrysler's electric-powered TeVan II recently broke the long distance record for electric vehicle, completing 4 167 km with 55 fast recharges.



3

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.



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)

The truck then switches to diesel mode for the drive to the out-of-town dump, charging the batteries at the same time.

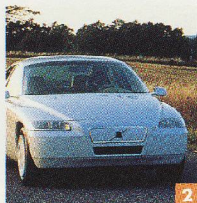
Saft's programme for continuous improvement

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.

1. Noiseless and zero-emission deliveries in urban areas thanks to a diesel/STM battery dual mode truck.

2. Volvo's hybrid ECC is a high-technology concept car introduced in 1992 and featuring a gas turbine and STM battery propulsion system.

3. A diesel/STM battery dual-mode waste collection vehicle.



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.

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.

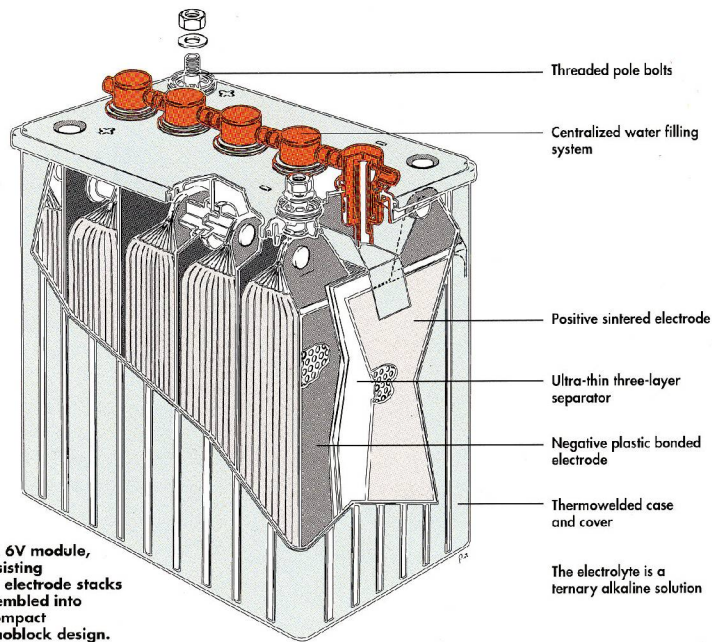
And Chrysler's TeVan II recently broke the long-distance record for electric vehicles, completing 4 167 km with 55 fast recharges. Cleanly, quietly and efficiently.

This Tours city electric bus has already driven 100 000 km using one STM battery.



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)

	Cell type	Lead Tubular open	Lead Maintenance-free	Ni-Cd	Ni-Fe	Ni-MH	ZN-Br ₂	Na-S	Li-FeS	
	Type	3ET205	6V160	STM 5 200	NIF 200	H.CELL	ZBB/5/48	PB MK3	B11	proto
Unit	Manufacturer	Chloride	Sonnenschein	Saft	Eagle Picher	Ovonic	SEA (Autriche)	Chloride	ABB	Saft
Wh/kg	Specific energy	33	36	55	51	55	79	79	81	66
Wh/dm ³	Energy density	78	92	104	118	152	56	123	83	133
h	Charge time	8	8	6.5	10	11	7	10	10	10
%	Overcharge coefficient	15-20	10	11	40	10	7	0	0	5
%	Energy efficiency	68	84	78	58	80	75	88	91	81
W/kg	Specific power (at 80% DOD)	91	68	175	99	175	40	90	152	64

* 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 largely sufficient 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

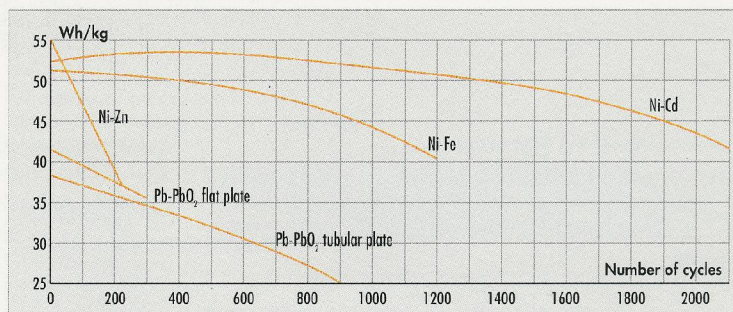
Saft has developed STM batteries by combining the successful plastic bonded negative electrode solution (PBE) with sintered positive electrodes that have demonstrated their exceptional robustness in aerospace applications. Sinter/PBE technology easily accepts 2 000 cycles of charge and discharge; this 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

