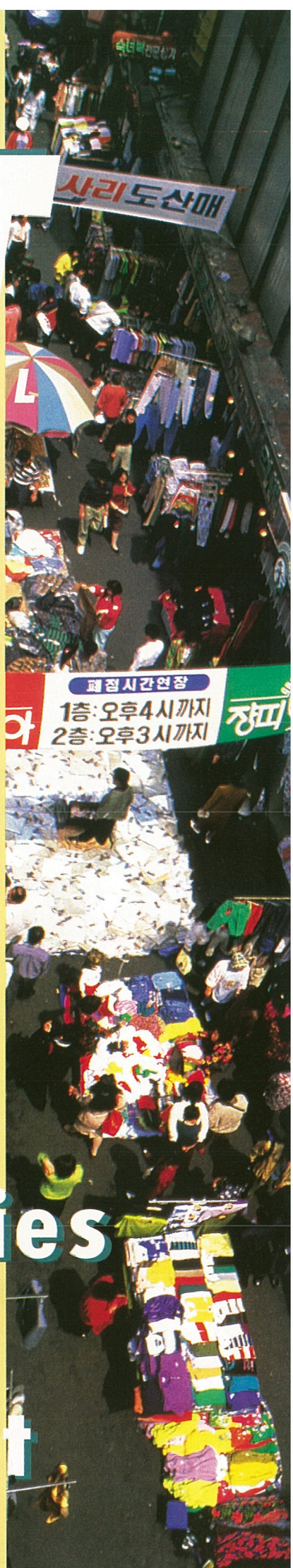


● Number 5 • Summer 1994

SAFT

INTERNATIONAL



Portable batteries
in Asia:
a boom market

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S A F T

SAFT INTERNATIONAL

A MAGAZINE FOR SAFT'S CLIENTELE AND BUSINESS PARTNERS

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THE WORLD IS RAPIDLY CHANGING, WITH NEW AREAS OF INTENSE ACTIVITY COMING TO THE FORE. And Saft is keeping up with

the pace. We have long been moving beyond our traditional areas of activity, in Europe and the United States. In this issue, we present one of our more recent areas of expansion, Asia, zeroing in on the portables activity which has seen such remarkable growth since the 1980s. We have made it a major priority to be present to serve this market, offering both the international reach and the local know-how that has become the Saft hallmark. This local emphasis has already taken us to Japan, Singapore, Malaysia, Korea, Hong Kong – and will soon be taking us into China, whose growing need calls for a local manufacturing base.



Peet Simard

The Saft global/local equation for service goes beyond Asia and portables, however. In this issue we take a trip around the world to examine our Sunica batteries for solar installations and our products installed in power plants from Brazil to Abu Dhabi. We go from India,

where we are supplying batteries for 1000 new locomotives, to the United States, where Saft portables are big in the warehouse club market, and Australia, where our power systems products equip navy frigates.

But service is not only being in the right place at the right time with the right product – it's also anticipating the needs and evolution of clients and the market over the coming years. This is where Saft's new power systems client training program comes in – giving our customers the tools to get the best use out of our products. Looking even farther down the line, this is also the role of Saft's two research facilities, one based outside Paris in Marcoussis, and one in the United States in Maryland. Work on developing technologies like rechargeable lithium batteries prepares a more productive future – not only for applications in wide use today, like laptops and camcorders, but also for those that promise to change our lifestyle, like the electric vehicle.

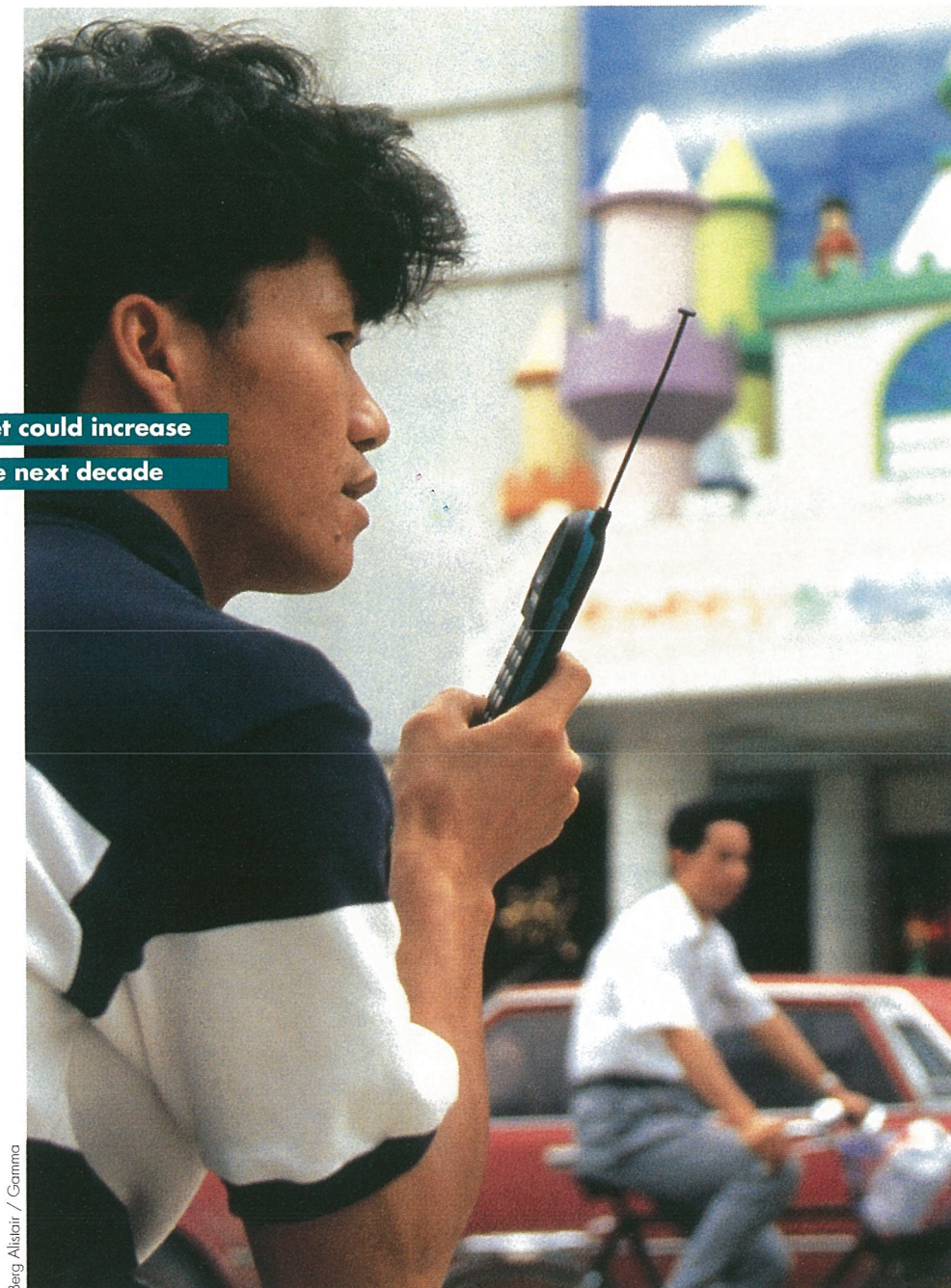
Saft will always be committed to preparing the energy of the future, as well as ensuring the energy of today.

