Number 1 **March 1992**

SAFT INTERNATIONAL

SAFT AND NIFE MERGE & ORGANIZE WORLDWIDE

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Lithium packs: the Lithoguard range expands with three new packs making their mark on the Asian market.

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North Sea rig: custom-made energy systems meet a tough set of specifications on a Norsk Hydro oil rig.

Frisco trolleys: equipped with STH batteries, they are able to travel without using overhead cables.

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EDITORIAL

Photo: Marc Bertrand

Bernard Pierre, formerly an Executive Vice President of Alcatel Alsthom, took up his responsibilities as Chairman and CEO of Saft on January 1st, 1992. He replaces Claude Darmon, now Managing Director of GEC Alsthom's transport division.

"A magazine to get closer to the customer worldwide". Call it instinct or strategy, Saft salesmen are usually known as the nice guys, the ones you can rely on, whether you're located in North America, Asia or Europe. Since the merger between Saft and Nife, we happily discovered our new Swedish partners were on the same wavelength as we were: international market-oriented technicians. Our product lines range from portable power packs to power sources for space and defense including aviation and industrial batteries, and power systems. As a consequence, most of our customers only know part of our activity. The time has come to explain that each Saft product line is backed up by a strongly organized international product group. Each activity fertilizes the enthusiasm of our onsite commercial structures. This first issue of *Saft International* aims to bring all of Saft even closer to you. Twice a year, you'll know more about our products, whether customized or standardized; you'll discover their applications all over the world; you'll understand how we organize to get the right product into the right place. And, twice a year, we'll present a technical close-up of one of our activities.

BERNARD PIERRE

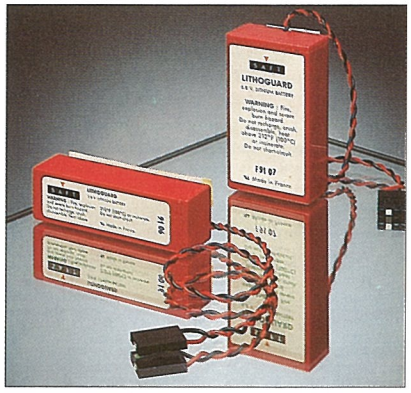


Photo: Jarlan

LITHIUM

What makes them tick?

A pioneer in lithium technology since 1964, Saft recently expanded its Lithoguard line of lithium packs, which are used to power internal clocks in microcomputers. The packs offer very high volumetric energy capacity; the new 1LS6 Lithoguard 3.6 volt 1.8 Ah pack can replace up to three classic batteries. This line also includes 5.6 and 6.8 volt PC-compatible packs. Lithoguard has already made its mark on the Asian market, notably in Korea, Hong Kong and Taiwan.

INDUSTRIAL

Best of three

How to integrate three product lines, three companies, to best serve three customer bases spread all over the world?

This was the problem facing the Industrial Battery product group, formed of a mixed Saft, Nife and Alcad team, after the February 1991 Saft Nife merger. Their answer? The Common Product Range. Its essentials: a standard line, dubbed Saft Nife, was chosen from the best of the three individual lines. The name Alcad will be applied in its traditional market base. Development of new products is centralized. Of course, production of specific items for customers will be continued as required.

This coordinated program allows all clients to benefit from quicker access to new technologies such as the sintered plastic-bonded electrode, PBE. Scheduled to be launched early in 1992, this pilot product offers high performance in a more compact package – 15% lighter, and up to 25% or 30% less costly than its traditional counterpart. Newly consolidated, the Industrial Battery Group offers a complete product range, a world leader in nickel-cadmium technologies, notably rail batteries.

On a practical level, the integration of worldwide sales networks brings Saft Nife even closer to the client.

CONVERTERS

Teaming up with Alcatel

Saft's converter and power supply activities have joined forces with Alcatel CIT and AEA, two of its sister companies in the Alcatel Alsthom group. The new structure, Alcatel Converters, brings together the group's expertise in conversion and energy supply for telecommunications and other civil and military areas, including computers and automatism.

Saft holds 49% of the capital; Alcatel CIT, the balance.

Foam technology – less is more

Saft's latest development in response to the demands of the dynamic portable battery market: cells with foam technology. Used in the cylindrical Super High Energy Series, VSE, a nickel foam strip takes the place of the standard sintered support in the positive electrode. More porous than its predecessor, the nickel foam absorbs more active material. The result: higher volumetric energy density. The VSE packs 15% to 40% more capacity into consumer electronics applications such as cellular phones, camcorders and laptop computers. Foam technology is currently being produced in an AA 800 mAh configuration. 4/5 A 1200 mAh and A 1400 mAh versions are due in the first quarter of 1992.

