#38 June 2018

INTERNATIONAL MAGAZINE

saft

The magazine for Saft's customers and partners

CENTENARY ISSUE 1918 • 2018

Message from the CEO

Celebrating 100 years in business

Ghislain Lescuyer,
CEO

Welcome to this special issue of Saft International Magazine, dedicated to our 100th anniversary. Saft was founded in 1918 by Victor Herold, a visionary engineer who was a disciple of Thomas Edison and involved in the battery industry as early as 1907. He created France's first nickel-alkaline battery plant, to address the country's gasoline shortage after the First World War. From the beginning, Saft was an early innovator in mobility - our very first contract was with SNCF to power luggage trolleys around the Gare de Lyon in Paris. We are still working with SNCF and the rail industry today, providing back-up batteries for vital safety functions. But today, Saft does so much more, making customized batteries for a range of critical applications and industries.

Throughout our 100-year history we've played a key role in some of the world's most important developments. We powered the Rosetta mission lander, Philae, after it separated from the spacecraft to land on comet 67P/Churyumov-Gerasimenko, ten years and eight months after departing Earth. Captain Sullenberger, who performed the Miracle on the Hudson, used Saft back-up batteries to restart the auxiliary power unit, allowing him to land the aircraft safely on the river and save 155 lives. We built the world's largest battery in 2005, which gives lifesaving back-up power to the people of the town of Fairbanks, Alaska, who live through extremely cold winters. And we are even responsible for the discovery of a much-used, important electrochemistry, lithium-thionyl chloride, used in IoT applications like smart meters. Saft is also powering lots of everyday applications that improve people's lives.

Today's world is changing rapidly, and our customers' requirements are evolving at a similar fast pace. Saft continues to work on technology for the world's newest markets, always pushing the boundaries of what is possible. Together with Total, we are energizing the world - on land, at sea, in the air and in space. And we hope to continue to do so for the next 100 years.

SAFT MAGAZINE #100 YEARS

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Saft International Magazine
a magazine for Saft's customers
and business partners
Editor: Elma Peters
Managing Editor: Karen Hollington
Text: Saft and FirstWord
Cover: ©Saft
Graphic design:
www.freedomprocessstudio.com
Printed by: Graphoprint
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1920 / 1955

The making of an international group

1924
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1946
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1949
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1952
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1955
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1966
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1974
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1975
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1980 / 2004

Diversification through acquisition

1980
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The CGE group slowly transitions into Alcatel and Alsthom

CGE decides to combine two of its battery subsidiaries into one and creates Saft-Mazda

1985
Sale of consumer battery activities to Bernard Tapie and acquisition of the industrial battery company Wonder

1987
Acquisition of Alcad Ltd, an international firm based in the UK and the US

1989
French explorer Jean-Louis Étienne and his team embark on their Transantarctica mission powered by Saft batteries

1991
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1994
Saft America awarded TRP funds by the US military for development of lithium-ion products

1995
Alcatel repurchases all the shares of Saft SA that were de-listed in 1995

2000
Acquisition of Tadiran, an Israeli manufacturer of lithium batteries, with operations in Israel, the US and Germany

2004
The Mars Exploration Rovers "Spirit" and "Opportunity" land on Mars with Saft batteries

2005 / 2015

Multi-technology leadership around the world

2005
Saft becomes a Public Limited Company with shares listed on Paris Euronext

Saft's battery energy storage system in Fairbanks, Alaska, recognized by the Guinness Book of Records as "the world's most powerful battery"

2006
Opening of Saft China new factory in Zhuhai to support domestic market

2008
Johnson Controls - Saft opens world's first production factory for lithium-ion hybrid and electric vehicle batteries in Nersac, France

2011
Inauguration of state-of-the-art lithium-ion factory in Jacksonville, Florida, US

Launch of Intensium® Max megawatt-scale containerized energy storage system

2012
Scuderia Ferrari recognizes Saft with 2012 Innovation Award

2013
Inauguration of a factory in Bangalore, India, to support local nickel-based market

Opening of new subsidiary in Moscow for Russia and CIS markets

2014
Saft's primary lithium battery powers the Rosetta Mission and Philae lander for its historic comet touchdown

2016 / Present

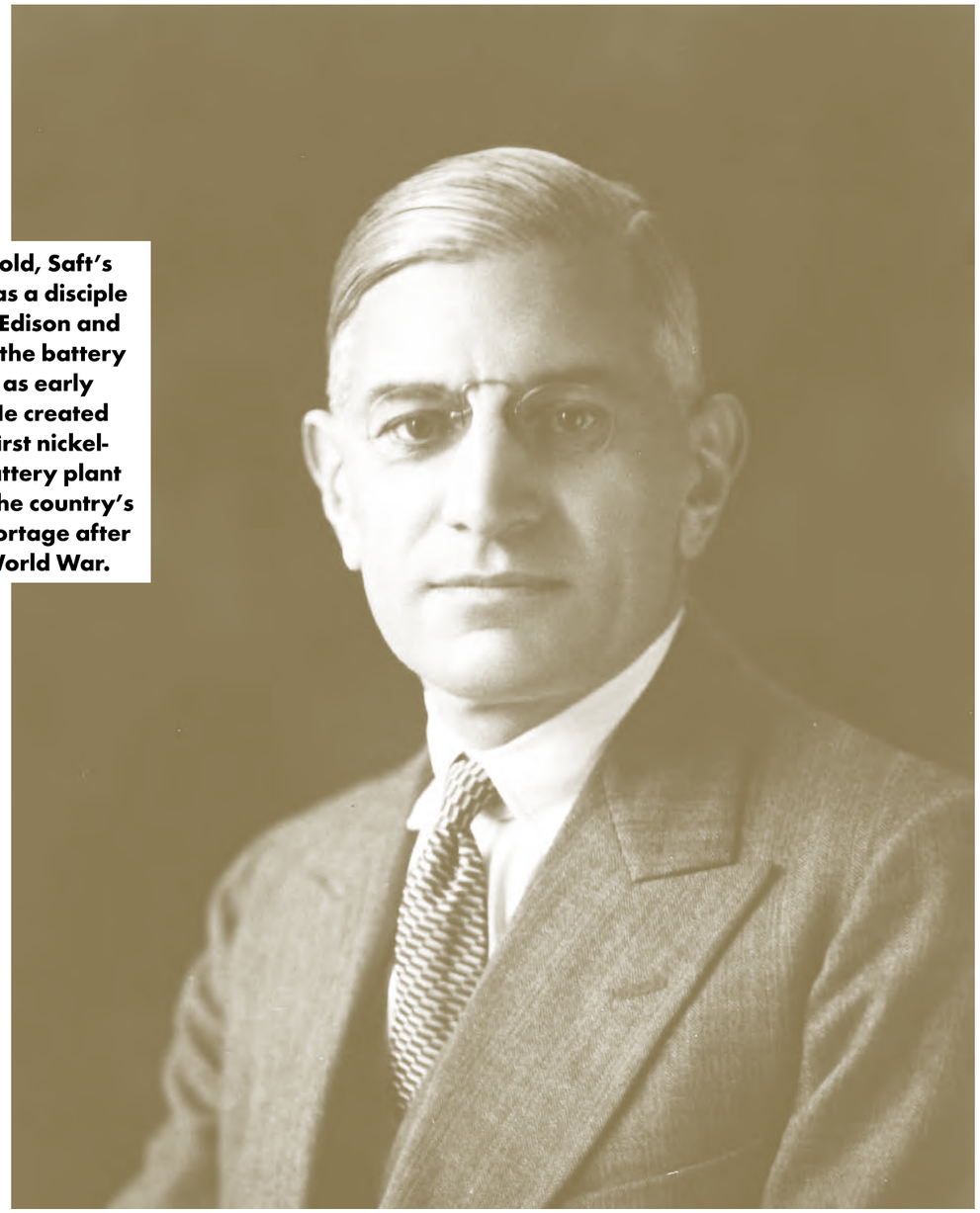
A new era- Saft as part of Total

2016
Total acquires Saft

President Obama visits Saft America's advanced lithium-ion battery factory in Jacksonville, Florida, US

TOTAL

Saft: France's battery pioneer



Victor Herold, Saft's founder, was a disciple of Thomas Edison and involved in the battery industry as early as 1907. He created France's first nickel-alkaline battery plant to address the country's gasoline shortage after the First World War.

