

Ni-Cd

**Low-maintenance
nickel-cadmium
batteries
for electric vehicles**

STM MR - MRE series



Launched initially to satisfy the needs of french car makers, Saft nickel-cadmium has now become a standard for EV applications. Saft nickel-cadmium batteries provides electric vehicles an autonomy of 60 miles (90 km), ideal for city 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)
- Adapted to extreme temperatures: -20°C to +40°C
- Rapid recharge
- Fully recyclable

Technology

- Sintered positive electrodes
- Plastic-bonded negative electrodes

Electrical characteristics

	STM 5-100 MR*	STM 5-100 MRE**	STM 5-140 MR*
Nominal voltage (V)	6	6	6
Rated capacity at C/3 (Ah)	100	100	136
Typical specific energy at C/3 (Wh/kg)	55	54	54
Typical energy density at C/3 (Wh/dm ³)	88	87	95
Typical specific power at 3/4 U ₀ at 80% DOD (W/kg)	122	120	108

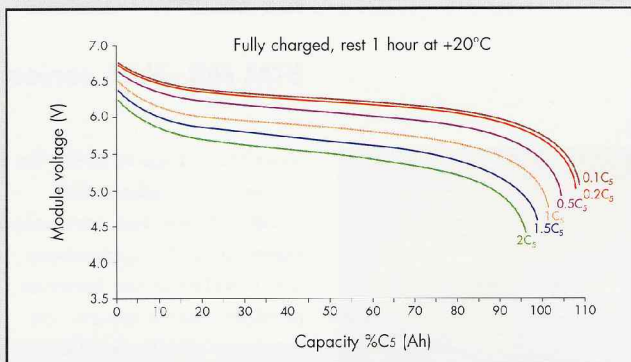
Mechanical characteristics

Typical weight (kg)	12.9	13.2	17.0
Dimensions (mm)	248x120x260	246x123x260	244x153x260
Volume (dm ³)	7.74	7.87	9.7

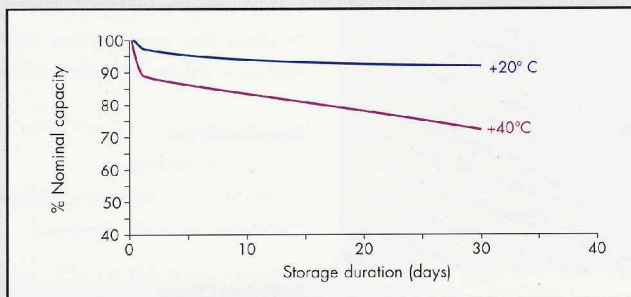
*MR: air-cooled - **MRE: integrated liquid cooling



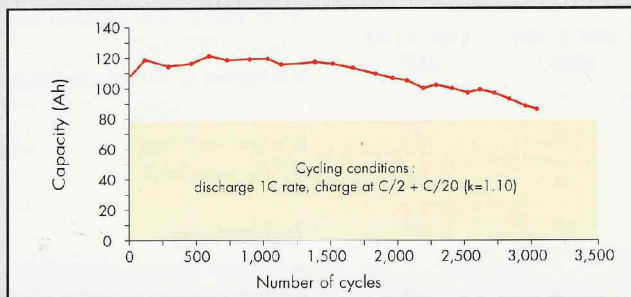
Typical discharge at +20°C



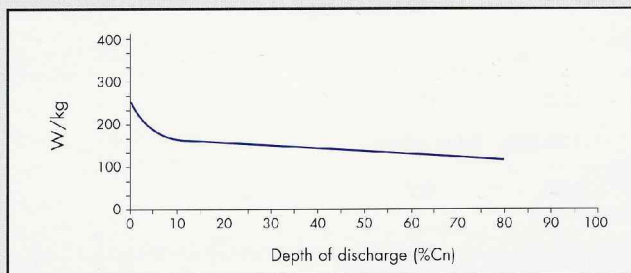
Charge retention at various temperatures



Capacity at 1 C rate during cycling at 80% DOD



Specific power at +20°C at 3/4 U_0



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DOC. N° 09 98-51025-2

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Ni-Cd

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

STH series

These advanced Ni-Cd batteries provides 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.