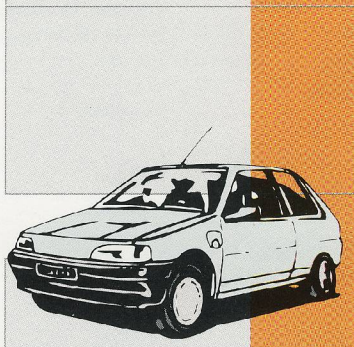
The real work of STM batteries begins once they are fitted inside the vehicle. Saft's approach ensures that compared to other solutions STM batteries make significant overall running cost savings over lifetime by tonne-kilometre or by passenger-kilometre.

Usable specific energy as a function of the number of cycles



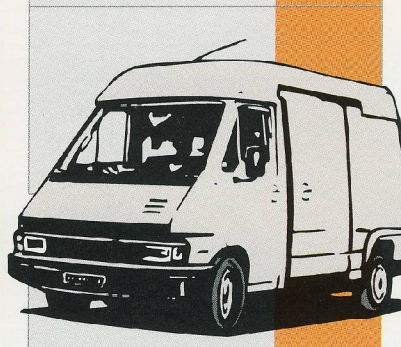
Examples of vehicle performance for STM-equipped EVs

Characteristics	Performances
Range	90-160 km
Max. speed	90 km/h
Acceleration 0 - 50 km/h	< 9 sec
Payload	280 kg
Service life	200 000 km



City car (4 seats, 1 275 kg) powered with a STM battery (120 V, 100 Ah, 12 kWh, 260 kg, 180 dm³).

Characteristics	Performances
Range	134 km
Max. speed	100 km/h
Acceleration 0 - 50 km/h	10 sec
Payload	696 kg
Service life	200 000 km



Van (3 180 kg) powered with a STM battery (220 V, 190 Ah, 41.8 kWh, 882 kg, 496 dm³).

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

STM nickel-cadmium batteries

A solution sized for every requirement

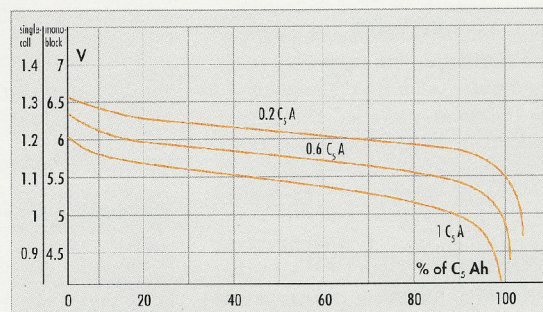
The STM family of batteries offers a full range of products designed to meet key needs on the electric vehicle market. They are manufactured to the highest standards in dedicated industrial facilities.



Characteristics of the STM range

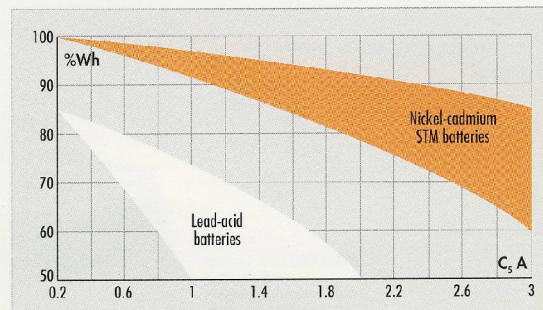
Type	Nominal voltage (V)	Rated capacity (Ah)	Dimensions			Weight (kg)	Electrolyte reserve (cm³)
			L (mm)	W (mm)	H (mm)		
Single cells							
STM 1.40 B	1.2	37	85	45.5	198	1.4	45
STM 1.60	1.2	61	85	45.5	278	2.0	90
STM 1.80 B	1.2	75	85	85	198	2.5	90
STM 1.130	1.2	125	85	85	278	3.7	180
STM 1.200	1.2	208	166	78	336	6.3	690
STM 1.230	1.2	234	166	87	336	7.0	780
STM 1.280	1.2	285	166	103	336	8.5	950
Monoblocks							
STM 5.100	6	100	244	123	260	13.0	100
STM 5.140	6	136	244	153	262	17.5	100
STM 5.180	6	180	260	190	260	23.2	200