Neither the First World War nor the refusal of a patent was enough to stop Victor Herold from creating the first company producing nickel-alkaline batteries in France.

Victor Herold

In 1901, the first rechargeable alkaline batteries appeared. They were more efficient and easier to store than their earlier lead-acid counterparts. As with many inventions, the technology was "discovered" by two different parties at almost the same time. On January 21, 1901, a Swedish engineer named Waldemar Jungner filed a patent application, followed on February 6 by Thomas Edison with one for a similar device. It is fair to say that the American inventor supplied much more detail than his Swedish counterpart. When Thomas Edison began selling the batteries in 1902, Jungner took him to court for patent infringement. The lawsuit lasted for five years, and in the end the claim was dismissed. Jungner had never fully developed the nickel-iron battery, preferring to bet on his nickel-cadmium one. In the meantime, Thomas Edison had equipped thousands of trucks with his own nickel-iron batteries.

Impressed by this success in the US, one of Edison's German friends asked for and received a license to produce and sell the product in Germany and Austria-Hungary. Sigmund Bergmann set up his company, DEAC, in 1904. DEAC was the firm Victor Herold joined three years later. Born in Paris in 1883 to Swiss parents, he had studied chemistry at the Zurich Polytechnic School from 1901 to 1905. Almost as soon as he started working for DEAC, he traveled to Orange, New Jersey, home of the research and development center of Edison General Electric, to learn about the industrial processing of the active materials.

Victor Herold starts out in France

DEAC did not succeed in Germany because of increasing competition from lead-acid batteries, which although less durable were cheaper. The company was eventually sold to AFA - a competitor in lead batteries - and production of alkaline batteries stopped. Victor Herold tried to buy the business himself, but his offer was rejected. He then decided to open his own factory in France. He had the capital, mainly thanks to his family, and qualified staff because some of the DEAC team - the chief engineer, chief designer and an equipment foreman - were prepared to follow him. Together they created the Société Industrielle des Accumulateurs Alcalins (S.I.A.A.), or the Industrial Alkaline Battery Company, in 1913.

While a factory was being built in Romainville near Paris, the company rented a workshop in rue Servan in the French capital to prepare all the equipment it would need. In May 1914, the factory was ready - however in August, the First World War broke out. The German staff had to leave France, and the premises were commandeered by the French army before production could even begin.

Saft's first customer

The very short story of S.I.A.A. ends there, but Victor Herold's own industrial adventure entered a new chapter in 1917. Suffering from a gasoline shortage after three years of war, France saw a solution in the US army electric vehicles, which were powered by Edison alkaline batteries. The Ministry of Armaments asked car manufacturer Louis Renault to set up a factory making rechargeable alkaline batteries. Renault turned to Herold with a request to get his plant working again, and on November 22, 1918, S.A.F.T. (Société des Accumulateurs Fixes et de Traction) was created with one million francs in capital from French car manufacturers and the electrical industry.

S.A.F.T. (Société des Accumulateurs Fixes et de Traction) was created with one million francs in capital from French car manufacturers and the electrical industry.

Saft's first products - an order of 25 batteries to power electric luggage trolleys in the Gare de Lyon - were delivered in late 1919. The station was at that time the headquarters of the Paris-Lyon-Méditerranée (P.L.M.) railway, one of six train companies that later merged to become SNCF. Saft batteries were also used to power lights for trains' passenger cars, outperforming and then superseding lead-acid batteries. In 1921, a train equipped with gas lights caught fire in the Batignolles Tunnel in Paris, causing dozens of casualties, and electric lighting became mandatory for all trains three years later. The railway sector was Saft's first client, and remains an important growth area for the company 100 years later.

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A century of railway adventures

Batteries used to power luggage trolleys in Paris train stations and lights for passenger trains were the first orders that put Saft on the path to growth.

In the early 20th century, luggage trolleys were a necessity as travelers often set out on long trips, taking with them several trunks filled with clothing - they changed a few times a day to go for a walk, dine, attend receptions - as well as household linen, and sometimes even cookware.

At the time, traveling in first class with a single suitcase would have seemed ridiculous. Since the origin of the railways, the train companies strove to keep luggage moving smoothly and quickly.

Saft batteries were also used for lighting trains. An initial order of 12 batteries gave Saft the opportunity to showcase the superiority of its nickel-based batteries over lead-acid batteries. "We can confidently say that the success of this first trial helped Saft gain a foothold in an application that would unexpectedly take off a few months later," says Victor Herold, the company's founder, in "The Origin and History of Saft." In October 1921, a suburban train equipped with gas lights caught fire in the Batignolles tunnel in Paris, causing dozens of casualties. Following this terrible accident, electric lighting became mandatory for all trains in France three years later.

In December 1921, P.L.M. ordered 2,000 batteries from Saft. Saft won the contract by offering a price that was not much higher than the production cost, but consequently laid the groundwork to begin mass production at the Romainville factory near Paris. After this first order, the other railway companies turned to Saft. Saft's order book then expanded in leaps and bounds. Saft had a strong business relationship with P.L.M. The September 1935 issue of "Bulletin P.L.M." included a small advert on the back cover touting the fact that "All P.L.M. passenger cars are lit using Saft's batteries, and come with a four-year guarantee."