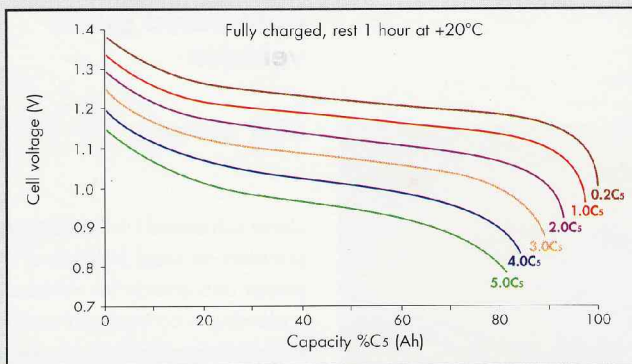


STH RANGE

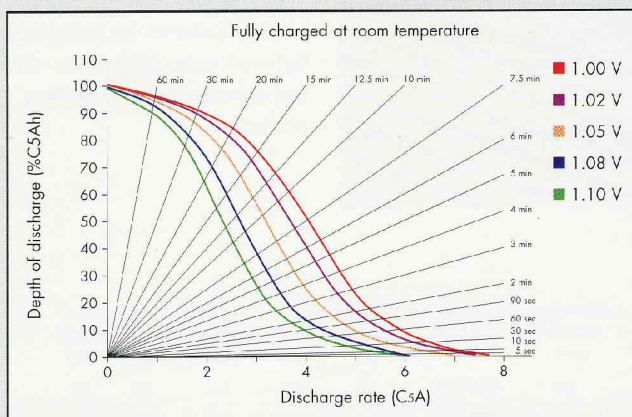
Cell Type	Rated	Cell Dimensions			Appro	Electrolyte	
	Capacity	H (mm)	W (mm)	L (mm)	Weight	Reserve	
	Ah				(kg)	(cm ³)	
STH 160B	16	196	86	46.5	1.1	60	
STH 210B	21	196	86	46.5	1.1	60	
STH 300B	29	196	86	61	1.5	95	
STH 360B	36	196	86	86	1.9	130	
STH 470B	47	196	86	86	2.0	130	
STH 210	21	276	86	46.5	1.6	160	
STH 240	24	276	86	46.5	1.7	160	
STH 300	30	276	86	61	2.1	215	
STH 340	34	276	86	61	2.1	215	
STH 400	40	276	86	86	2.7	325	
STH 450	45	276	86	86	2.9	315	
STH 520	52	276	86	86	2.9	315	
STH 600	60	306	86	86	3.3	315	
STH 700	70	306	86	86	3.5	315	
STH 800	80	306	86	86	3.3	315	
STH 900	90	339	166	78	5.6	370	
STH 1000	100	339	166	78	5.9	365	
STH 1200	115	339	166	78	6.1	360	
STH 1300	130	339	166	87	6.8	410	
STH 1500	150	339	166	103	8.0	495	
STH 1700	170	339	166	117	9.5	570	
STH 1900	190	339	166	117	9.8	565	

SAFT

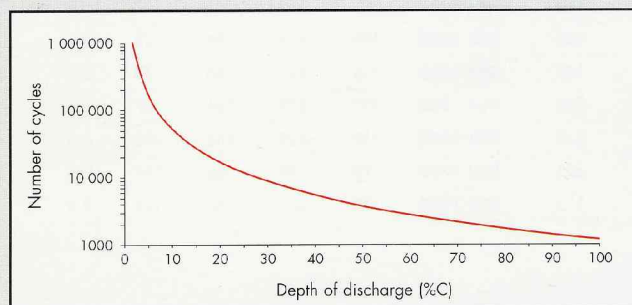
Typical discharge at +20°C



Available capacity versus end voltage and discharge duration



Cycle life at +20°C



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 +55°C
- Centralized water filling system
- Rapid recharge
- Fully recyclable

Technology

- Sintered positive electrode
- Plastic-bonded negative electrode



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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.

Electrical characteristics

Nominal voltage (V)	1.2
Rated capacity (C ₁ Ah)	56
Specific energy (Wh/Kg)	35
Typical power at 50% state of charge and 0.8V (W/kg)	350
Peak power at 100% state of charge and 0.8V (W/kg)	500

Mechanical characteristics

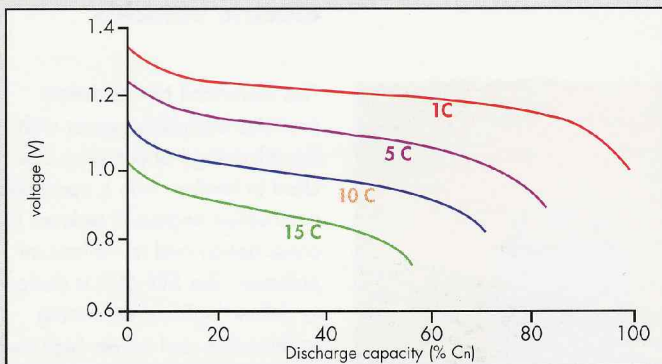
Typical weight (kg)	2.0
Dimensions (mm)	63x86x218
Volume (dm ³)	1.18