BERNARD PIERRE
Chairman and CEO

Portables in Asia: on the rise

The Asian market could increase
500% over the next decade

**Saft reinforces
activities in Asia
to respond to
a burgeoning
market.**



Berg Alstair / Gamma

Fueled by the increasing demand for laptop computers, cellular telephones, and cordless appliances, the market for rechargeable portable batteries has seen spectacular growth worldwide over the past decade. Nowhere has this been more true than in the rapidly expanding Asian market. Recent annual growth rates for portable batteries have

topped 15% in Asia, and are likely to surge more in years to come. To keep up with the pace of client needs, Saft's Portable Battery Group is developing its Asian operations as it heads towards a new and even more dynamic century.

Over half of the roughly \$2 billion global portable battery market is generated by Asian sales, primarily in Japan, where 530

THE WALKMAN: A 1980S SUCCESS STORY

As it tried to miniaturize its Walkman in the mid-1980s, Japan's Sony Corp. encountered a problem: how to shrink the battery to fit the new trim Walkman line.



Sony asked Saft partner JSB to create a powerful battery within the space constraints of the new Walkman. JSB's answer: the prismatic battery, a flat, sleek cell less than half as big as the cylindrical batteries previously used in Walkmen.

A few years later, Motorola, the world's leading manufacturer of portable telephones, asked JSB/Saft joint venture GS-Saft to adapt the prismatic battery to its cellular phones. Since then, GS-Saft's innovation has become the standard battery for all modern cellular phones.

"The growth potential is much greater for prismatic batteries than for cylindrical, due largely to its applications in the growing telecommunications sector," says GS-Saft Vice-President John Conely. "We first took this product to market in 1986, meaning it's a young market. But since then, the prismatic cell has become the battery of choice for the telecommunications industry. That leaves us very well-placed for the future."

million of the world's 1.8 billion cells are sold. The rest of Asia purchases around 350 million cells per year, just behind the 375 million bought by the U.S., and ahead of Europe's 300 million.

A major reason for Asia's large appetite for rechargeable batteries lies in its role as a leading producer of battery-powered portable consumer appliances. Cylindrical batteries are used in appliances like portable vacuums, while assembled packs of cylindrical batteries can be charged and recharged to operate laptop computers, video cameras, cordless tools, and toys. Prismatic batteries have become the preferred battery for lighter, smaller products such as cellular telephones, portable stereo sets and radios – though they can also be used in packs for laptops, among other applications.

■ A LOCAL NETWORK

Saft currently weighs in as the world's third-largest supplier of portable batteries. The company has been present in Asia since the early 1980s, and has become the region's largest non-Japanese producer. To respond to the needs of the Japanese market, Saft formed the GS-Saft joint venture with Japan Storage Battery, one of the country's major manufacturers, in 1986. Saft's shared successes there – notably its part in the development of the prismatic battery (see box) – allowed it to establish an important foothold in this key market.

"In its first five years, GS-Saft was essentially a domestic company, serving the Japanese market almost exclusively," comments John Conely, GS-Saft's Vice-President. "In 1994, however, over 70% of GS-Saft's principal prismatic battery production will be sold as export... While the market in Japan has actually been declining in recent years, in the rest of Asia it has not only been growing, but is outstripping any other market in the world."

To increase its presence in the rest of Asia, Saft began establishing affiliates throughout the region in the early 1980s.



C. Jorlton

They now serve a significant portion of the region's portable battery market. Leading the way are Saft's sales offices in Singapore, Hong Kong, Australia, and South Korea. Plants in Singapore and South Korea assemble battery packs for laptops, power tools, and cellular phones using some of the 30 million individual cells GS-Saft's Kyoto factory produces each year, as well as cylindrical cells manufactured in Saft's plants in Tijuana and Nersac.

The Saft network now represents around 15% of the regional market share, with some notable exceptions in individual markets. Saft's Seoul operation, for example, has claimed around 40% of the booming South Korean market.

Saft in Hong Kong has played an important role in servicing the group's clients in the People's Republic of China – a nation whose growth rate is nearly as impressive as its future potential. Patrick Houzé, mar-



INTO

Japan, the world's largest portables market, buys 530 million cells a year

The GS-Saft prismatic battery is
the choice for mobile phones

South Korea
is one of the
most active
new OEM
markets



Office National de Tourisme Coréen

keting and sales manager for Saft's Portable Battery Group, says Saft is looking forward to increasing its work with clients in China. "Our first step has been to follow European and U.S. clients – as well as Japanese, more recently – into China to provide them with whatever they need to meet their goals," Houzé explains. "Next we'd like to start serving the growing local OEMs. To do that we'll need to set up a local operation."

Philippe Soulié, General Manager of Saft's Portable Battery Group, suggests that a local operation in China could go beyond a simple facility for battery pack assembly. "To provide for a market as huge as Asia – particularly with China set to explode – we'll need a big factory capable of producing batteries and cells for the entire region," Soulié comments. "For me, China is the logical location for it. We are currently looking into ways to set up that operation, which will not only give us greater reactivity on the Chinese market but also provide us with additional competitive capacity to serve worldwide demand."

China's portable battery market has enormous potential. While Soulié notes that the

\$400 million Asian market (outside of Japan) could increase 500% over the next decade, he says there is no telling how fast the Chinese market could take off. And Saft is planning to be there soon, says Soulié: "If everything goes our way, in just a couple of years we are looking at a factory in China employing several hundreds of people – like our Kyoto, Nersac or Tijuana bases."

"Given the vital role batteries play in the entire telecommunications industry, Asia as a whole will be booming for years," agrees Conely. "Beyond the entire region, you also have China, whose potential for growth is virtually unlimited. It is going to be a crucial area." The decision to open a plant in China will also be an advantage for Saft's clients. Saft has long held that the best way of meeting clients' needs anywhere in the world is to set up strong teams of local managers, whose insight and experience in their national markets make them important on-site partners.

"Our Japanese competitors have traditionally been export-minded, operating from a very strong centralized base," comments Soulié. "Our philosophy has been to view each affiliate as a local entity, not an

extension of a French or European company. Part of this approach involves recruiting the most competent local managers available in individual markets. The same will be true in China. We will have to find the best Chinese managers out there to help us succeed."