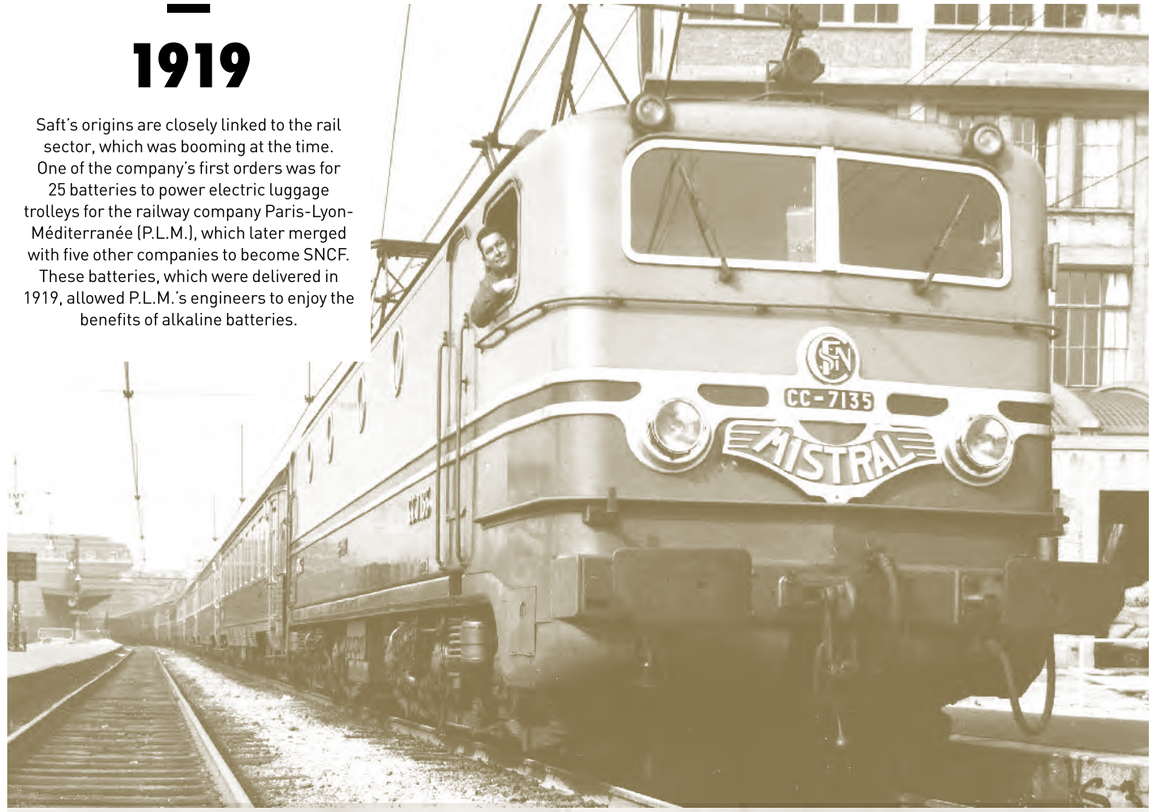
An international sales network

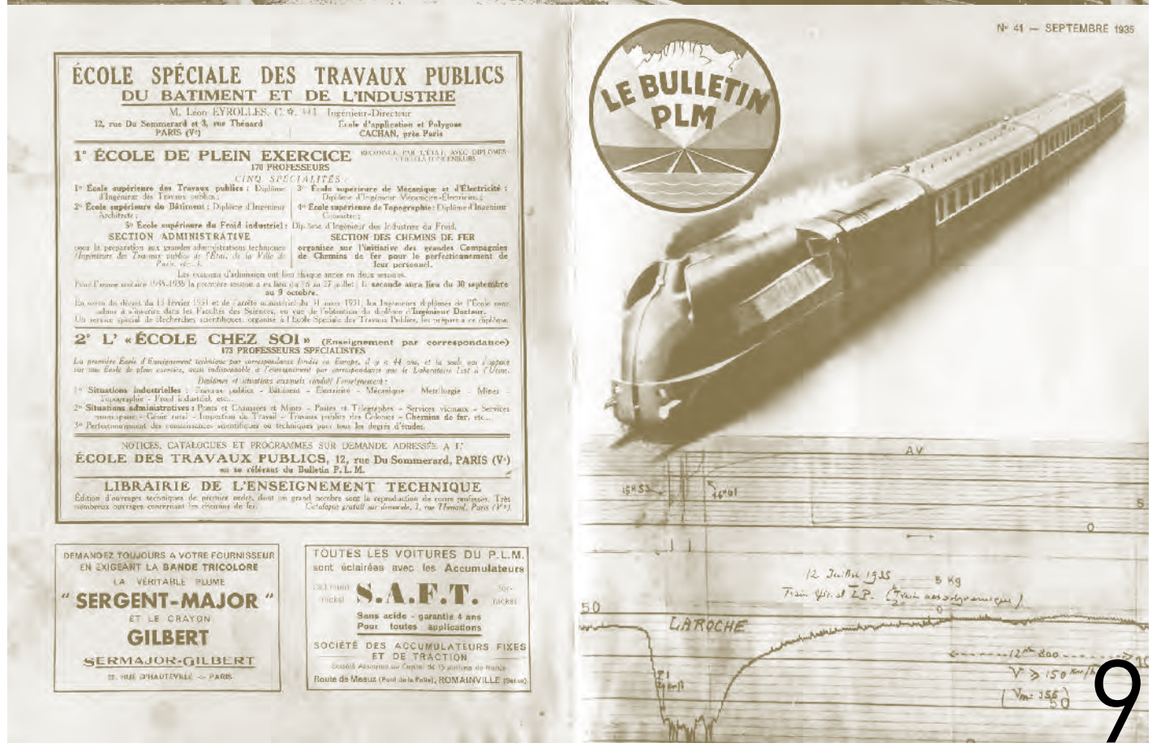
Saft also supplied batteries to foreign railway companies. An order from the Madrid-Zaragoza-Alicante railway company spurred a shift in Saft's strategy. This order caught the interest of the Stone Company in London, which until then had been the world's largest supplier of equipment and batteries to power lights for trains. A Stone representative offered to give Victor Herold exclusive rights to supply Saft batteries to power lights for trains all over the world except for France. In return, Stone agreed to pass on to Saft all orders that it would receive for alkaline batteries. This arrangement gave Saft access to an established international sales network. "The Stone contract was very beneficial to Saft," says Victor Herold. "Until 1939, 30 percent of its output was delivered to Stone at very profitable prices." Saft batteries were used by various railway companies in Spain, Portugal, but also in South American countries, South Africa, India, Pakistan and other English colonies in Africa and Asia. At the same time, Saft continued to supply more and more batteries for electric tractors and trolleys. After starting off with a production of 1.6 million Ah (ampere hours) in 1921, Saft reached 20 million Ah in 1930 and 36 million Ah in 1939.

SNCF was thus Saft's first customer. Today it is still a key partner, and Saft equips most of its rolling stock and provides it with innovative preventive maintenance solutions. SNCF's entire fleet of over 200 TER 2N NG (double-decker new generation) trainsets are currently being equipped with Saft nickel-based batteries to replace traditional lead-acid batteries. These on-board batteries play a vital role on SNCF trains, providing critical back-up power for the control, safety and communication functions in the event of a power outage. Today, Saft batteries, which have been designed to ensure improved performance and reliability over a long service life and a wide temperature range, are still widely used all over the world: from Europe to the US, Hong Kong to mainland China, India to Japan, and in many other countries.

1919

Saft's origins are closely linked to the rail sector, which was booming at the time. One of the company's first orders was for 25 batteries to power electric luggage trolleys for the railway company Paris-Lyon-Méditerranée (P.L.M.), which later merged with five other companies to become SNCF. These batteries, which were delivered in 1919, allowed P.L.M.'s engineers to enjoy the benefits of alkaline batteries.





10 **Electric vehicles**

Back to the future

Saft has always supplied energy for electric vehicles, from luggage trolleys at the Gare de Lyon in 1919 to the future electric buses in Europe's major cities.

Today, electric mobility is an important topic, as it can reduce our CO_2 emissions and counter the depletion of oil resources. However, electric vehicles were being developed as early as the late 19th century, before the combustion engine took over. In addition to mass market cars, they are already in use, and widespread, in our environment.

Obviously, when we talk about electric vehicles, a key element is batteries. Saft is a major player in this sector. For more than 20 years, the company has been delivering lithium-ion (Li-ion) batteries for specialized hybrid and electric vehicles. The first electric vehicles equipped by Saft, in 1919, were luggage trolleys for the company P.L.M. (Paris-Lyon-Méditerranée). Since 1924, Saft has provided the manufacturers Krieger, Berliet, Renault, Laporte and Crochat with batteries for tractors, trucks, buses, vans and cars, both large and small. In the 1970s the first oil crisis pushed Saft and its parent company, the Compagnie Générale d'Électricité (CGE), to refocus on the electric vehicle market.

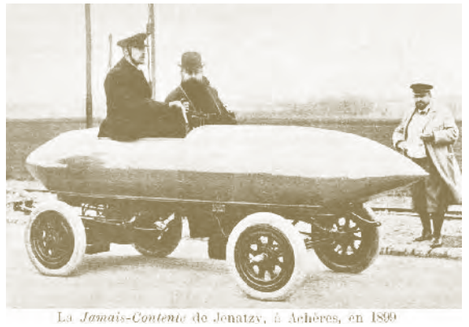
Together they designed an electric micro-car, an "Autoette," in the Marcoussis research laboratory. Saft also worked with Peugeot, firstly on an electric 205, then on other electric cars (106 and Citroen AX); they were proposed as self-service cars in the streets of La Rochelle from 1993-2000. During the same period, Saft worked on electric vehicles with Chrysler, while Saft America was awarded two research and development contracts by the American consortium USABC.