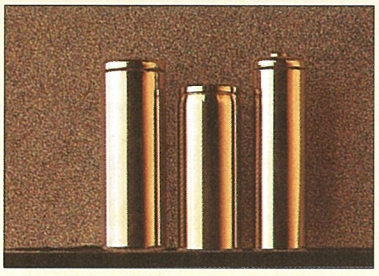


Photo: Jarlan

Saft's Troyes (France) factory will join the new company, while its activity in industrial and telecommunications power systems in Tours will continue as a division of its Power Electronics product group.
Alcatel Converters is expected to have a turnover of 250 million French francs in 1992.

UPS SYSTEMS

Rugged flexibility

Coordination advances on all fronts: in late 1991, a product formerly developed by Nife joined the new Saft Nife family. The Power Electronics product group launched its 901/903 series of on-line single- and three-phase uninterruptible power supply (UPS) systems.
The 901/903 is designed for industrial applications including process control and instrumentation, in demanding environmental conditions such as off-shore oil rigs.

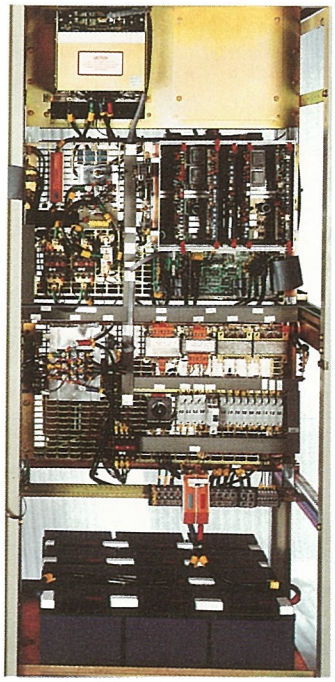


Photo: DR

Its flexibility can accommodate widely varying programs, molding itself to a number of power supply needs.
Systems can be supplied with lead-acid batteries, or nickel-cadmium for more volatile environmental conditions. The 901/903 series has several self-protecting features, including high frequency pulse-width modulated (PWM) transistor switching allowing rapid response to changes in load conditions. LEDs and digital instruments on the front panel indicate control and alarm status for constant monitoring. Self-diagnostic capacities, associated with easy-to-remove plug-in PCBs, facilitate speedy repairs.

A rising star in the States

Saft Space department was recently honoured by the TRW Space and Technology Group as one of its outstanding suppliers for 1991.
The division has been delivering nickel-cadmium battery cells to TRW for use in an American military space program throughout 1991.
One of 14 laureates chosen from an international pool of over 500 companies, Saft's product quality, competitive prices, efficient delivery and general commitment to performance were praised.
Saft shares the spotlight with companies like Honeywell, General Atomics and Control Data Corporation.
The honour takes its place in a long line of Saft Space achievements. Having built its reputation in Europe, equipping the vast majority of European space programs, Saft has found a firm foothold in the new world.

AVIATION

Sky-high standards

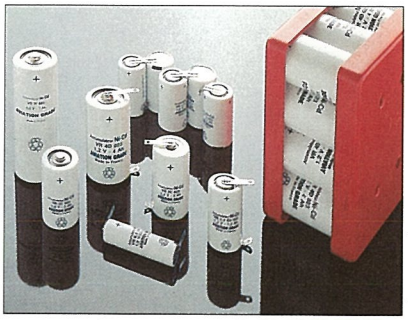


Photo: Jarlan

Number one supplier to the commercial aviation market worldwide, Saft extends its range to meet rigorous industry requirements.
Its Aviation Grade® line of scaled-down sealed nickel-cadmium batteries maintains smooth operation of on-board systems from lighting and exit signs to Inertial Navigation Systems and radar. They can be customized to fit any energy need within the 0.5Ah to 7Ah range.
Specific control procedures ensure only the highest performance levels. The sturdy nickel-cadmium structure of Aviation Grade® stands up to severe temperatures and other occupational hazards. In close partnership with clients such as Boeing and Airbus, Saft has developed batteries tailored to market needs. And its service platform rises to the demands of this always-exacting industry, with distribution and service points at all the world's major airports. Aviation Grade® ensures the flawless functioning essential to airplane safety – a high-performance product for a tough customer.

Saft + Nife: A new contender

February 1991: Saft merges with Swedish-based battery manufacturer Nife. A year later, a new rationalized structure is in place.

Before the merger, both companies were already major players on a worldwide scale. As a result of an enterprising expansion policy, Saft has become an international force over the past ten years. Its NiCd portable batteries and advanced applications for space and defense have made their mark in Europe, North America and Asia.

A leader in technologies such as lithium batteries, Saft's highly diversified range of activities also includes emergency lighting and industrial batteries.

Established in twenty-two countries, Nife introduced its world-leading NiCd industrial battery sector into the Saft range, as well as a large division in power systems. Nife has a long-standing international tradition, with manufacturing bases in both North and South America and Europe. A distinct plus for Saft's global position, its industrial batteries were strong performers in South America, as well as in Asia, Australia, North America and their native Scandinavia.