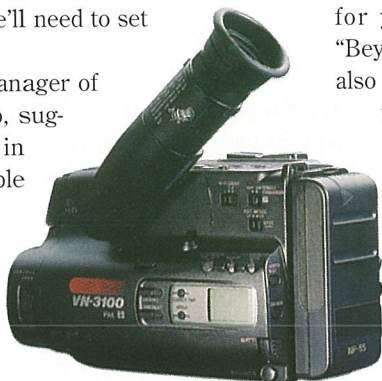
"We have the best industrial and sales network in Asia, and that is because we believe in making each affiliate as 'local' as it can possibly be," Houzé agrees. "That allows you to give your clients – be they Asian, American or European – the same expert service and quality in every market they operate in, including their home market. We follow them wherever they want to go, and provide them with partners in each country who know their local markets best."

■ SMALL IS BEAUTIFUL

This internal corporate strategy will continue to set Saft apart from its competition qualitatively – and will remain a constant in the rapidly evolving Asian portables market. "Certain countries – Thailand or Indonesia, for example – are moving towards adopting lifestyles similar in many ways to those in the West," Houzé explains. "That means increasing use of consumer appliances like cordless vacuum cleaners, cordless tools, laptop computers, etc."

Houzé also says that another consumer concern – the status value of a product – will grow as the use of these portable items increases. "Often, size – which is dependent on battery volume – is key to a product's image. The smaller it is, the more prestigious it becomes," Houzé notes. "This is particularly true for products used in public such as cellular phones."

Design innovation and technological advances will continue to shape the development of the Asian marketplace. As its growth is sustained over the next decade, Saft can be counted on to be on the spot to respond to its evolving needs. ■



D.R.



D.R.

Nonstop power

The world's power plants count on backup energy provided by power systems and batteries.

The hydroelectric station of Itaipu, on the Brazil-Paraguay border, is the most powerful plant in the world. And – as in many power plants located all over the world – Saft products are an integral part of it.

“It’s the biggest operating plant on earth, and it’s the biggest order we’ve taken on a power company,” says Roberto Mayo, manager of marketing and strategic planning at Saft Nife Brazil. Each of the Itaipu plant’s 18 generating units produces 700 megawatts. It has a total capacity of 12,600 megawatts – the equivalent of ten French nuclear reactors.

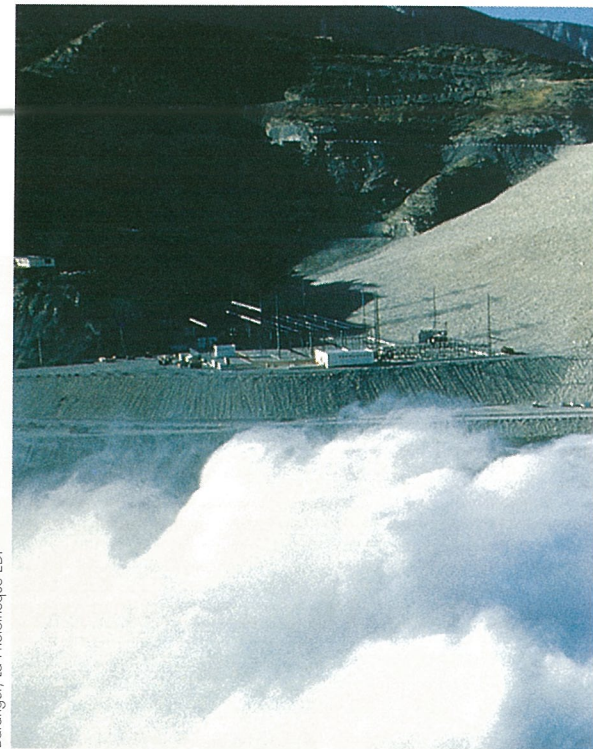
Saft Nife Brazil’s role in the project has been equally outsized. “We have supplied all the nickel-cadmium batteries and all the rectifiers for these batteries,” Mayo says, adding that the total capacity of the 51 Saft Nife Ni-Cd batteries in the Itaipu project is two million ampere hours. A program to replace the old batteries is currently under study.

The Itaipu plant is just one example – although a massive one – of the thousands of power plants at work around the world, providing energy for every conceivable application. And, as at Itaipu,

the companies that build these plants, from Australia to the C.I.S., are turning increasingly to Saft for the power systems and batteries that provide consistent backup. Saft-designed power systems include chargers and rectifiers (for DC) and inverters and UPSs

(for AC). Saft UPSs, for example, are crucial for continuous supply of electric power to critical AC loads including computers, annunciators, and other critical sources.

Saft’s Charles Streb, a power electronics expert, points out that, while many of these



Baranger, La Photothèque EDF

products represent a small part of a power plant’s needs, they are of vital importance in power plant operation. “There’s a certain disproportion between the backup system budget and its importance in assuring security,” he says.

The world’s power plants are expected to generate about 81 gigawatts a year throughout the year 2000. They break down into five different types of technologies: steam turbine (with 35% of the market), combined cycle (23%), gas open (18%), hydroelectric (15%), and nuclear (9%).

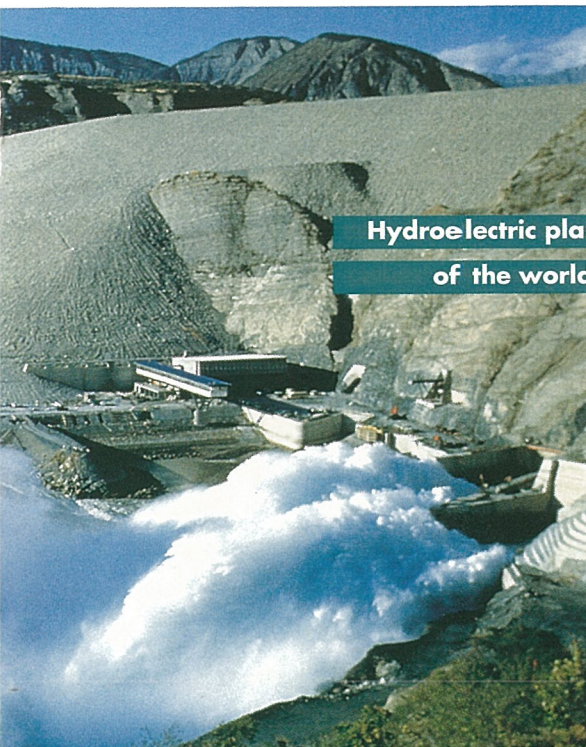
■ NEW HORIZONS

Market growth is geographically defined, with greater growth in newly industrialized countries – including China and Southeast Asia – than in such countries as France or the United States. “In general, industrialized countries already have sufficient electrical production,” explains Serge Leroy, director of French sales for Saft’s Power Systems Division. But more recently industrialized countries remain dynamic. Industry sources predict that Asia will dominate the power plant market until the year 2000, with 36.5%. The rest of the market will be divided among North America (24.7%), Europe (including Eastern Europe) (16.0%),



P. Moisson

The battery bank at Itaipu provides 2 million Ah of backup capacity



Hydroelectric plants generate 15% of the world's electricity

the Middle East (6.4%), the C.I.S. (7.1%), Latin America (6.1%), and Africa (3.2%).