Saft boosted by lithium-ion

At the beginning of the 2000s, Saft started to develop Li-ion batteries under a joint venture with the American company Johnson Controls, to pool the expertise of both partners. In 2004, La Poste invested in an electric Renault Kangoo. Baptized "Cleanova La Poste" and fitted with Saft Li-ion batteries, it was tested in Paris and later in Bordeaux. In 2008, a factory was set up in Nersac, France, to produce Li-ion accumulators. It was the first industrial production line in the world for the mass manufacturing of Li-ion batteries for hybrid vehicles. Saft contributed its technologies based on nickel and Li-ion and Johnson Controls provided its know-how in systems integration. In particular, the two companies worked on hybrid prototypes for a Mercedes S class 400 and a BMW 7 Series. However, the two companies had strategies that were too different and the joint venture was not continued.

Today, the company continues to produce Li-ion batteries and equips various hybrid and electric vehicles, although these are not aimed for the mass market. Saft's batteries power all sorts of vehicles, both on-roads such as rubbish collection, cleaning or delivery trucks, and off-roads for building sites (cranes), airports (tugs for maneuvering aircraft), as well as at port facilities.

Saft is also active in the field of public transport, notably with Volvo. Saft batteries equip Volvo buses in Gothenburg (Sweden), Hamburg (Germany) and Differdange (Luxembourg). The performance of the latter is impressive: energy consumption reduced by 80 percent compared to diesel, silent propulsion, no emission and batteries that can be recharged at stations in three to six minutes.



La *Jamais-Contente* de Jenatzy, à Achères, en 1899

"La Jamais contente" an electric racing car

This framed picture had pride of place in the lobby of Saft's first factory in Romainville. The "Jamais contente" ("Never Satisfied") is an iconic car: it was the first electric vehicle to exceed 100km/h – a record set on April 29, 1899, in Achères, France. It was driven by its designer, the Belgian engineer Camille Jenatzy, who developed an early interest in electric vehicles.

"La Jamais contente" boasted two electric engines powered by Fulmen batteries, a brand that, like Saft, belonged to the CGE. The torpedo-shaped vehicle cut a fine figure. Despite this speed record, electric cars were finally supplanted by gasoline and diesel-powered cars at the turn of the 20th century.

Saft also takes a big interest in sports cars

Saft is also a specialist in Formula 1. Since 2009 it has equipped racing cars with kinetic-energy recovery systems. It was thanks to this system that Kimi Raikkonen won the Belgian Formula 1 Grand Prix in 2009, making the decisive overtaking maneuver merely by pressing a button! In 2014, the device gave way to ERS, which recovers both thermal and kinetic energy, and provides the driver with an additional 160 hp (brake horsepower) for about 30 seconds per track circuit. Just what's needed to overtake rivals and spice the race. Saft is also a player in the Andros Electric Trophy which, since 2007, sees electric racing cars compete each winter on ice-bound roads. Fun and games guaranteed!

What's next? In February 2018, Saft launched an alliance with other European industrial champions to develop the battery of the future. The program's ambition is to provide Europe with new generation batteries for energy storage and other market segments like electro-mobility and specialty industries - based on a disruptive, solid-state technology by 2023. A subject to keep an eye on.

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12 The evolution of Saft's logo

BEGINNING 1971

Since 1901, the logo has evolved...

Saft's vintage-style logo

We are proud to unveil Saft's very first logo dating back to the late 1920s when Saft became part of CGE.

1972 1990

A powerful and diversified group: one single logo for all Saft's brands

A new logo was created to unify Saft's various brands (Leclanché, SOGEA and URA). From 1972, the name of each brand would feature Saft's new logo.

1991 2004

A new logo for CGE and each of its subsidiaries

In 1990, Compagnie Générale d'Électricité (CGE) introduced its new graphic identity and logo at the annual CGE convention in Paris. A name change to Alcatel-Alsthom earlier in 1990 required a new logo for CGE and each of its subsidiaries (including Saft). The logo of each CGE subsidiary reflected this new design and served to further unify CGE.

2005 PRESENT

Saft's simplified logo

Until recently, our simplified logo, which is an integral part of our visual identity guide, was only used in a few communications' materials. We've decided to extend the use of this logo which is more modern and easier to use than the previous one.

2005 2017

End of the Alcatel era

In 2004, Saft was sold by Alcatel to Doughty Hanson Funds and became a Public Limited Company with shares listed on Paris Euronext. For this reason, Saft created new brand guidelines along with a new logo.

2018

Logo for #Saft100

We've customized our logo to celebrate Saft's centenary. This special logo is being used throughout 2018.

A century ago, communicating with the other side of the world took weeks. Airmail changed all that and, in the process, helped drive a boom in aviation. Saft's batteries were crucial - and continue to be so. Here's the story of how airmail brought the world closer together.

Airmail

and the rise of international flight

1.

The first scheduled airmail service flew between Hendon and Windsor, UK, in 1911. By 1918, the US had a service between Washington DC and New York.

2.

In 1918, Latécoère Airlines, later Aéropostale, began France's first international airmail service connecting Toulouse and Madrid. Here's a 1929 poster advertising the service.

3.

Germany mostly used airships for mail delivery throughout the 1920s and 1930s, but still relied on airplanes in part. The picture shows aircrew taking "Flugpost" airmail sacks on board at Berlin's Tempelhof in 1919.

4.

The Latécoère 300 was an Aéropostale seaplane - and the first powered by a Saft battery to start the engines. In 1933, it set a record for the longest non-stop seaplane flight on a trip from Marseille to Saint-Louis, Senegal.

5.

In 1938, Boeing developed the 314 Clipper for Pan Am. It had 74 seats that could convert into 40 bunk beds. Designed for luxury travel, passengers would enjoy six-course meals on board.

6.

After the Second World War, seaplanes were replaced by aircraft that could carry more passengers and fly long distances without refueling. Airmail became just a standard part of cargo. Here's Air France McDonnell Douglas DC3 being loaded with mail in 1953.

Today, while 80 percent of modern commercial airliners rely on Saft batteries, the company also plays a vital role in global communications by powering many satellites.

French resistance from the Ouessant submarine

At the beginning of 1934, Saft received an order for a large-capacity alkaline nickel-cadmium battery for a submarine. The first tests proved successful. A 480-cell battery was ordered in 1936 for the Ouessant submarine, then under construction.

It was of particular interest to the navy due to its "low hydrogen release, high endurance when diving, and excellent performance in maintaining electrical insulation". In fact, this battery quadrupled the operating autonomy of the Ouessant compared to France's first three submarines.

The Ouessant conducted several patrols in the Atlantic, and off the American and Caribbean coasts. In June 1940, during the "phoney war" period, the vessel was moored at Brest for a major refit. In view of the German army's rapid progress, the decision was taken to scuttle the submarine. However, this was the start of a real odyssey for the Ouessant.

The German army raised it and towed it to Bordeaux in 1942, for use as an electric power plant. It was scuttled again in Pauillac in 1944. Refloated once again in 1948, it was transformed into a wreck retriever.

Today, Saft is still working on batteries for the propulsion of submarines, now using lithium-ion technology; these higher-performance batteries are used not only in submarines but also in other civilian and naval vessels.

Uncommon longevity

To go back to where it all started, the Ouessant stayed in the Bay of Brest, at a depth of 11m, until 1942, when it was refloated. The German navy, deeming that the battery was unusable, returned it to Saft.

Despite having spent 18 months in seawater, all the battery plates were salvageable and were reused in production, which says a lot about the quality and sturdiness of this first battery.

Buvard offert par Monsieur Pile

The Leclanché battery, part of Saft's history

For many of Saft's employees, the companies of Leclanché and Saft have a single past, based around the factory at Chasseneuil-du-Poitou, France.

Georges Leclanché

However, both companies had a considerable history before coming together. Well before Saft's founder Victor Herold established the first alkaline-battery factory in France, Georges Leclanché created the first French "dry" battery and opened a factory in Paris in 1871. When Georges Leclanché died in 1882, he left a flourishing business to his brother Maurice and his son. Max, Georges' son, sought to perfect the battery, but competition increased and the company went into decline. After several changes of shareholders, it was taken over by Fulmen, a lead-battery manufacturer.