This common international orientation smoothed the way for the Saft Nife fusion. The challenge remaining: how to structure an expanded range of products and outlets on five continents, with a turnover of almost 4 billion French francs, to best reach and remain close to the client?

Four Product Groups

The first step was to finalize the organization of balanced product lines, pooling the considerable resources of each company. Saft broke down its combined activities with Nife into four product groups of equivalent weight. Portable Batteries, formerly responsible for a third of Saft's turnover, now handles a more equitable fourth. With Nife's input, Industrial Batteries supplies 60% of the world's needs in NiCd rail applications. World leader in defense applications, the Advanced Battery Group is also second worldwide supplier for space projects.

Finally, the Power Electronics Group takes on new importance, thanks to Nife's preeminence in the field. Worldwide organization is centered in Paris, where the four product groups establish individual policies for marketing, research and development, and industrial organization.

Each group has attacked its particular merger challenge according to the requirements of its market. The Industrial Battery Group, one of the most affected by the merger, has hit on a solution coordinating product development and commercial organization. The three major players, Saft, Nife and Alcad in Great Britain, all market a common range culled from the best of their former individual lines. Other groups are at work on a similar solution. Clients thus have access not only to the original lines, but to a newly enriched spectrum of options.

Four Commercial Zones

Commercial organization is then broken down into four geographical zones: Europe, North America, South America, and Asia-Pacific. Saft and Nife subsidiaries' activities have already been combined in several countries, including Sweden, France, the UK, Belgium, Italy and Canada. Saft products are now sold via the ex-Nife network and distribution continues to be rationalized. Ultimately, all subsidiaries will operate under the Saft Nife banner.

Subsidiaries remain number one in Saft Nife's commercial policy. Sizeable installations around the world ensure direct access – always Saft's philosophy. In countries where production facilities do not exist, subsidiaries offer the resources of trained technical personnel for maintenance and the manufacturing of prototypes.

An emphasis on communication strengthens the partnership between clients and decision-makers on all levels. A centralized international structure crossed with a strong regional presence – the best of both assures the success of the new Saft Nife partnership.

4 Product Groups

- Power Electronics Group
- Portable Battery Group
- Advanced Battery Group
- Industrial Battery Group

Jean-Pierre Lescieux: Power Electronics Group General Manager

Philippe Soulié: Portable Battery Group General Manager

Bertrand de Saint-Julien: Advanced Battery Group General Manager

François Putois: Industrial Battery Group General Manager

4 Strategical Geographical Areas

- North America
- South America
- Europe
- Asia-Pacific

Graphic: Idé

Jacques Blanc: South American Area General Manager. Saft Deputy General Manager, Administration & Finance

Frank D. Westfall: North American Area General Manager

Ken Klinker: European Area General Manager

Pierre Lenfant: Asian-Pacific Area General Manager

Photos: Robert Canault & Peter Simard

NORWAY

Oil rig energy

Saft Nife power systems are safely weathering tough conditions in the North Sea. Four custom-made energy systems meet sophisticated technical specifications for the Bradge project, on a Norsk Hydro oil rig. They supply process control, security lighting, high-voltage switch control and battery capacity testing. In a field where any power malfunction is counted in millions of dollars, Saft Nife systems ensure impeccable security standards.

Saft Nife A/S, in charge of the project, brings its substantial experience to complement the advantages of new production facilities in Tours, France. The project team is now geared up and ready to tackle any challenges, including five projects that are in development for next year.

Photo: DR

The Saft exhibition calendar

March		
Hanover, Germany	Cebit	11-18
Las Vegas, USA	Hela	22-23
Birmingham, UK	Electronics International (NEC)	24-26
April		
Hanover, Germany	Hanover Fair (DIM)	01-08
Utrecht, Netherlands	Het Instrument	06-10
May		
Ottawa, Canada	Canadian High Technology Show	05-06
Hong Kong	Elenex	06-09
Göteborg, Sweden	Elfack	11-15
Boston, USA	Electro International	12-14
Beijing, China	EP China	19-24
Chicago, USA	Summer Consumer Electronics Show	30-02 June
June		
Hanover, Germany	Interhospital	01-04
Berlin, Germany	International Aerospace Exhibition	15-21
New York, USA	Electrica 92	22-24
Cherry Hill, N.J., USA	US Power Sources Symposium	22-25
Munich, Germany	Eltec	25-27
London, UK	UDT	30-02 July
July		
Birmingham, UK	Electrotech (NEC)	20-24

JAPAN

A streamlined bullet train

The Mini-Shinkansen, a new version of the Japanese bullet train, gets in shape for the 1992 National Athletics Meet – with the help of Saft STM nickel-cadmium batteries. This model of the Shinkansen was developed to accommodate different track standards on the run from Tokyo to Yamagata, site of the meet. More compact and lighter than the conventional lead-acid batteries, the STMs aid in the reduction of load. The Saft batteries' highly stable specific energy is particularly suited to this kind of intensive use. They are capable of resisting extreme temperatures and require minimal maintenance.