Advantages

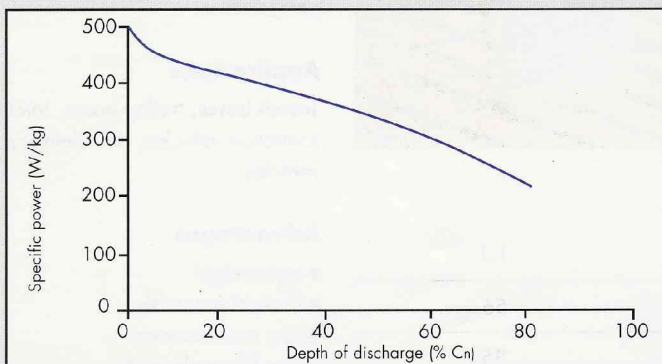
- Lightweight
- Ease of assembly
- Low maintenance
- Low life cycle cost
- Adapted to extreme temperatures -20°C to +55°C
- Single point water filling system
- Rapid recharge
- Fully recyclable



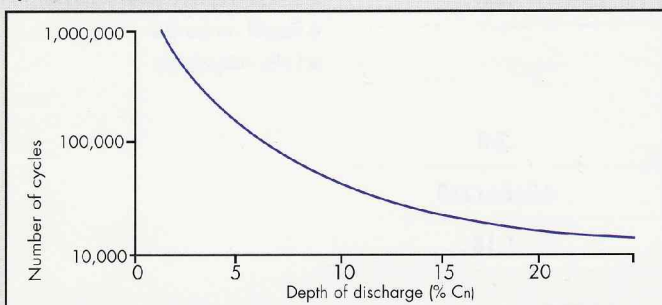
Typical discharge at +23°C



Specific power at +23°C at 2/3 U₀



Cycle life at +23 °C



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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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.

Electrical characteristics

	Module 12V	Module 24V
Capacity at C/3 rate (Ah)	93	93
Typical specific energy at C/3 (Wh/kg)	64	64
Typical energy density at C/3 (Wh/dm ³)	133	135
Typical specific power at 3/4 U ₀ at 80% DOD (W/kg)	150	150

Mechanical characteristics

Weight (kg)	18.8	37.3
Dimensions : L x W x H (mm)	390x120x195	760x120x195

Cycle life

Number of cycles at 80% DOD	>1200	>1200
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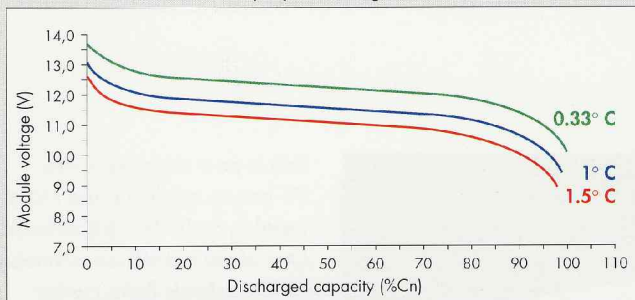
Application

All-electric vehicles

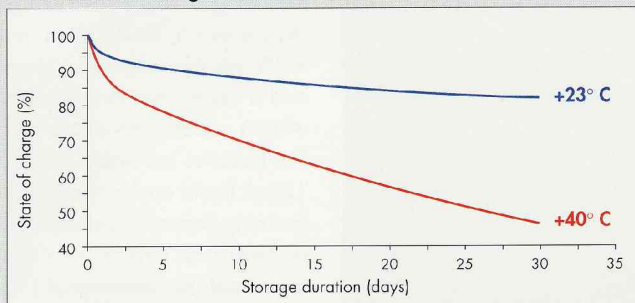
Advantages

- Maintenance-free operation
- High power/energy ratio
- Excellent safety and flawless resistance to abusive testing
- Easy fast charging
- Fully recyclable
- Liquid cooling
- More than 1,200 charge/discharge cycles

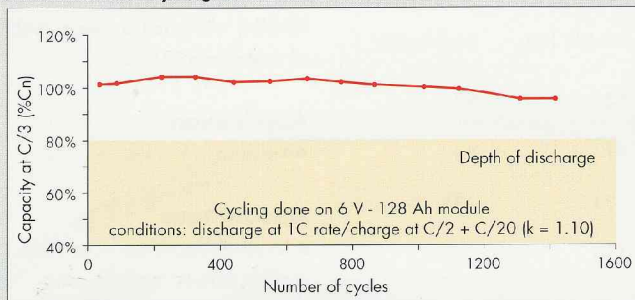
12 V - 93 Ah Ni-MH Module (G1) - Discharge at +23°C