In 1938, Fulmen bought a former abattoir in Chasseneuil-du-Poitou to turn it into a factory producing small electrical equipment. Electric batteries were also manufactured there, under the Leclanché brand. This facility was taken over by Saft in 1952, when Saft and Fulmen both belonged to the Compagnie Générale d'Électricité (CGE). In the 1950s, the factory at Chasseneuil-du-Poitou had up to 1,000 employees making dry batteries, the uses for which were multiplying rapidly. The factory was a significant industrial center in a rural part of the country and attracted numerous young people from the local area, with whole families working there in some cases (see article "A family affair"). At the time, the factory was known simply as "Leclanché", or "La Pile" (The Battery).

Saft continued to make batteries for the general public until that aspect of the business was taken over by Bernard Tapie in 1985. In the meantime, in 1965, the Chasseneuil factory was transferred to a site in nearby Poitiers, where it now employs about 700 people. In a nod to its history, the address of the factory is Avenue Georges Leclanché.

Today, Saft's factory in Poitiers is the largest industrial employer in the area, just as the Chasseneuil factory was in days gone by. The factory no longer makes batteries for the general public but specializes instead in high-technology batteries for aerospace, defense, civil electronics and the marine sector.

Mr and Mrs Pascal Gaborit

A business is most importantly the men and women who work there. This is particularly true at Saft, where careers are often long. Let's take the example of the Chasseneuil-du-Poitou factory.

"My grandfather started working at La Pile in 1946, and my grandmother was a cleaner there. His brother, his son and his two sons-in-law worked there for their entire careers. Out of the grandchildren, three worked at the factory for a while, and two of us, including me, stayed at the factory for our whole careers," explains Philippe Fredon, technical engineer at the satellite unit in Poitiers.

His grandfather, Pascal Gaborit, worked at Leclanché from 1946 to 1965.

A family affair

In this rural region, the Leclanché factory, and later the Saft factory, acted as a magnet for many workers. In fact, some families became fixtures at La Pile, as it used to be called, generation after generation.

Pascal Gaborit joined Leclanché on his return from the Second World War, during which he was imprisoned in the Krems region of Austria. On his return to Chasseneuil-du-Poitou, at the end of a very long journey, he started working at the Leclanché factory. "He used to start work very early in the morning, around four o'clock, to prepare the paste for the workers who started at five, and he finished at six pm," recounts the family album - "Our grandfather's story" - produced by Pascal's family for his 100th birthday. He was also involved in the Sporting Club of Chasseneuil Leclanché, a football club that excelled in the amateur championships in 1954-1955.

Through this album, we get an idea of what the Chasseneuil-du-Poitou factory was like in the 1950s, when it employed nearly 1,000 people and mainly produced saline batteries. There was a vegetable garden near the factory, which supplied the canteen, and not far from that was the football stadium. "From 1946 to today, there has always been a member of the family at La Pile," explains Philippe Fredon, Pascal Gaborit's grandson. All in all, 18 members of this family worked at the factory, including 10 who spent their entire careers there. Yves Gaborit, Philippe's uncle, also spent his whole career at La Pile. From 1953 to 1998, Yves saw all sorts of production lines and witnessed the entire history of the factory.

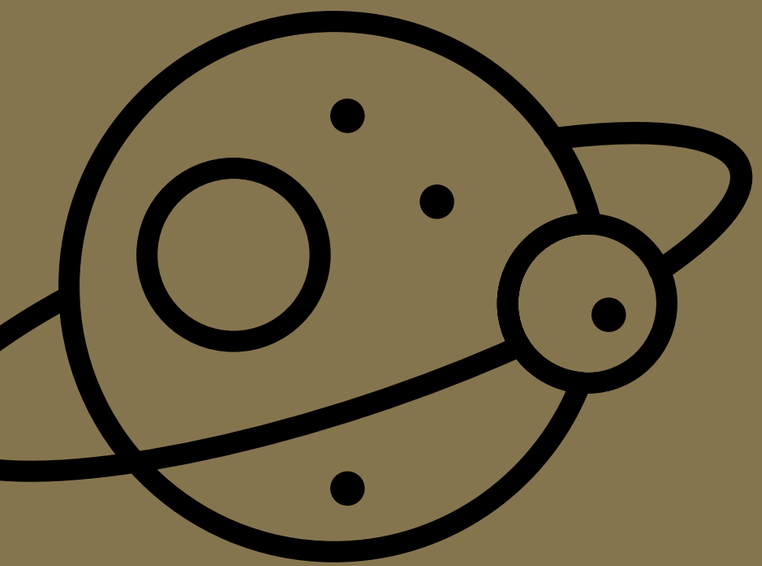
While not all Saft employees have had such long careers with the company, many of them show a real attachment to it. Indeed, employees with 30 or 35 years of service are not unusual within the company.

Wall of fame

Valdosta's US factory "Wall of Fame" represents all our current and past employees with 30+ years of service with Saft. Because without them we are nothing.

Lasaundra Sirmans has been with Saft since 1975 when the factory opened. She is currently the longest-serving employee still working at the plant.

Key figures

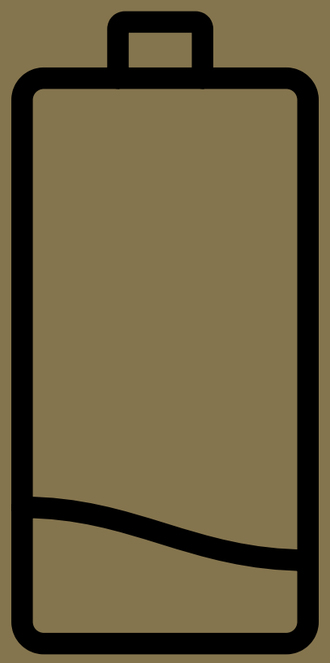


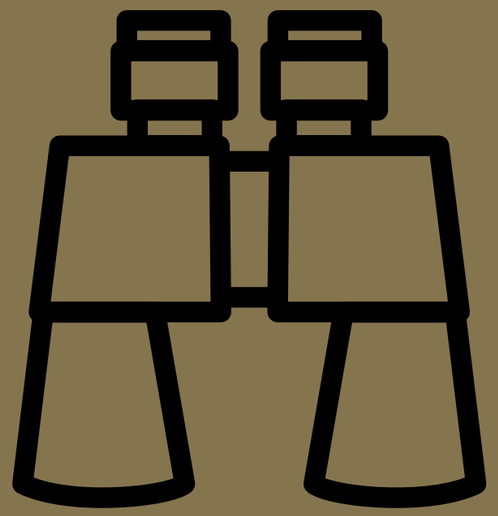
50+

years in space

1st

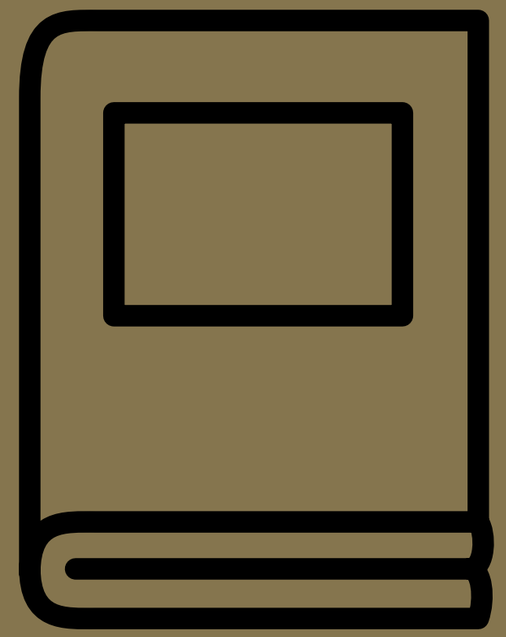
to start the production of nickel and lithium-ion batteries in France





3

polar expeditions with Jean-Louis Étienne



1

Guinness World Record for the World's Most Powerful Battery in 2005

SAFT MAGAZINE #100 YEARS

Transantarctica

Crossing Antarctica from the west coast to the east on foot - that was the unprecedented challenge undertaken by the international Transantarctica expedition almost 30 years ago.