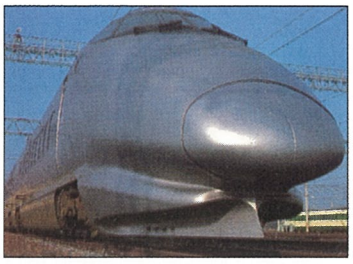


Photo: Sakurai Kan

UNITED KINGDOM

Stansted: safety first

Stansted, London's £400 million airport project, makes an investment in security – Saft Nife UPS systems and rectifiers provide backup emergency lighting.

In the tunnels of the airport's automatic, driver-less shuttle train, two AC UPS systems run lights for escape walkways between the main terminal and Satellite 1. They

San Francisco trolleys

Saft batteries help conquer the steep streets of San Francisco. The 37 new trolleys in the city's flotilla will be equipped with STH batteries as an alternative power source. The STHs allow the trolleys, powered in general by catenary wires, to tackle stiff hills and areas without aerial catenary infrastructure. Composed of 192 units of 300 volts, the batteries provide up to 30 minutes of autonomous power. They replace a noisier and more polluting diesel engine.

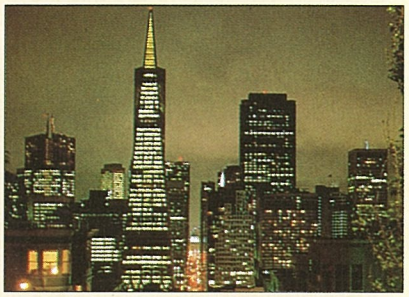


Photo: DITE/Bernard André

This is Saft's second major project in this realm, following an Italian trolley fleet developed in 1991 to provide access to historic monuments without disfiguring wires. The beginning of a Saft trolley tradition...

ensure two hours of autonomy in the event of a power failure – more than enough time to evacuate passengers. Emergency lighting in Satellite 1 is backed up by a DC power supply, which reacts rapidly to a full or partial loss of power. The systems were customized to meet the rigorous requirements of the British Airport Authority and the Railways Board. Passengers can rest assured that the Saft Nife systems will never leave them in the dark!

PUBLICATIONS

New brochures

Advanced Batteries:

• Lithoguard data sheet (English, French, German).

Industrial Batteries (including Aviation):

• Saft Nife block batteries and single cells catalogue (English) • Aviation Grade® sealed NiCd batteries pamphlet (English).

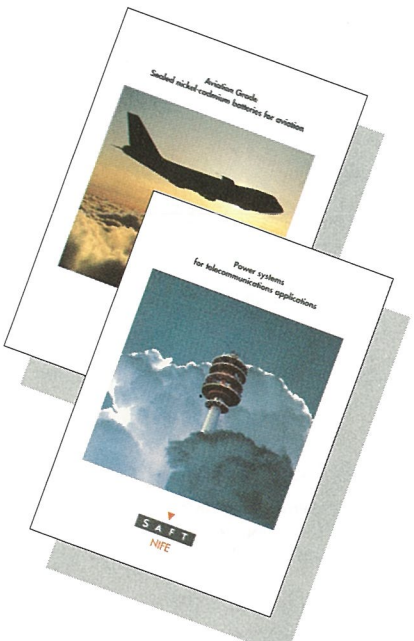
Portable Batteries:

• Data sheets for the entire range (English, French, German) • Recycling data sheet, (French and German).

Power Electronics:

• Power systems for telecommunications applications brochure (English). • Emergency lighting catalogue (French) • Emergency lighting short forms (English/French, Dutch/French).

Brochures are available from your local Saft or Saft Nife branch office; or you can contact the Communications Department at Saft headquarters in France: (33-1) 4942 3434.



IN BRIEF

The world's highest powered lithium battery for military applications: Saft's High Power LSH20 HD range provides unparalleled performance under extreme conditions. ▬ *British Rail's Certificate of Quality Approval goes to Saft's Lithium and Primary Industrial Battery Division, for its primary industrial batteries.* ▬ GP cells take the cellular phone market by storm! In 1992, 3.5 million will be delivered to Motorola, the sector's world leader, with another 2 million going to Nokkia Mobile Phones. ▬ ***Saft seawater activated batteries run newly obligatory distress light signals on life jackets; they can power flares for an entire night.*** ▬ **In the ultra-light Slim Razor, GP batteries guarantee a whole week's worth of shaves – a long-lasting solution to five o'clock shadow.** ▬ ***The United Parcel Service, America's top delivery company, equips its entire driver network with portable bar code readers run by either Saft GP or VE cells.***

Closing the industrial loop

Saft addresses problems concerning the environment at all levels of production, from development to the manufacturing and recycling processes themselves.