Saft Nife Power Systems' factory in Singapore is in a good position to serve the burgeoning Asian market. Fong Chee Heng, marketing manager of the establishment, says, "We're close to the customer in terms of manufacturing presence – and our products are a good fit for market needs." Saft Nife PS serves all the major oil and gas companies, railways, utilities and telecom sectors in the region, and its products equip plants in every country in Asia, from the Philippines to China.

Although new power plant projects are no longer being built in regions like Europe and North America, the market is still an active one, with many older plants being refurbished and others being converted. Saft products can be found throughout Europe, and Saft Nife subsidiaries cover a broad base. For example, the Italian subsidiary works extensively with the Middle East, most recently on thermal power plants in Yemen and, notably, in Abu Dhabi – a 28 MF order, half power systems, half high-capacity SBM batteries.

The world's energy is generated at power plants located all over the globe; in almost every geographical location, Saft is there. ■

VALDOSTA GOES ELECTRIC

Saft's Valdosta, Georgia, plant is now equipped to produce electric vehicle (EV) batteries. After a year of close cooperation between the U.S. team and Saft's EV plant in Bordeaux, France, the first STM5-180 nickel-cadmium batteries rolled off the line in late May.

Valdosta is now ready to take on the projected market surge, with a capacity of 3000 modules a year. Clients include members of the big three, as well as the growing hybrid and electric bus market. ■



Philippe Guignard

INDIAN RAILWAYS ON THE RIGHT TRACK

Saft Nife AG in Switzerland will be supplying SBL 199 Ni-Cd cells to the Indian national railway. The 78-cell batteries power control electronics and circuits in some of the most powerful locomotives in the world, the Bo'bo and the Co'co, built by ABB Transportation Systems. In the contract's first phase, 33 locomotives will be delivered to India. The second phase will extend into the 21st century: 977 additional locomotives will be produced in India according to a technology transfer agreement. All phases taken into account, the contract will represent a total of FF 100 million. ■

FAST FAULT-FINDING

Locating the source of a power outage is not always easy in remote locations. Nortroll fault current indicators, powered by Saft lithium LS33600 cells, solve this problem:



Nortroll

attached to power lines, they detect changes in current. If a line is cut, they send out a radio signal or a powerful flash to help the electric company pinpoint the failure. Saft's lithium batteries are especially suited to this use, thanks to their high capacity,

excellent performance in extreme temperatures and long life – they can last up to ten years. ■

INTERNATIONAL SEAL OF APPROVAL

● Saft adds two ISO certifications to its list... Saft Nife Power Systems Singapore received ISO 9001 certification in February 1994, after a year and a half of preparation. The facility assembles and markets power systems and sells batteries throughout Asia for sectors like telecommunications, oil and gas, petrochemical, railways, aviation and industry.

● In Europe, certification was also awarded to Saft Nife GmbH's Berlin operations. The company focuses on power electronics, including emergency lighting and backup power systems. ■



Saft

Stocking solar energy

Jon Wodström

From the desert to close to the Arctic circle, Sunica batteries help harness the sun's energy.

Late at night, in a violent winter storm on the rocky Scandinavian coast, the dependability of a lighthouse lamp can mean the difference between life and death. Recognizing this, in 1991 the Norwegian Coast Guard launched a 5-year project to install Saft Nife Sunica batteries in every lighthouse along the 35,000-kilometer Norwegian coastline.

"They bought the whole range of Sunica batteries," says Trond Beyer, general manager at Saft Nife A/S in Norway. Sunica batteries are used in solar installations to store the photovoltaic energy captured from the sun's rays, thereby allowing a given apparatus – in this case, a lighthouse – to function even after the sun has gone down.

Because of the widely variable Arctic light – which ranges from nonexistent in the winter months to summer's famous "midnight sun" – the Coast Guard project presented a special challenge. "We're talking about back-up times of three to four days due to bad weather in the south of Norway," Beyer says. In addition, "there's heavy charging up north in the summer, with back-up time from mid-December to the end of February."

■ LONGER LIFE

Adding to the challenge was the fact that the batteries – many of which are installed in lighthouses on remote islands and fiords – would be scheduled for only one yearly maintenance visit. To be sure they chose the best product, the Coast Guard installed both lead-acid batteries and Saft nickel-cadmium products during a prolonged testing period. "They saw very early that the lifetime of the Sunica battery was much better," Beyer says. Installation of the batteries will be a five-year process, from 1991 to 1996, and has an annual turnover of 4 million



D.R.

Norwegian crowns per year. For clients all over the world, including Australian Telecom, Esso Petroleum, and the Agiba Oil Company in Egypt, the consistent performance of Sunica batteries can literally turn out to be a lifesaver. The nickel-cadmium batteries are an integral part of solar systems in a variety of photovoltaic applications, including telecommunications stations, oil and gas pipelines, and offshore platforms. Their long life and reliability are ideal for communications and navigational applications in remote regions.

Sunica has come into its own with the new maturity of the solar energy market. This market has changed considerably in the last few years. The batteries are increasingly seen as critically important. "People now understand that the total equipment won't work if one part – the battery – doesn't," says Dominique Manet, Saft's marketing manager for industrial batteries.

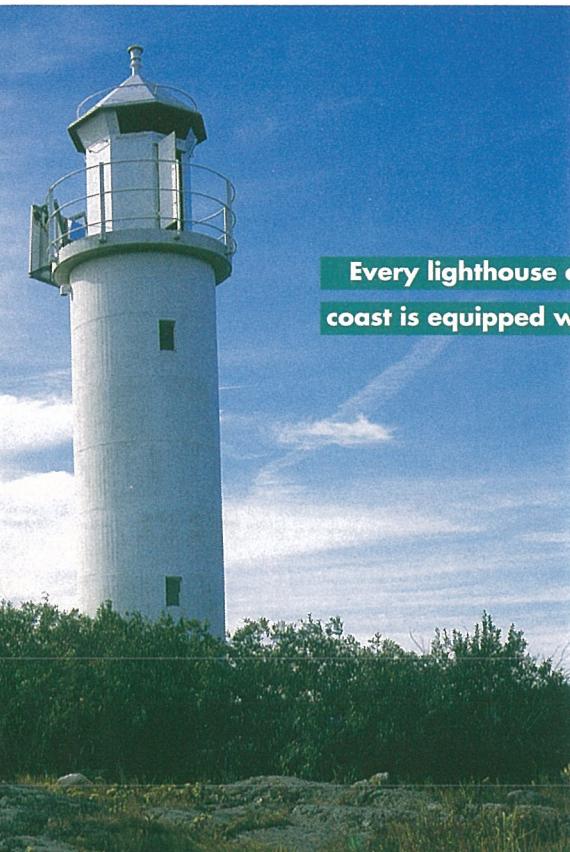
The advantages of Ni-Cd batteries like Sunica over lead-acid are indisputable. Longevity is Ni-Cd's strongest asset; the Sunica's lifecycle is 10 to 20 years. Its mechanical parts do not corrode and there is no significant shedding of active materials. Because the alkaline electrolyte doesn't react with steel, the Sunica's supporting structure remains intact; as a result, there



Sunica batteries, right, store energy gathered by solar panels, inset above



D.R.