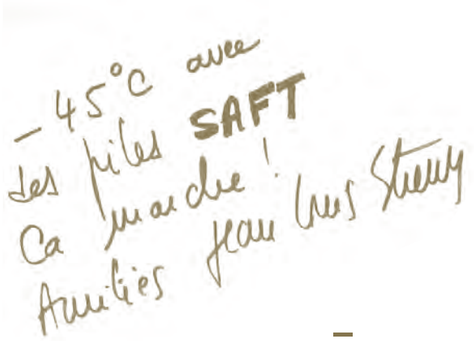
1989

Co-led by the explorers Jean-Louis Étienne of France and Will Steger of the US, a team of six men from six different nations set off in September 1989 for a seven-month trek in the most extreme conditions. As well as Étienne and Steger, the other team members were Geoff Somers of Great Britain, Victor Boyarsky of the Soviet Union, Keizo Funatsu of Japan, and Qin Dahe of China.

Meticulous planning

Transport for the mission - the longest non-mechanized crossing of Antarctica - relied on three key elements: 42 sled dogs trained by Will Steger, three sleds, and a polar schooner.

The 35m-long schooner, named Antarctica after its destination, was a mix of traditional naval architecture and sophisticated technology. If caught in ice, its rounded hull was built to resist the pressure by sliding above the frozen water. It would also double as a base camp and communications platform for the explorers. For power, the boat relied on nearly a ton of Saft batteries. Installation of the batteries started in April 1989, at the Société Française de Construction Navale (SFCN) shipyard in France. Made in Saft's Bordeaux facility, the batteries were all nickel-cadmium with a special "extreme cold" electrolyte developed specifically for the expedition. One of them started the boat's generator, two others started the diesel propulsion engines, and a fourth powered the on-board electronics needed for navigation and transmission. Philippe Ulrich, responsible for Saft's SRX "grand froid" (extreme cold) battery development at the time, remembers: "Specialists and scientists were focused on temperatures of -30°C. It was a real obsession at the time! As a result, we equipped the batteries with an electrolyte that could resist temperatures of -30°C and below. We all thought of it as our scientific rescue mission."



Despite the difficulties along the way, Transantarctica was a success; a technological success in part because of the polar schooner and other equipment, but mainly and most importantly, a human one.

Expedition

The expedition gets underway

The Antarctica crossing started on Friday, July 28, 1989, in the best conditions possible: hard snow, good weather, and only -3°C. The team and the dogs were in high spirits as they began their seven-month-long walk, thrilled to be starting their expedition and to bring global attention to Antarctica and its unique environment.

However, after only a week, they were reminded of the continent's perils; after 132km, the team came face-to-face with a dangerous field of crevasses. The wind rose, reaching 125km/h, whipping up the snow and greatly reducing visibility. Unable to go farther, the explorers set up camp and were stranded for more than three days.

The difficulties continued a month later, by which time the team was already a week behind schedule. Because of the poor visibility and weather conditions, they were unable to find a cache that should have resupplied them with food. This was one of 12 caches spread out along their path from the Antarctic Peninsula to the South Pole. Placed ahead of time, they were the main solution to keeping the six men and their dogs fed on such a long journey across the deserted continent. The cache locations were marked out with beacons linked to the Argos and Sarsat tracking systems powered by Saft lithium batteries, so the team could find them. However, this one had been buried deep in drifting snow and was inaccessible. Luckily, a Twin Otter aircraft was able to resupply the team and keep them going until the next cache.

After 136 days of walking, covering more than 3,000km, with temperatures reaching -40°C, the Transantarctica Expedition reached the South Pole on December 11, 1989. They enjoyed three days of well-deserved rest, then set off again for the second half of their journey. On this leg the weather was better, and they were able to go much faster. The more pleasant conditions held up until a few days before their arrival on the east coast. On the eve of the last day, Keizo Funatsu stepped outside in the evening to feed the dogs as usual, but was taken by surprise by a blizzard. Unable to see his way back to the tents, he dug himself a hole in the snow and spent the entire night in his makeshift shelter. The team didn't find him until morning, cold but luckily unharmed. Finally, on March 3, 1990, the expedition reached Mirnyi, the Soviet base that marked the end of their crossing from the Atlantic to the Indian Ocean and what remains today the longest non-mechanical crossing of Antarctica.

But the adventure was not fully over, because the team harnessed the publicity their success attracted to raise awareness of the importance of protecting the environment, particularly in Antarctica. As Jean-Louis Étienne described it, Antarctica is "the continent of all men": it doesn't belong to any one country, as highlighted by the international nature of the expedition. The multinational aspect was one of the reasons Saft became an official sponsor of Transantarctica, as the company was and is still present in all six of the represented countries. The extraordinary challenge also illustrated some of Saft's values of performance, reliability and working together.

24 Guinness World Record Battery

Do you know a Saft battery held a Guinness World Record?

In 2003, the Alaskan city of Fairbanks saw the installation of an impressive energy storage system. Bigger than a soccer arena, it was recognized as the World's Most Powerful Battery by Guinness World Records in 2005.

In Fairbanks, Alaska, winter temperatures can fall below -50°C. In such conditions, water pipes can freeze solid in two hours, so a steady supply of electricity is crucial to the local population. However, this remote area is an 'electrical island' - meaning it has no grid connection to the rest of the US or Canada - and so has to be self-sufficient.

Golden Valley Electric Association (GVEA) is the main supplier to Fairbanks, using local electricity generation and power imported via a single transmission line from Anchorage. Before the battery system was built, consumers had their electricity cut off when a problem occurred: there was no spare capacity because of the high cost of generating power in this isolated region.

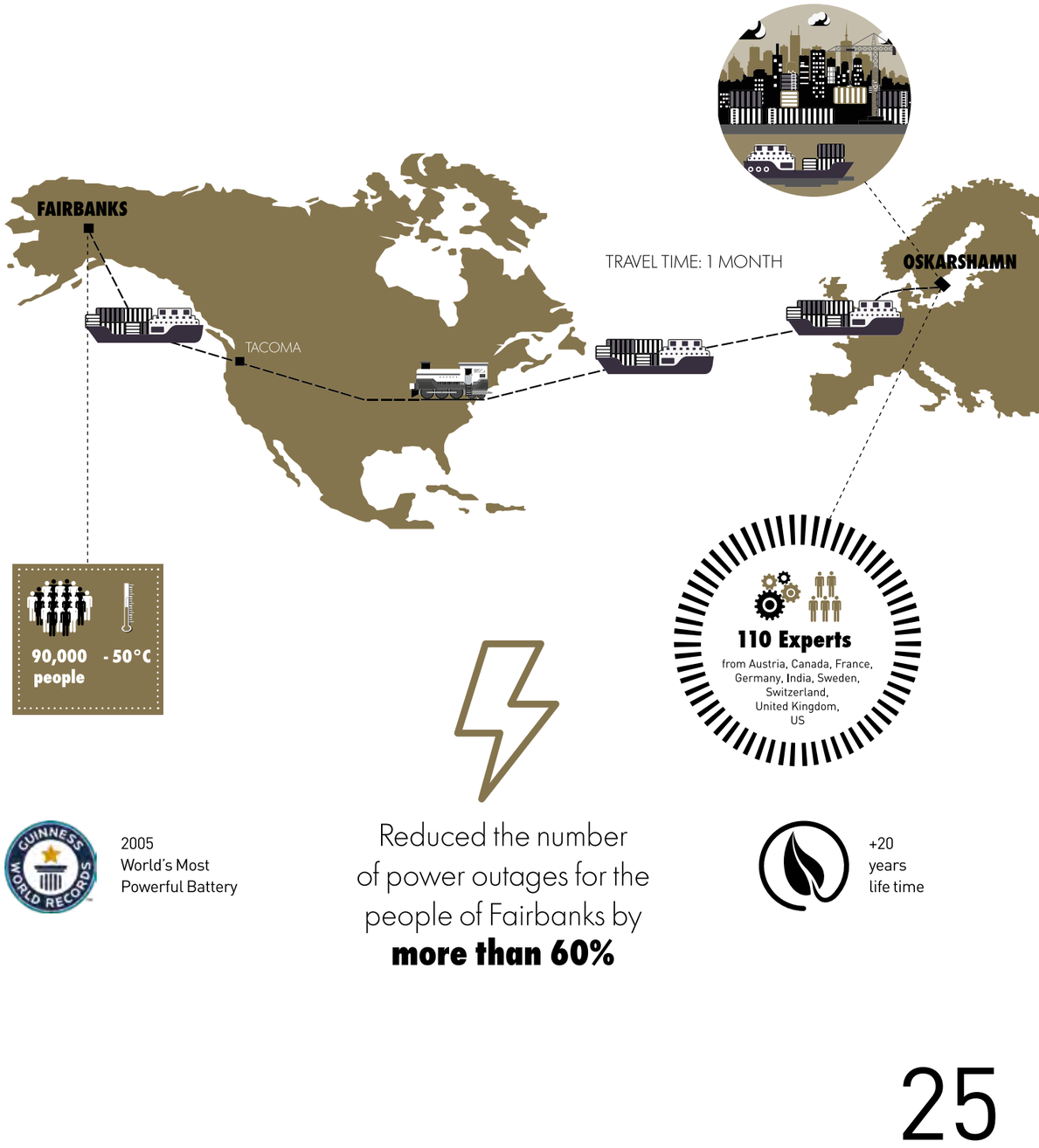
The frequent disconnections were becoming increasingly unacceptable to people living in this cold, harsh environment. GVEA investigated a number of potential solutions, eventually deciding on a Battery Energy Storage System (BESS). After a rigorous selection process, GVEA joined forces with Saft and ABB to build it.