Saft environmental policy focuses on processes that actually reduce the amount of waste generated. Its production concentrating on secondary batteries, some lasting up to 25 years and rechargeable hundreds of times, is already a step in this direction. Research into electric car applications testifies to Saft's long-term commitment to a cleaner environment. At the same time, Saft has taken substantial measures to close the manufacturing loop, keeping primary materials in the production circuit. Facilities are already in place for the recycling of sealed and vented nickel-cadmium batteries, the bulk of Saft production.

Cadmium, recycled indefinitely

After being dismantled, the batteries proceed to the distillation and pyrolyse stages. The resulting pure cadmium is directly reintegrated into the battery production cycle; and the nickel-iron scrap which remains is delivered to the steel works.

More than 90% of battery materials can be recovered. Initial conservation is an important side effect; a smaller amount of raw material is needed. The form of cadmium used in batteries can be recycled indefinitely without deteriorating in quality, a major advantage. Vented nickel-cadmium batteries are especially easily tracked down for return, as their market is very concentrated. Saft's Industrial Battery product group has long had a policy of picking up used batteries when they deliver new ones. They expect the percentage of recycled batteries to rise from 75% to 90% within the next few years.

Saft's European recycling activities are concentrated in France and in Sweden, where a factory has been implementing new nickel-cadmium recovery procedures discovered by Nife since 1986. In the American market, batteries are collected for sorting in Greenville, South Carolina. After being shipped to Sweden, they are dismantled and treated.

Saft is also looking towards new solutions for the future. Batteries made up of easily recyclable combinations of compounds are being developed, and the process of marking composition on battery housing itself is being implemented to facilitate sorting.

Necessary to the success of the entire entreprise is, naturally enough, effective communication.

Photo : Snam

Recycled cadmium

Keeping the client informed

Saft has chosen the direct method: an information sheet is distributed with confirmation of every sealed nickel-cadmium battery order, informing clients where and how to deliver batteries for recycling. Special telephone lines have also been set up to answer client questions, in France and in Sweden for Europe, as well as in the United States.

A system is in the works for Asia and the rest of Europe.

SAFT INTERNATIONAL IS THE NEWS MAGAZINE FOR SAFT'S CLIENTELE AND BUSINESS PARTNERS

Editor-in-Chief: Roland Bourgeois • Managing Editor: Bénédicte Piret • Journalist: Catharine Weese • Design & Editing: Angle • Published by the Saft Corporate Communications Department, 156, avenue de Metz F. 93230 Romainville

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TECHNOLOGY

SOLAR ENERGY: THE NICKEL-CADMIUM ALTERNATIVE

Maximizing solar power potential – nickel-cadmium batteries. Bringing together durable technology, minimal maintenance requirements and a compact energy source, nickel-cadmium promises to give new impetus to the field.

Batteries used in solar-powered systems must have particular properties in order to minimize overall cost and maximize reliability. Although most photovoltaic (PV) systems installed to date use lead-acid batteries, experience shows that the nickel-cadmium (NiCd) battery is now a serious alternative for solar applications.

Because of market pressure to keep total photovoltaic system prices as low as possible, the initial cost of NiCd has hindered its use in the past. Users are also often unaware of the NiCd battery as a photovoltaic alternative. The option is therefore not even considered – a situation which only reinforces the basic unfamiliarity with NiCd on the part of photovoltaic equipment manufacturers and of PV system battery manufacturers.

Solar energy systems – in lighting, cathodic protection, telecommunications, refrigeration, or railway signalling installations – operate very differently than normal standby or motive power applications. They impose a unique combination of demands on batteries, including long life, reliability, high charging efficiency, low self-discharge, low maintenance, ability to withstand temperature extremes, and rugged construction. In addition, capacity to operate in various states of charge and cycling capability are key considerations.

Nickel-cadmium or lead-acid?

a) Charging efficiency

The charging efficiency of any type of battery depends on its state of charge. A fully discharged battery recharges at almost 100% efficiency. As the battery approaches a fully charged condition, its charge efficiency falls off. Under photovoltaic charging conditions, the NiCd's charging efficiency is similar to that of the lead-acid type, at least 80%. A PV system