Every lighthouse on the Norwegian coast is equipped with Sunica batteries

is no risk of "sudden death." Its long cycle life continues even when the charge/discharge cycle involves 100% depth of discharge. "That's something that's very difficult for most batteries to tolerate," Manet points out.

The Sunica's extra electrolyte reserve makes it ideal for remote installations, enabling long intervals to pass between maintenance sessions. It also has sustained performances even at high or low temperatures (from -50° C to +60° C).

The Sunica's long life and low maintenance mean that it is more economical in the long term, in spite of its higher initial purchase cost. Low maintenance makes all the difference – as Manet says, "It's when you have to go 1,000 kilometers by helicopter into the Australian bush to repair a malfunctioning battery that your costs begin to rise."

With Sunica, this kind of costly and drastic emergency repair operation is virtually eliminated. And that's why it has become a name synonymous with solar-powered applications worldwide. ■

Joseph Muscatello, Studio Seven



NEXT STOP, CHANNEL TUNNEL

All the trains which will pass through the Channel Tunnel – including the Eurostar TGV, the high-speed link between London, Paris and Brussels – are fitted with Saft SRX batteries. The batteries take over if the current goes out, ensuring non-stop operation of air conditioning, fire alarms and calculation and radiocommunication systems. Also in the tunnel, Saft power systems back up pumping stations which eliminate the constantly infiltrating seawater – and help guarantee all voyagers a dry run! ■



Augusto Da Silva, Photothèques P. Guignard

JOINING THE NAVY

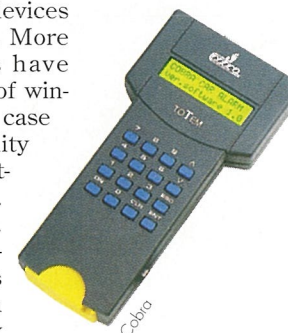
Ten frigates – eight for Australia and two for New Zealand – will rely on backup power supplied by Saft SRX batteries manufactured in Australia. Built by Transfield Shipbuilding, the 118-meter Anzac frigates have a modular energy system designed to withstand rough treatment. 16 sets of Saft batteries power control centers when the main diesel generators fail, keeping vital systems like navigation and weapons control going. To ensure resistance to underwater explosions, the batteries' custom cases have been impact-tested with a one-tonne hammer. ■

LET'S MAKE A DEAL

All 170-plus Price Costco locations in the United States will be stocking Saft portable batteries. Against stiff competition from major players like Eveready and Panasonic, Saft won a \$20 million contract, the biggest in its consumer battery history. The deal covers the supply of all rechargeable batteries, as well as chargers, over a two-year period. The wholesale club, which offers unbeatable prices to a broad membership, is making a special merchandising effort to help bring the rechargeable message to its customers. ■

CRACKING DOWN ON CAR THEFT

No false alarms for car protection devices with Saft nickel-cadmium batteries. More than just alarms, these devices have evolved to include remote control of windows, door locking, and tracking in case of theft. Nickel-cadmium's reliability and longevity have made it the battery of choice for this application. For the past ten years Saft Nife S.p.A. in Italy has been an important supplier in its home market – Italy is Europe's major producer of alarm systems. The company currently supplies 35% of the Italian market with 1/2 AA and 1/2 A portable cells. ■



Cobisa

Training the client

A power systems program helps customers make the most of their Saft products.

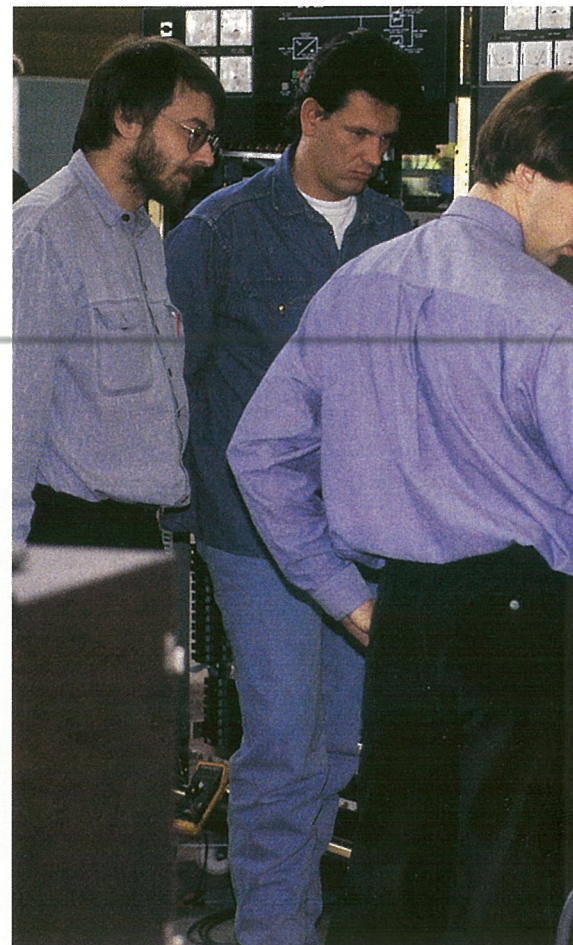
When Alcatel CIT went looking for a company to rehabilitate its underwater telecommunications lines in Lebanon, it turned to Saft. The installations had hardly been maintained during Lebanon's protracted civil war and were ravaged by neglect. An efficient telecommunications system would be crucial, of course, to the new Beirut and the work needed to be accomplished fast.

"We had eight months to rehabilitate the lines and train PTT and Alcatel Liban personnel in their care and maintenance," recalls Pierre Pacaud, responsible for customer training for the Power Systems Division, who led the 2.3 million French franc project – the largest underwater cable rehabilitation ever. The work was carried out in two stages over a six-month period.

■ HUGE DEMAND

Customer service at the Power Systems Division is a three-part process, including repair work on Saft products and installations, service work, and training, a facet that is being increasingly emphasized at Saft. "It's a whole new level of service," says Bernard Foubet, Quality Manager for the Power Systems Division. Saft invites clients to send personnel to either its facility at Romainville or to its new training center at Tours for further training. It also, as in the Lebanon project and other recent ones in Shanghai and Nigeria, sends training teams to client's locations. Companies who have received extensive training in the operation and maintenance of Saft products include Alcatel Bell/Shanghai, BTA/Beijing, and Alcatel International in France.