The battery's Guinness World Record was achieved in 2005 during commissioning, when the BESS was discharged at the full overload capability of 46MW for five minutes, earning it the title of the World's Most Powerful Battery.

13,760 CELLS manufactured

During **18 MONTHS**

66 CONTAINERS shipped

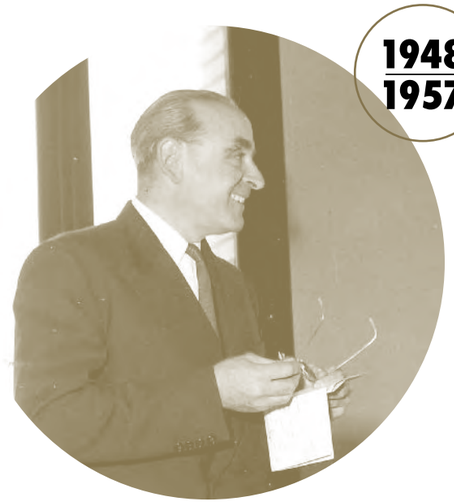


World Leaders

Some CEOs from Saft's history

1918
1948

Victor Herold
Franco-Swiss chemical engineer Victor Herold was the founder of S.A.F.T. (La Société des Accumulateurs Fixes et de Traction).



1948
1957

Pierre Jacquier
Pierre Jacquier was originally a production engineer in the parent company CGE. After the Liberation of Paris, he joined Saft as President and CEO. He pushed continuously for the research program to move forward as a top priority.

2002
2014

John Searle
President and CEO John Searle positioned Saft as a world leader in the manufacturing of advanced technology batteries. He enabled Saft to enter new markets and put the emphasis on lithium-ion battery development and manufacturing.

1981
1987

Georges-Christian Chazot
Georges-Christian Chazot joined Saft in 1976 as Managing Director for Industrial Batteries. He became Saft's CEO in 1981 and president in 1983. He successfully pursued Rémillon's modernization and extension policy.

1969
1979

Robert Rémillon
Robert Rémillon started as CEO in 1969 and became President and CEO from 1972. He was the instigator of the internationalization of Saft (particularly in the US with the creation of Saft America Inc.). He also achieved much in terms of modernization.

Saft America: half a century in the United States

Saft entered the US with the ambition to bring its new nickel-based technology to the airline industry.

Beginnings: 1954-1957

In 1951, Saft began talks with the Bureau of Aeronautics through a businessman, Hazard Reeves, who was eager to get the license to produce Saft batteries in the US. After Saft submitted its Alcabloc and Voltabloc batteries to the Bureau of Standards in Washington for approval, the Bureau of Aeronautics signed a $500,000 contract.

In 1957, Saft Corporation of America was formed in Lodi, New Jersey, as a joint enterprise with Reeves Soundcraft Corporation. But although the Saft batteries had a technological advantage, working with associates with no battery experience proved difficult, and the new company struggled to win against American lead-acid competitors. Separate difficulties in the qualification process led to the closure of Saft Corp in October 1957.

PROGRESS

December 1983 Volume 27 Number 12

VALDOSTA AND LOWNDES COUNTY CHAMBER OF COMMERCE • VALDOSTA, GEORGIA

Mulvey Explains How Batteries Are Made and Chazot Speaks At Dedication.

SAFT America Dedicates Third New Plant

SAFT America, Inc. dedicated a new 36,000 square feet battery assembly plant this month with a snip of a ribbon and remarks from local VIP's and SAFT Worldwide officials. The new plant will create about 120 new jobs.

The addition brings SAFT's total manufacturing floor space at the Valdosta headquarters to 188,000 square feet. The expansion and installation of a water cooling tower and new computer order entry system will exceed $1-Million, according to officials.

Edward J. Mulvey, SAFT's president presided at the ceremony and introduced Mr. Georges Chazot, President of SAFT Worldwide. He directs the world operations from his Paris, France offices.

Chazot spoke to the crowd prior to dedicating the new plant which is to manufacture a cylindrical battery that is used for military and civilian applications. This is the third expansion for SAFT since they located here in 1975.

Ed Nargi, vice president and general manager of the Valdosta divisions said the new plant is a result of relocating the SAFT portable battery operation from St. Paul, Minn. and consolidating it with the Valdosta headquarters operation. The 120 new jobs will include more than 45 in marketing, accounting, engineer and professional positions. The remainder will be in production work.

SAFT America, headed by Mulvey, is America's second largest battery manufacturer. The company produces state-of-the-art batteries for private industry and the military.

When Mulvey assumed his presidency in 1977, the company was losing $3.6 million on sales of $9.8 million. Six years later, after a series of mergers and acquisitions, SAFT expects to achieve planned profits on sales of $68.0 million in 1983. The company's goal is to have a $250 million business by 1990.

"SAFT America has grown and experienced tremendous advances while headquartered in Valdosta," said Mr. Chazot, Director of SAFT Worldwide. "We're pleased to make another addition here."

SAFT America Inc. operates eleven facilities in the United States, Canada and Mexico and employs more than 1100 people in those facilities.

For the consumer market, SAFT was a pioneer in the development of nickel cadmium batteries. Marketed under the "Again and Again" label, and under various OEM labels, SAFT sealed cell batteries power a wide range of consumer applications. Included are stereo equipment, photoflash equipment, video cassette recorders and mobile transceivers. The batteries are produced in all sizes and can be recharged up to 1,000 times.

"We are entering a world of portability," Mr. Mulvey points out. "It will continue to be a substantial issue in our lifestyle in the future. SAFT will provide the power with its battery systems to support this increasing lifestyle, and I can think of no better place to do it than right here in Valdosta."

Foundations: 1974-1989

By 1974, the company understood that to develop rapidly in the US it needed its own local production site. Saft, then part of Compagnie Générale d'Électricité, had owned a share in the aircraft-battery division of Gulton Industries and increased its holding in 1973 to become the largest stakeholder. A year later, the company was renamed Saft America. Gulton manufactured nickel-based cells for aircraft from its facility in New Jersey. In August 1974, Saft America relocated its operations to a brand-new plant in Valdosta, Georgia, producing portable cells for the commercial market and prismatic cells for aviation. The Valdosta facility is still going strong today, and some of the original members of staff are still working there, more than 40 years later.