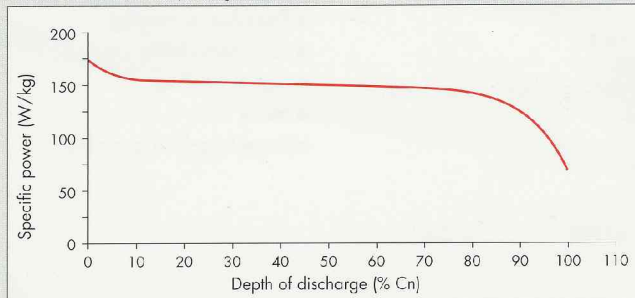
Ni-MH Module - Charge retention



Ni-MH Module - Cycling at 80% DoD



12 V - 93 Ah Ni-Mh Module (G1) - Specific power at 8 V with 300 A max current (30 s peak)



Technology

- Nickel foam positive electrode.
- AB₃ hydride on nickel foam negative electrode.



Advanced Technologies Division Electric Vehicle Marketing

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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
- AB₅ hydride on steel foil negative electrode



Electrical characteristics

Nominal voltage (V)	12	24
Rated capacity at C/3 rate (Ah)	109	109
Typical specific energy (Wh/kg at C/3)	73	73
Typical energy density (Wh/dm ³ at C/3)	162	164
Typical specific power (W/kg at 80% DOD, 30 sec, 2/3 U _o)	170	170
Typical power density (W/dm ³)	370	373

Mechanical characteristics

Maxi dimensions (mm): L x W x H	390x120x195	767x120x195
Typical weight (kg) *	19.6	38.7
Typical volume (dm ³)	8.8	17.4

Operating conditions

Operating temperature range (°C)	-20/+60
Transport or storage temperature range (°C)	-40/+65

* Liquid cooling included

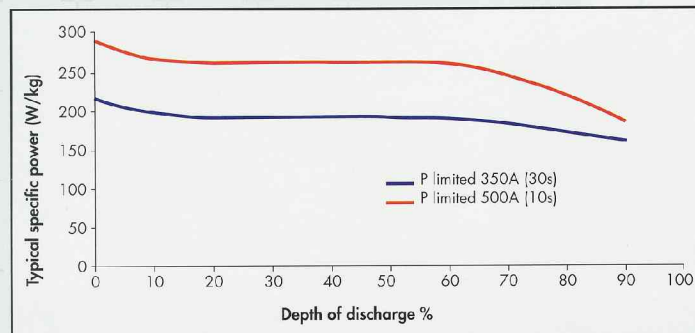


HIGH ENERGY

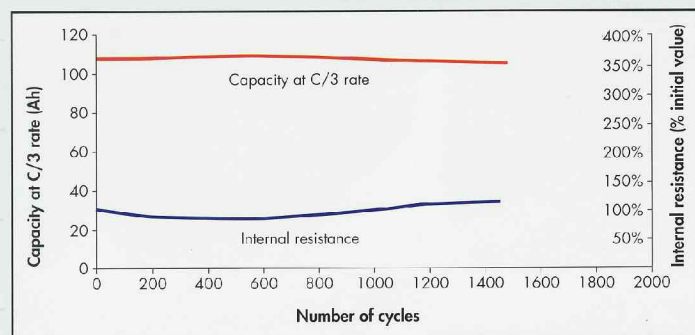
Nickel-Metal Hydride module for automotive industry

Ni-MH

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

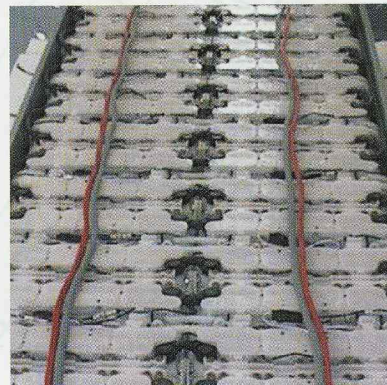


109 Ah Ni-MH Module - Capacity at C/3 rate - Internal resistance cycling at 80% DoD at RT: discharge at 1C rate/charge at C/3 + C/20 (k=1.10)



Fast charge

Saft 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 Saft Ni-MH battery. For any information please contact Saft.