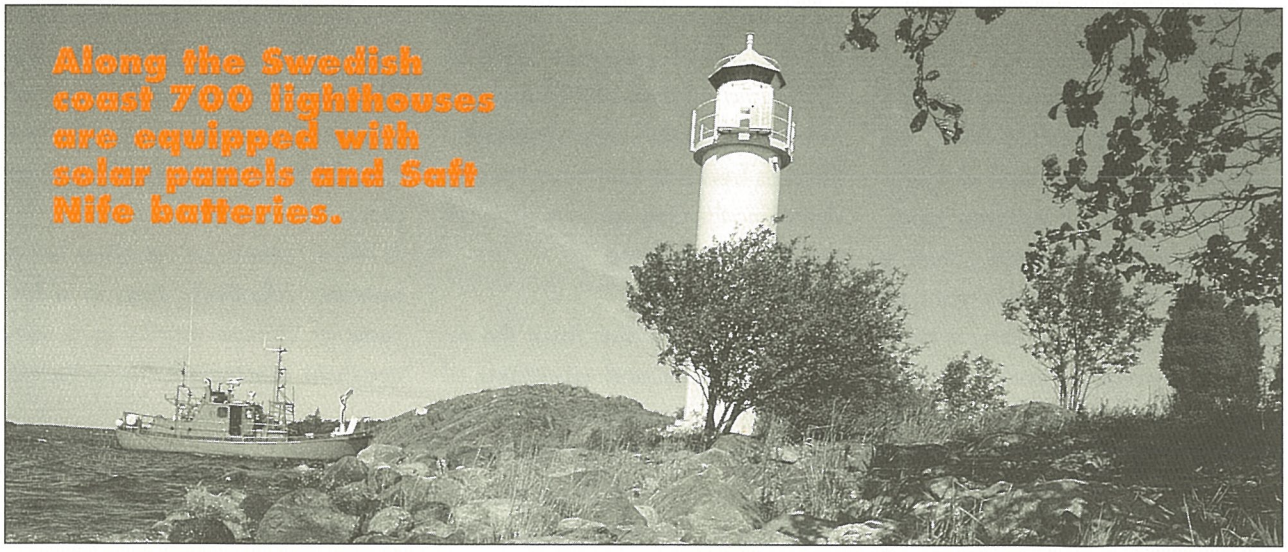


Photo: Jan Wadström

battery's typical state of charge is 20 – 80%. Lead-acid charging efficiency decreases with time, a factor that affects battery size. This is not the case with NiCd.

b) Self-discharge rates

Low self-discharge is also essential for solar-powered application batteries; like poor charge efficiency, a high self-discharge rate calls for larger photovoltaic modules and increases cost.

Although the battery will not stand on open circuit for prolonged periods, charge retention must be high to maintain charging efficiency.

A NiCd battery drops to approximately 80% of its capacity in one year when on open circuit. It then remains at this level with less than 5% loss of rated capacity per annum. As PV batteries operate at less than 80% of fully charged state for most of the year, NiCd needs little or no compensation for self-discharge. A fully charged, vented, lead-acid battery, on the other hand, self-discharges at a rate of 1-5% of its capacity per month, until it is discharged.

c) Maintenance

As solar generators are often located in relatively inaccessible areas, the battery must require minimal maintenance, even under extreme conditions. In a well-engineered system, a vented NiCd battery needs topping up only about every 10 years; a lead-acid battery requires annual maintenance. As NiCd electrolyte takes no active part in the charge/discharge cycle, the amount of electrolyte can be increased to allow for long intervals between maintenance. New "maintenance-free" NiCd battery designs can last 20 years without requiring topping up. Also, the regular charges needed to equalize lead-acid battery cell voltages cannot be provided in PV-charged applications.

d) Operating temperature

Solar generator location often subjects batteries to temperature extremes. Consequently, they must be able to operate efficiently under all conditions.

A NiCd battery works between -50°C and +60°C. At extremely low temperatures its capacity diminishes (50% reduction at -50°C), but not permanently.

A lead-acid battery, on the other hand, operates only between -20°C and +40°C, and capacity decreases at temperature extremes (50% at -20°C and 45% at +40°C) are permanent. In addition, when discharged the cells freeze at low temperatures, damaging the plates and cracking cell cases during thawing.

e) Ruggedness

The battery must also resist the inevitable shocks and vibrations of transportation to remote sites. Rough transport can ruin the soft lead internal components of a lead-acid cell. The NiCd battery, by the very nature of its construction, is probably the most robust battery on the market today. Storage and delays in transit can also harm lead-acid batteries. Unless they are shipped dry-charged, they can self-discharge and eventually be ruined by sulphation.* Sealed lead-acid batteries cannot be shipped dry-charged and need refresher charges every six months.

FIG. 1: COMPARISON OF BATTERY TYPES

SYSTEM	NUMBER OF CYCLES	LIFE YEARS
NiCd Pocket Plate	2,500	25
Plate Lead Acid	1,000	20
Tubular Lead Acid	1,500	15
Industrial Flat Plate	1,000	10
Lead Calcium	500	10-12
Sealed Lead Acid		
Glass Fibre	500	5 or 10
Gel Type	150	4
Automotive	150	2-4

Graphic: Idé

f) Cycling

Batteries in PV systems must withstand a long life of daily shallow charge / discharge cycles.

The cycles follow a seasonal pattern: the battery is gradually discharged during periods of little light and then slowly re-charged as sunlight increases. Under such conditions, many standby power and all automotive batteries have a short life (Fig. 1). To avoid being discharged when there is little sun, lead-acid batteries must be designed with a reserve of capacity. In fact, they often discharge more deeply than anticipated, and are damaged by lack of sufficient reserve at the end of the season. Furthermore, when a lead-acid battery is repeatedly charged and discharged at low rates, "stratification" occurs: acid accumulates at the bottom of the cell, corroding the positive plate.