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

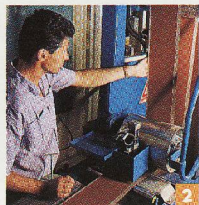
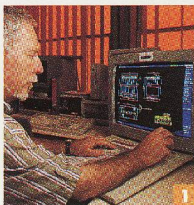


STM batteries provide highly stable specific energy, making them particularly effective for highly intensive use.

Quality-driven manufacturing

At Saft's dedicated Bordeaux facility, production teams utilize ISO 9001-

1. Computerized battery design.
2. Making plastic-bonded electrodes.
3. Cell assembly line.



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.

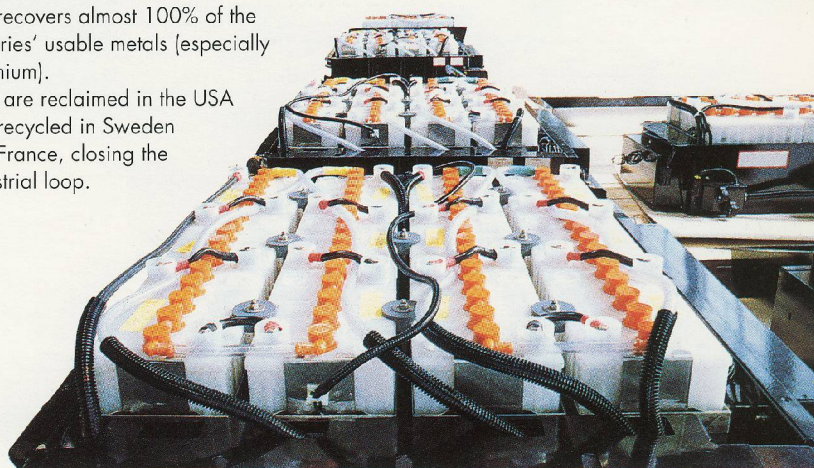
Partners for the environment

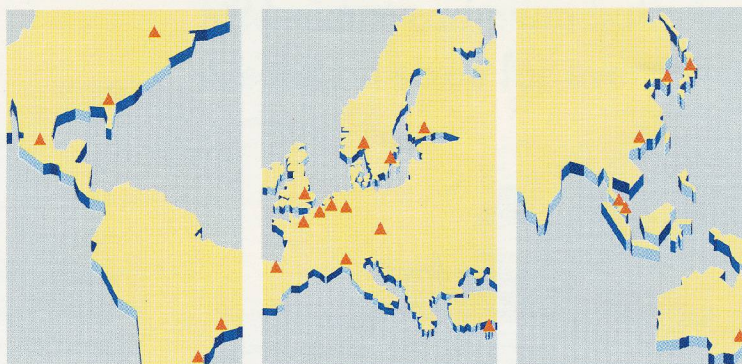
Moreover, Saft's concern for environmentally-friendly products covers the batteries throughout their lifetime, from the manufacturing process to end of service life and recycling.

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.

Customized assembly of STM blocks into a vehicle specific battery boxes.





Saft, a subsidiary of the Alcatel Alsthom group, is the world leader in self-contained energy systems, with research and manufacturing facilities in Europe, North and South America, and Southeast Asia. Saft and Saft Nife products are used in a wide variety of applications, ranging from space and military technology to railroads, portable systems, data processing and office automation. Its major sectors of activity are industrial batteries, portable power packs, advanced battery systems, and energy conversion.

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