Example of battery-system with Saft Ni-MH modules

Saft Automotive Sales and Marketing Direction

12 rue Sadi Carnot
93170 Bagnolet - France
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Fax: 33 (0)1 49 93 19 50
DOC. N° 0900.51033.2

www.saftbatteries.com

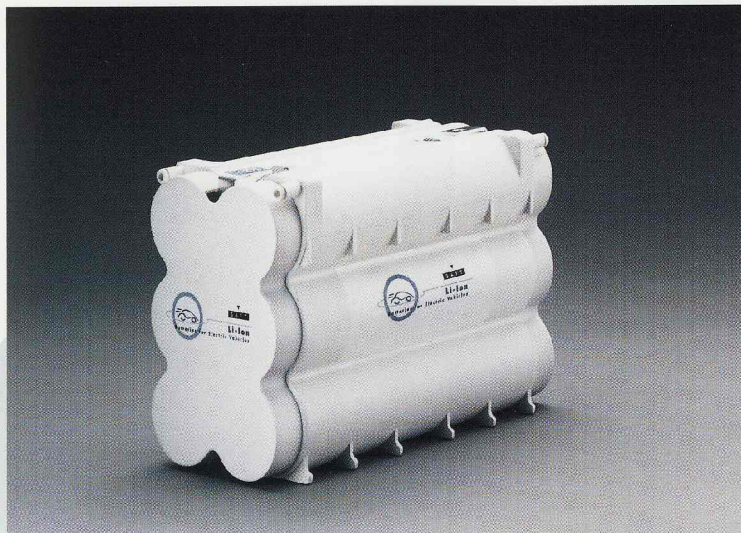
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SAFT

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

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

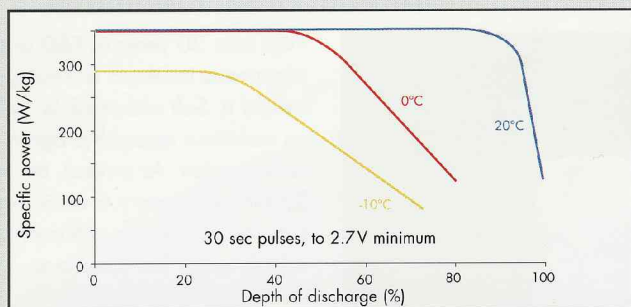
Electrical characteristics

Maximum voltage (V)	25
Maximum current (A)	330
Specific energy (Wh/kg)	150
Energy density (Wh/dm ³)	250
Specific power (W/kg)	300

Operating conditions

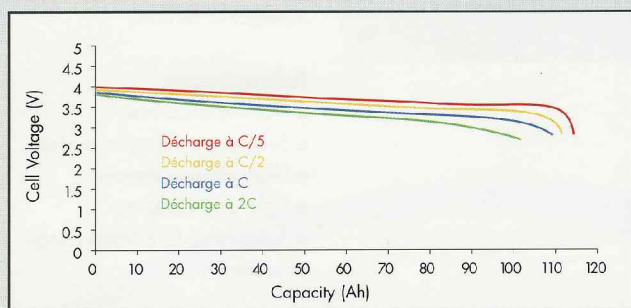
Temperature range	-10° to +50°C
Charging method	Constant current and constant voltage

Specific power at various depth of discharge



Discharge curves of 100 Ah battery

at various rates, ambient temperature +20°C



Electric Vehicle Division

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RECYCLING PROCEDURE

The Saft program

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 how to properly label and return spent nickel-cadmium or nickel-iron batteries for recycling on a standard bill of lading.
2. Nickel-cadmium and nickel-iron industrial batteries may also be shipped to us for evaluation. This service will only be provided under a written agreement.

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". Call Saft's Recycle Facility 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, evaluation and recycle.
 - B. Battery Service Agreement for:
 - Nickel-cadmium or nickel-iron batteries, recondition, return or replace.
 - Nickel-cadmium or nickel-iron batteries, evaluate, return or recycle.
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.

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.

Saft only assumes liability for spent batteries **ONCE THEY HAVE BEEN RECEIVED**. The Saft 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: Saft America, Inc.
Attn: Recycle Facility
Dock #4
711 Industrial Blvd.
Valdosta, GA 31601

Batteries packaged unsafely are subject to refusal by Saft.



State of Georgia
Department of Natural Resources
ENVIRONMENTAL PROTECTION DIVISION



HAZARDOUS WASTE FACILITY PERMIT

Permit No. **HW-001(S&T)-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**

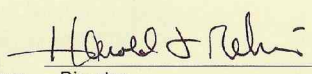
This Permit is conditioned upon compliance with all provisions of the Georgia Hazardous Waste Management Act, the Rules, Chapter 391-3-11 (as amended through **April 5, 1993**) adopted pursuant to that Act, and any other condition of this Permit.

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

S A F T

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Tel.: (912) 247-2331 Fax: (912) 245-2880
website: www.saft.alcatel.com