A NiCd battery, on the other hand, operates effectively even in a low state of charge thanks to a very constant discharge characteristic

** Sulphation is a corrosive attack by the sulphuric acid on the discharged plates, a process that can be irreversible.*

(Fig. 2). Its strong steel construction – capable of withstanding the plate swelling and contraction caused by charge/discharge – suits it to deep cycling applications. Even over-discharged batteries are not harmed permanently.

g) Reliability

As an installation with a faulty battery is useless, reliability is also vital. Per hour, a lead-acid battery fails 100 times more often than its NiCd counterpart. A NiCd battery can undergo many system mishaps without damage, while a lead-acid battery suffers irreversible harm.

Furthermore, the death of a lead-acid battery is unforeseeable and sudden. For example, an internal component can deteriorate to the point of breakage and result in a short circuit. In contrast, as a NiCd battery nears the end of its life, the user is aware of it.

Cost comparisons

It is generally assumed that NiCd batteries are considerably more expensive than lead-acid types.

However, in a well-engineered NiCd system, the relative purchase price is not as high as is often supposed. A NiCd battery has a design life of 25 years and a long operating life even at high temperatures. As NiCd does not undergo sulphation and operates in any state of charge, it does not need built-in excess capacity.

Furthermore, in certain applications (e.g. village street lighting) the NiCd battery can be engineered for frequent deep discharges where long periods of autonomy are not required. The superior cycling characteristics of NiCd cells thus result in a smaller, and lower cost, battery and PV modules.

Lead-acid battery maintenance is also more costly; they may need to be replaced as many as four times throughout the system's life. NiCd batteries resist electrical abuse better – unlike lead-acid, they are not harmed if the voltage regulator fails. Consequently, NiCd-equipped PV systems are often more cost-effective in terms of replacement and system downtime costs.

At low temperatures the relative difference in capacity and hence cost required for lead-acid batteries increases dramatically, as they must be kept in a high state of charge to avoid freezing.

Battery engineering

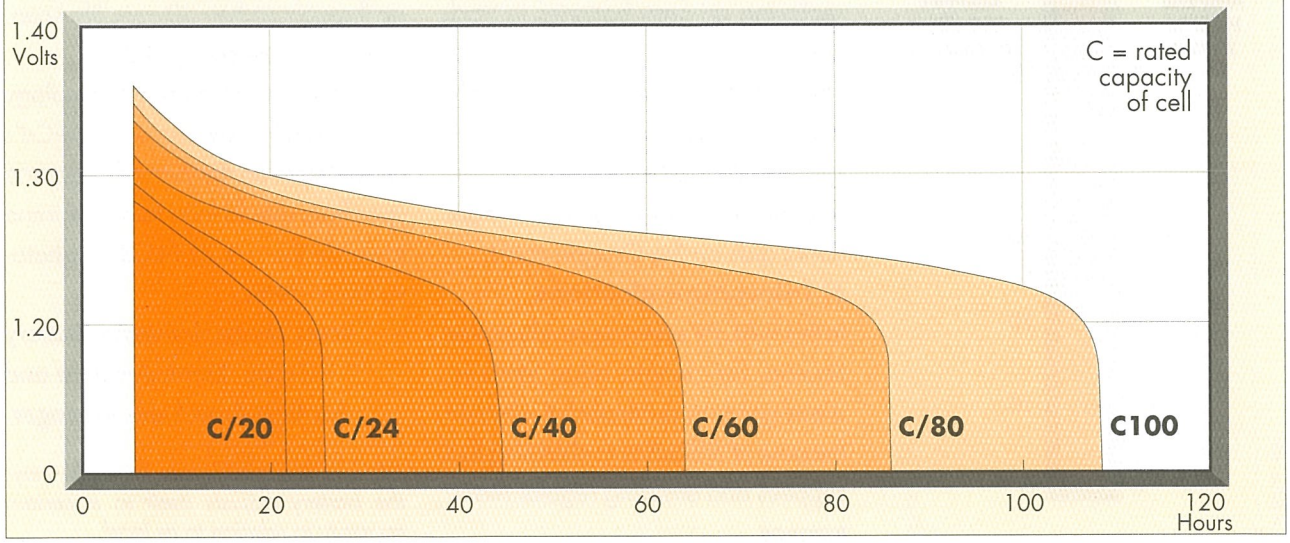
As most PV manufacturers are unfamiliar with NiCd batteries, they tend to use lower first cost batteries which are not necessarily best suited to the application.

To size a battery correctly, it is necessary to know discharge load, length of discharge, autonomy, average ambient temperature, the required maintenance interval and charging characteristics.