The work the Power Systems Division training team undertakes is diverse. In the new Beirut project, they taught Alcatel Liban personnel about the various Saft products, including rectifiers, inverters, and converters, that were being installed in the new telephone exchanges, and how they



should be maintained and repaired. Recently, a project team from BTA/Beijing, at the Tours site for a training session of two weeks, studied in detail the Saft static switches, cubicles, and inverters being used at the telecommunications center in the Chinese capital.

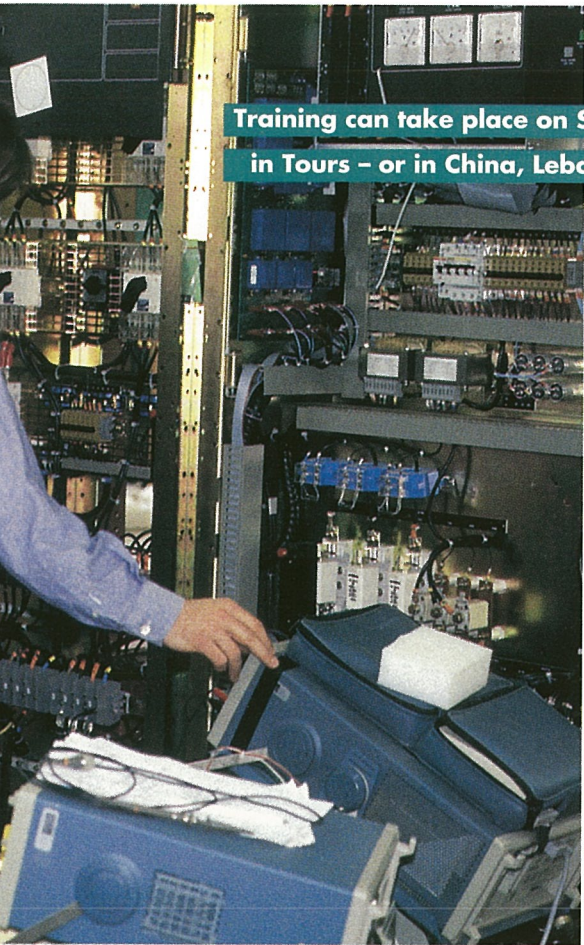
The division's training program was first conceived by Pacaud in 1989 when he noticed that "there was a huge demand for it on the part of clients." Saft's first training room was inaugurated in 1990. Clients were told of the new service through Saft's sales staff and through mailings. The program was immediately successful, Pacaud says. About 450 people have trained at Saft since it was founded. This year looks particularly promising, he adds; about 150 people received training at Saft in the first half of 1994 – nearly twice as many as during the same period in 1993.

Training sessions typically begin when a client approaches Saft and explains his requirements; Saft then comes up with a specific program to best meet these needs. Each program is custom-made exclusively for the client. Saft's training centers are officially recognized by France's Ministry of Labor.

Training is conducted in either English or French by two leaders and mixes theo-



Hands-on experience is a major priority in Saft's training sessions



Training can take place on Saft premises, here in Tours – or in China, Lebanon or Nigeria...

D.R.

retical studies with hands-on experience. The design of each Saft product in use in the client's power system – including rectifiers, chargers, inverters, converters, and UPSs – is discussed. Trainees, who are typically engineers or technicians, also participate in mock repair and operation sessions using actual products and demonstration material. They may also visit the Saft factory to see how the company's products are made.

For Jean-Francois Schwerkolt, an electrical engineer with the STNA (Service Technique de la Navigation Aerienne), a French governmental agency, training at Saft's Power Systems division provided a way to acquire detailed information about the Saft chargers at use in civil aviation.

"I learned a lot," Schwerkolt says. "I now have a much better knowledge of chargers and how they function. It helps me choose chargers better, and it allows me to answer the questions asked by our maintenance people when they install these devices."

For Pacaud, this kind of positive, specifically-targeted training experience is exactly what Saft's training program should strive for. "Our primary vocation is service to the client," he says. "It's to satisfy them. The more service we offer, the better off we all will be!"

NEW DEVELOPMENTS FOR ELECTRIC VEHICLES

Twice the fuel efficiency and 99% lower emissions than diesel engines: fuel cell technology has big potential. This technology combines hydrogen and oxygen atoms to produce electricity. Hybrid buses using fuel cells and batteries provide the same performance as conventional vehicles. Saft NiCd STM batteries have been chosen for a Fuel Cell Bus project partially funded by the U.S. government. They provide extra power needed to start, accelerate and climb; and store energy generated during braking.

SPOTLIGHT ON NORWAY

Saft Nife AS in Norway is the company's oldest subsidiary. It was established in 1917 as a Nife branch, to respond to the needs of a growing railway system. The 6-person team now sells Saft's entire line to a vast territory – Norway is 2000 km long, with 35,000 km of coast including all the fiords. It is not surprising that one of their main clients is the Coastguard, which uses Saft batteries to power lighthouses, buoys and traffic control centers. Other clients include Norwegian railways, ABB (power systems) and Jotron Electronics (lithium batteries for emergency beacons). Electric cars are a main priority for the future: the Norwegian team is at work on an EV prototype with Pivco.



Alcoa/Norway

ALL ABOARD

France's first nuclear aircraft carrier was launched in May. A "city" of 2000 which can survive on its own for six weeks and handle 35-40 planes, the French carrier *Charles de Gaulle* is powered by two nuclear reactors. Back-up is partially handled by a Saft charger-battery set; the 120 ECBs (28V) run the vessel's navigation and automation systems in the event of a main power outage – keeping the carrier on the right track for the 1000 miles it covers daily!

Photo DCN Brest



WHERE THERE'S SMOKE...

Saft's fire detection equipment now does double duty. After passing rigorous testing for French standards, Saft has launched a combined detection system and central fire safety system. At the first sign of fire, the SDI-CMSI T1 kicks into gear, sounding the alarm and at the same time activating security measures like fire doors and "de-smoking" devices. The product will help keep small- to mid-size facilities like hotels twice as safe.



D.R.

Saft's two research centers, in France and in the U.S., are working towards better technologies – for today and for the future. On the agenda: the nickel-metal hydride couple, rechargeable lithium...

New directions in el

Saft's leading position in the international battery market is sustained by a consistent research programme. At the two main research centres of Marcoussis, near Paris, and Cockeysville, Maryland, Saft research teams are working both to improve today's battery technology and to develop entirely new systems for tomorrow's applications. Mobile communications, computers, power tools, electric vehicles – these are the prizes that increasingly drive the quest to find higher power, higher energy, longer-lasting and more quickly rechargeable batteries.