NiCd batteries are available in the traditional "vented" design or the new "maintenance free" type. Vented batteries can be designed with a 10-year topping-up interval; the "maintenance free" battery can operate for its entire life without topping up. In addition, if the voltage regulator fails or the system's design parameters are exceeded, a NiCd battery can be refurbished onsite – unlike sealed "maintenance free" batteries.

Many common misconceptions about NiCd batteries include allegations of poor charging efficiency and the memory effect. NiCd charging

FIG. 2: TYPICAL DISCHARGE CHARACTERISTICS OF A NiCd CELL



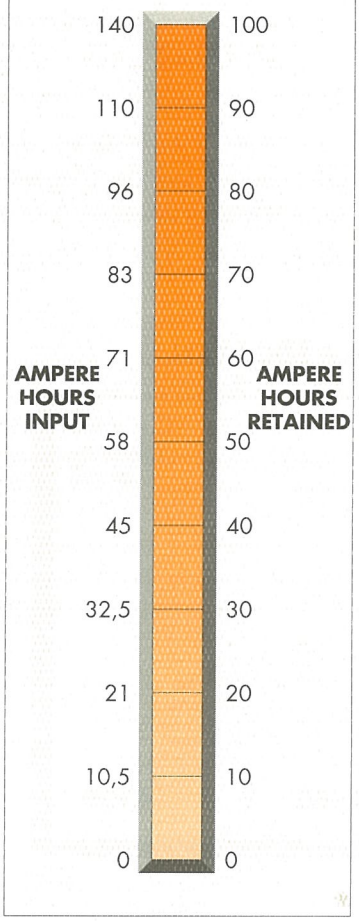
Graphic: Idé

efficiency under solar-powered conditions, shown in figure 3, provides proof to the contrary. And the memory effect* does not occur in pocket plate NiCds.

Applications

Solar power is becoming increasingly popular throughout the world for applications such as cathodic protection, refrigeration, railway signaling, and lighting, which require a relatively small amount of electricity – less than 20 kWh per day. For example, nickel-cadmium batteries power street lighting in remote regions of India, part of a large program of improving facilities in rural villages with no mains power but plenty of sunshine.

FIG. 3: AMPERE HOUR EFFICIENCY OF A NiCd BATTERY (PER 100Ah)



Graphic: Idé

a) Street lighting

A typical photovoltaic street lighting system consists of a solar pane, a metal pole with a fluorescent tube, with a rechargeable battery housed in a box at its base. The battery must store enough energy to power a 20W fluorescent tube for six hours per night throughout the year.

Nickel-cadmium batteries are particularly well suited to this type of application. First, as they tolerate heat well, they work effectively even in the Indian midday sun. Second, they have a longer working life than their lead-acid counterparts. In general, a NiCd battery designed for solar-powered street lighting lasts 15 years in an operating temperature of 40°C. Third, a much smaller Ah (thus less expensive) nickel-cadmium battery does the job of a large lead-acid type – a 30Ah NiCd battery provides the same amount of power as a 120Ah lead-acid battery.

b) Railways

Solar-powered systems are increasingly common in railway applications. In the USA, NiCd batteries equip a photovoltaic signal system; a system powering electronically-coded track circuits, signal lamps and repeaters; and hundreds of 2V and 12V systems replacing primary batteries in track circuits.

These batteries also operate highway crossing, approach and warning systems at a federal nuclear facility and power deck-mounted navigational aids on the Oregon coast.

c) Telecommunications

In this field, PV systems provide power sources for remote relay stations; diesel generators cannot be relied on because of difficulties in obtaining fuel supplies and ensuring regular maintenance.

Repeater stations in inaccessible areas like mountain tops suffer temperature extremes and rough transportation conditions. The weather often renders battery maintenance impossible.

Such applications include North American highway telephones run by small-capacity batteries, and batteries for PV systems on mountain-top radio sites accessible only by helicopter.

d) Navigational aids

Used extensively in this field, NiCd batteries can be counted on particularly at high latitudes. In Arctic or Antarctic regions batteries must operate in extreme conditions; only NiCd batteries can reliably withstand the deep discharges, long periods of operation in a low state of charge and freezing temperatures in remote sites where regular maintenance is impossible.

Future trends

A "maintenance-free" NiCd battery now offers solar clients the benefits of low maintenance combined with the reliability of traditional vented batteries. In these batteries, gas given off during operation is recombined within the cell. Little water is lost, so maintenance is unnecessary. They can be expected to operate without topping up throughout their 20-year life-span, when low rate charged.

Developments in battery technology and increasing awareness of NiCd's advantages on the part of users and specifiers should lead to a new trend towards the use of NiCd in photovoltaic systems.

JOHN TAYLOR, Industrial Battery Group, North America and Far East Area Sales Manager.

** Due to repeated use in the same way, the battery adjusts itself to a certain capacity in relation to its load.*