— COMPLEMENTARY CENTERS

At Marcoussis, the emphasis is on applied scientific research, aiming to help the development department of each Saft production line to better understand electrochemical phenomena and to design a "performance" product. Cockeysville, on the other hand, is more oriented towards development of specific projects, handling particular contracts, frequently with U.S. government agencies.

Saft's research work in France has been carried out at the extensive Alcatel Alsthom Marcoussis research establishment since September 1993. In fact, Saft and Alcatel Alsthom electrochemical research is united in a single 40-strong team headed by Jean Quobex. Known as the DRE (Department of Research in Electrochemistry), the joint team regroups Alcatel Alsthom's specialized battery unit with the Saft research departments which were previously based in labs in Bordeaux and Poitiers.

The resulting collaboration between Alcatel Alsthom and Saft brings with it the advantages of team synergy, unified management, and state-of-the-art equipment located on site. As a consequence, research is more coherent, effective and above all rapid – "time to market" is all-important in a field as competitive and fast-changing as battery technology.

Saft's research center located at Alcatel Alsthom Recherche labs in Marcoussis, France



Alcatel Alsthom Recherche



Philippe Guignard

Silver oxide-zinc cells developed in the U.S. for underwater applications

electrochemical research

RECHARGEABLE MARKET POTENTIAL

Breakdown by technology

Ni-Cd	Ni-Cd	Ni-Cd Ni-MH Li-C
technical advantages	cost advantages	choice made according to equipment cost
power tools	emergency lighting units	computers camcorders mobile phones

Saft America's R&D Center at Cockeysville, near Baltimore, grew out of Saft's Advanced Battery System Division. Headed by Khushrow Press, the Center has a full-time research staff of 16. As well as implementing U.S. government military contracts, the Center has an ongoing collaboration with USABC (U.S. Advanced Battery Corporation) whose members include the U.S. Department of Energy, utility companies, and the car manufacturers Ford, Chrysler and GM. Saft's research with USABC is driven by the future market potential for electric vehicles and their need for high-performance power units.

— MAIN PROJECTS

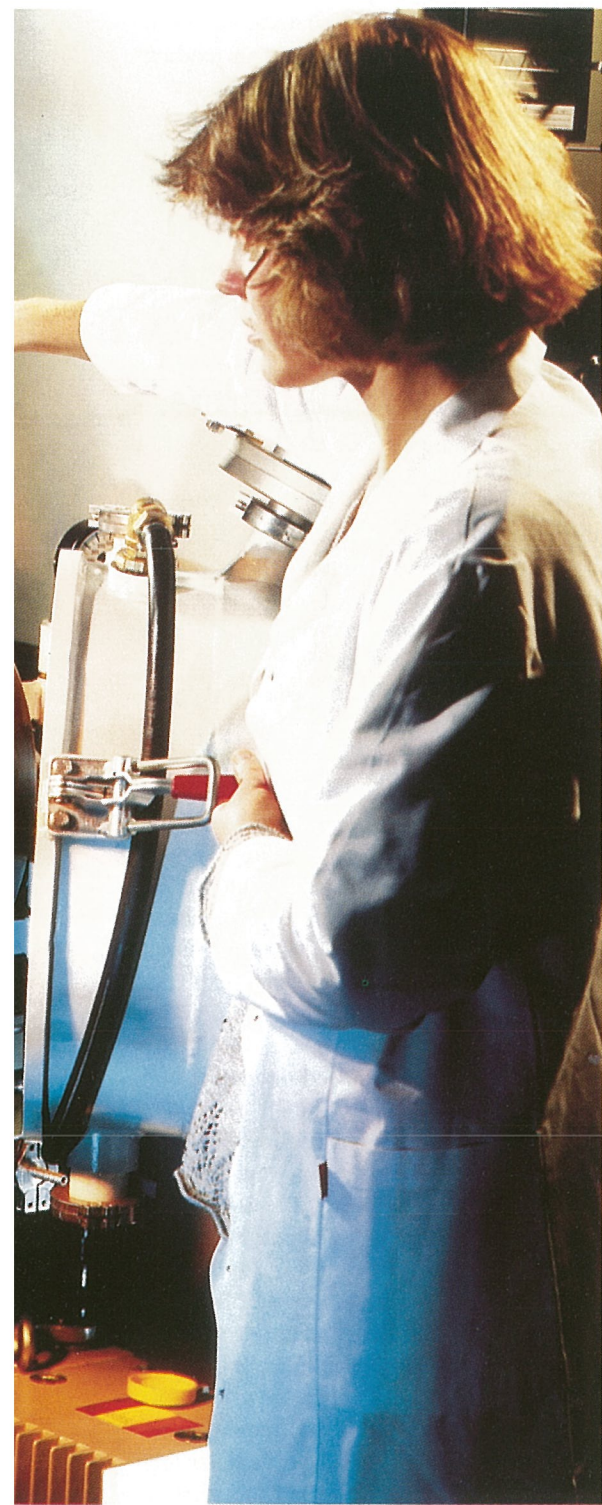
At Marcoussis, research is centered on three key electrochemical couples: nickel-cadmium, nickel-metal hydride, and lithium-carbon (or lithium-ion, as it is called when used in portables applications).

If the Ni-Cd couple has been a mainstay of Saft's success over the years, today's challenge is to find ways of improving the technology. One area for improvement is in higher battery energy (watt-hours available). A recent advance has been to make the positive electrode foam-structured. The electrode's greater capacity density gives a 20 to 40% boost in cell capacity over standard sintered plate technology. Greater capacity means extended operational periods for portable devices of all kinds – video cameras, cellular phones, computers, etc.

Equally important in this rapidly developing product sector is speed of recharge. The challenge is to find ways of ensuring faster recombination of gases produced in overcharge. To resolve it, DRE research has focused on the negative plate, improving plastic-bonded electrode (PBE) technology to ensure dynamic equilibrium during overcharge.

The emergent nickel-metal hydride (Ni-MH) technology offers a long lifespan, as well as 30% more capacity than the most advanced Ni-Cd cells. Though Ni-MH technology is similar in many ways to Ni-Cd, its negative electrode is made of a metal alloy able to adsorb hydrogen. The DRE is working on both cylindrical and large prismatic Ni-MH cells, with a twofold objective: to construct potentially effective alloys using different metals, and then to investigate their physical, electrical and hydrogen adsorption properties.

Major investment decisions also need to be made in relation to this new technology. Ni-MH is suited to many applications: electric vehicles, and a good part of the portable market currently served by Ni-Cd. Because of its currently higher cost, it responds to the needs of top-of-the-market equipment like cellular phones and computers. Lower- and middle-range products will continue to use the cheaper Ni-Cd technology, as will high-power applications like cordless tools. Saft is currently carrying out pilot production of cylindrical Ni-MH batteries for the



New directions in electrochemical research

portable market, and a commercial launch is envisaged for the end of 1994.

The market for Li-C is similar to that for Ni-MH – in particular, top-of-range camcorders, mobile telephones and computers. (See table on page 13). Saft is planning to launch a Li-C battery in 1995.

The DRE's research objective for Li-C is to complete its definition. In this pioneering technology, the constituent battery materials – carbon negative electrode, lithiated metal oxide positive electrode, electrolyte, and separators – need to be optimised. Not only does it involve new materials – for example, the alkaline electrolyte of nickel electrode batteries is replaced by non-aqueous liquid – but it requires different manufacturing methods, including mois-

equipment, especially computers, has been reduced in recent years, and is now tending towards a standard 3.6V. This means that a single Li-C cell can be used rather than the multi-element battery pack required to provide higher voltages. It also brings safety benefits, since charging a single cell is easier to control. On the other hand, Li-C cells can only be recharged on a special charger (not a standard model charger), and so Li-C technology should be conceived as a battery-plus-charger system rather than as a simple battery.

— UPSTREAM ACTIVITIES

The DRE team is also engaged in various more long-term activities. One upstream line of research is concerned with polymer-based solid electrolytes, a major departure from existing technologies which use liquid electrolytes. The prospect is that of an entirely solid battery. The immediate research aim is to find polymers having the required electrical and mechanical properties.

Work is also being carried out on the LiAl-FeS₂ couple, in collaboration with Cockeysville: the DRE is handling thermo-compression sealing and modelling for the development of this technology, which promises to provide three times as much energy as Ni-Cd. Part of an American consortium (see facing page), the project focuses on electric vehicles, a potentially vast market if the required economic and performance criteria can be met.

Research into supercapacitors (very high specific power density, but low specific energy density) is being carried out in parallel with battery development. Supercapacitors are appropriate for any system with a variable use profile, especially when it requires low permanent energy with occasional power peaks. A cellular phone, for example, uses a constant low current during its inactive mode and much higher power when in use. Cars have a similar profile, with high power needed for start-up

DIFFERENT TECHNOLOGIES, DIFFERENT STRENGTHS

Comparative values for AA battery ("R6" size)

COUPLE	VOLTAGE (A) (VOLTS)	CAPACITY (B) (AMP-HRS)	ENERGY (C=A x B) (WATT-HRS)
Ni-Cd	1.2	0.8	9.6
Ni-MH	1.2	1.1	13.2
Li-C	3.6	0.5	18.0

ture-controlled dry rooms. The crucial feature of Li-C is its potentially far higher energy provision, as the table above shows. The energy provided per unit battery volume is nearly twice that of Ni-Cd and a little less than half as much again as Ni-MH. Though its capacity is lower, its much greater voltage gives it this all-important edge in energy terms.

As well as higher energy, there is another, less obvious economic advantage to Li-C batteries, arising from its 3.6V tension. The voltage required to operate electronic

More capacity, less volume: the demands are the same, but the stakes are even higher in a more "portable" age...

and low energy for electrical systems. In electric vehicles, a supercapacitor covering high power requirements for climbing and sudden acceleration would enable battery size to be considerably reduced.

Another research area involving electronics rather than electrochemistry concerns battery management, aimed at improving battery use. Electronic systems are currently used to indicate state of charge on portable computers, for instance, but they also may be used to control battery charging conditions so as to avoid or minimize overcharge, thereby extending battery life.

Mathematical computer modelling of battery architecture is another developing research field. A general model has been built and is now being applied to various battery technologies. Rather than constructing batteries and then testing them on the bench, computer modelling will help predict how varying parameters will affect battery performance.

— MOLTEN SALT, STAR WARS, ELECTRIC CARS

A very different line of research pursued over a number of years at Saft America's R&D Center concerns the use of molten salt (at around 500°C) as an electrolyte. A primary molten salt battery, using pyrotechnics to melt the salt, was developed for the U.S. Navy as a power source for the Sonobuoy, a kind of small-scale floating radar system used either for locating ships and submarines or to act as a decoy for incoming torpedoes.

Interest in rechargeable molten salt batteries grew because of their combination of high power and high energy. In the late 1980s, the heyday of "Star Wars," they were seen as a possible energy source for satellite-sited laser beams intended to destroy incoming enemy missiles.

Today, through the USABC, the focus is on civilian applications, notably the electric vehicle – the focus of this grouping of major car manufacturers, utility companies and the U.S. government. With a LiAl anode and FeS₂ cathode, and using an electric heater to melt the salt, molten salt rechargeable



Philippe Guignard

Testing new electric vehicle battery cells at Saft's U.S. R&D center

batteries could well be the ideal power source for electric vehicles. With this technology, batteries optimized for energy can provide a power-to-energy ratio of 2 while batteries optimized for power can provide a ratio of 70.

At present a 20-cell enclosure is operational, and there are plans to develop a full 200-cell battery. However, this technology,

still in its infancy, will only be commercially available after the year 2000.

The two other main development areas at Cockeysville are lithium ambient temperature primary and rechargeable batteries. The Li-SOCl₂ electrochemical couple for primary batteries can be adapted to produce either high power or high energy according to the cell geometry and component characteristics. One major application of the high-power version being developed at Cockeysville is for the U.S. Army Night Range System, a night vision device using a laser beam generated by the battery's high power pulses to locate the distance to the target.

Lithium rechargeable batteries using Li metal for the anode and lithiated cobalt oxide (Li-CoO₂) for the cathode are being developed under a U.S. Navy contract for underwater unmanned vehicles. Though these batteries can be recharged only 80 times, they have the major advantage of producing more energy than any other system – 200-220 watt-hours per kilogram.

The other lithium rechargeable system being developed by Saft America's R&D Center is lithium-ion, dovetailing with the research being carried out in France on this technology. At Cockeysville the emphasis is on electrode technology and cell design for portable and space applications, as well as the next generation of electric vehicles.

Saft's research lines, in France and the U.S., offer an exciting vision of customized technologies adapted to a wide range of portable and industrial uses. As the third millennium approaches, we are living in an increasingly "wireless" – and increasingly electric – world. Saft research teams are helping create the products to power it. ■

Who's backing up your backup system?



You don't need your backup power system very often, but when you do it has to deliver.

Saft Nife Power Systems draws on nearly a half century of power electronics experience to produce backup systems you can count on. From initial design through installation and support, we tailor power systems that meet your specific needs, including guaranteed conformity with virtually all national and international standards.

Today, Saft Nife has established its leadership in this highly specialized field, thanks to fast and reliable service

for customers anywhere in the world. We make sure your telecom system stays on-line, your offshore rig keeps pumping, your plant keeps cracking, and your grid doesn't brown out.

When you need non-stop power, isn't it nice to know that your backup system also has some pretty powerful backup?