From these foundations, Saft began to expand. In 1978, it purchased SCORE, a company in Cockeysville, Maryland, that made thermal batteries for the space and defense markets. In 1983, Saft accelerated its nickel-based portable cell manufacturing by purchasing Gould National Batteries. In the late 1980s, Saft made another key acquisition when it bought Duracell's B2B operations in Valdese, North Carolina. After the Duracell deal, Saft made Valdese its center for both lithium-sufur dioxide (Li-SO_2) and lithium-thionyl chloride (Li-$SOCl_2$), and relocated Cockeysville's capability there, leaving Cockeysville as a mostly thermal-battery plant.

Growth: 1990-2003

In 1991, Operation Desert Storm saw a massive deployment of US forces to the Gulf, as America responded to Iraq's invasion of Kuwait. It created a huge demand for batteries for GPS, night-vision and other applications, and led to an order worth $120m, the largest in Saft's history. To meet the order, Valdese quadrupled in size. The plant would grow again 12 years later, with the second Gulf War.

In 1993, Cockeysville ceased to be a production site after Saft stopped making thermal cells that were no longer profitable. Cockeysville became an R&D facility and would remain so for 10 years. The 1990s also saw the development of in-house lithium-ion (Li-ion) technology and processes. Major discoveries were made and important patents granted. The Cockeysville R&D team was key in quickly building Li-ion prototypes, especially for defense applications.

In 1996, Saft began developing its own electronic battery-control systems, because Li-ion cells could not be used safely without them. Over the next decade, the electrical and software engineering team in Cockeysville developed increasingly complex systems for everything from small 28V batteries up to electronics and software for the Joint Strike Fighter 270V battery.

Meanwhile, Saft's pattern of acquisitions continued. NIFE, a Greenville, North Carolina company, was bought in 1991, as part of the acquisition of NIFE group, giving Saft America pocket-plate cell and battery assembly, industrial primary battery recycling and bring-back recycling for nickel-based batteries. All of this was transferred to Valdosta.

Gates Aerospace Batteries was acquired in 1993, bringing on board Annie Sennet, now Executive Vice President for Space & Defense and Saft America's President and CEO. Hawker Eternacell, bought in 2001, increased Saft's Li-SO_2 capabilities.

Today, Saft America represents 36 percent of the company's sales, and is a major contributor to its customer base. Saft America's five locations in the US employ close to 1,000 people and produce batteries for all its major markets.

Expansion: 2004-2018

In 2011, Saft opened a new facility in Jacksonville, Florida. The result was a state-of-the-art facility to enhance Saft's ability to produce Li-ion batteries, vital in the modern world for renewable energy, electric vehicles and telecoms.

Another growing technology has been metering, and Saft's batteries have been increasingly in demand in this sector, too. In 2012, Valdese began producing lithium-manganese dioxide (Li-MnO_2) cells for new metering applications.

Saft America's contributions in manufacturing, research, business development and, of course, the people who make it happen, are a significant part of Saft's history and part of the fabric of who we are today.

SAFT MAGAZINE #100 YEARS

Research: the bedrock of Saft's success

Research is a key component of Saft's success. The company produces hi-tech batteries that support the development of numerous cutting-edge industries.

Right from the start, research has been the cornerstone of everything Saft does. Victor Herold, the company's founder, was an engineer who graduated from the Ecole Polytechnique de Zurich and trained in rechargeable alkaline battery technology at Edison's research center in New Jersey. From Saft's creation in 1918, he never stopped working to improve his batteries for a wide range of uses, from luggage trolleys to submarines.

After the Second World War, Saft started to produce sintered plate batteries. In 1948, Pierre Jacquier took over from Herold and continued to invest in research. In 1965, Saft filed the first patents for its primary lithium technology, developed by a team of researchers based in Poitiers. In 1969, the innovative concept of lithium-thionyl chloride (Li-$SOCl_2$) batteries was discovered by Jean-Paul Gabano, an engineer and researcher who worked for Saft from 1962 to 1989. Most of Saft's primary lithium batteries are still based on this technology and are used in devices including smart meters.

Making innovation possible

Saft has been involved in all the major innovations of the 20th and 21st centuries. The company first supported the development of aviation, then satellites. These industries required highly reliable long-life products, able to withstand wide variations in temperature. They needed Saft's researchers to continuously innovate and make bespoke batteries.

To support its niche strategy, Saft joined the Compagnie Générale d'Électricité (CGE) group, which became Alcatel-Alsthom in 1991. This enabled it to collaborate closely with CGE's research laboratories in Marcoussis, south of Paris, and to work on hi-tech batteries, notably for defense, aerospace and electric vehicles. These collaborations between Saft's Bordeaux and Poitiers sites and the Marcoussis laboratories bore fruit in numerous areas, such as high-pressure nickel-hydrogen batteries developed for space, and lithium batteries.

In 1999, Saft's French research team - which had been working in Marcoussis for 10 years - was transferred to Bordeaux. Another team dedicated to lithium-thionyl chloride (Li-$SOCl_2$) batteries is based in Poitiers to this day.

Since the beginning, Saft's research has been backed by collaboration with France's national scientific research center (CNRS) and numerous university research laboratories.

The creation of the Cockeysville center, in support of the small team already working on Li-SO_2 and Li-$SOCl_2$ lithium batteries there, has accelerated Saft's lithium-ion (Li-ion) work. The Cockeysville team worked on Li-ion batteries for the F35 Joint Strike Fighter, in collaboration with the US Air Force. It also developed the batteries used in the energy and heat recovery system in Formula 1 racing cars.

This research center also made the company eligible for strategic public funding. One example is the company's involvement in the US Advanced Battery Consortium (USABC) programs in the late 1990s for the development of electric vehicles. Saft also worked with the Defense Advanced Research Projects Agency (DARPA) on high-power Li-ion batteries.

In both cases, the work focused on improving the batteries and the production processes; Saft's laboratories are involved in the design and improvement of production facilities, technical installations and industrial equipment. As in many other fields, digital technology is becoming essential, and Saft develops its own software.

"It is an important part of our activity; we work on modeling software and algorithms to speed up the research process, instead of the old trial-and-error methods," says Patrick Bernard, Saft's Corporate Research Director.

Today, Saft has two research centers: Bordeaux (France), which leads the company's research with 45 people, and Cockeysville (Maryland, US), created in 1990 and employing 15 people.

After the initial research phase, two incubators, in Bordeaux and Cockeysville, step in. "Once a technology has been validated, it can go straight into development, or be entrusted to the incubator, which is tasked with pushing the different technological building blocks forward," says Bernard.

The incubator is also tasked with submitting concepts to customers, and partnering with them in a start-up spirit.

In 2017, almost 10 percent of the company's revenue, €72 million, was devoted to R&D. That year, 26 patents were registered for the group.

Batteries of the future

In the future, two types of battery could revolutionize our industry: lithium-sulfur and solid-state batteries. A lithium-sulfur battery contains very lightweight active materials and its energy density is four times that of the current Li-ion batteries. They should offer great advantages for aviation and space.

In solid-state batteries, the liquid component is replaced with a solid inorganic component that allows diffusion of the lithium ions. Unlike liquid components, the solid ones are non-flammable. They are also very efficient in terms of capacity and voltage, which will make it possible to design lighter, denser batteries with a longer operating life. Solid-state batteries should be particularly important for electric vehicles. Saft is moving ahead strongly in both areas, addressing the major challenges of energy, cost and safety.

There have been three major phases so far in the development of batteries: the first batteries, in the 19th century, were lead. The 20th century saw the introduction of the nickel battery - more expensive but more efficient. Since the 1990s, lithium batteries have been developing. These are the batteries of the 21st century; their technology is evolving every day, and researchers believe there are still big advances to come.

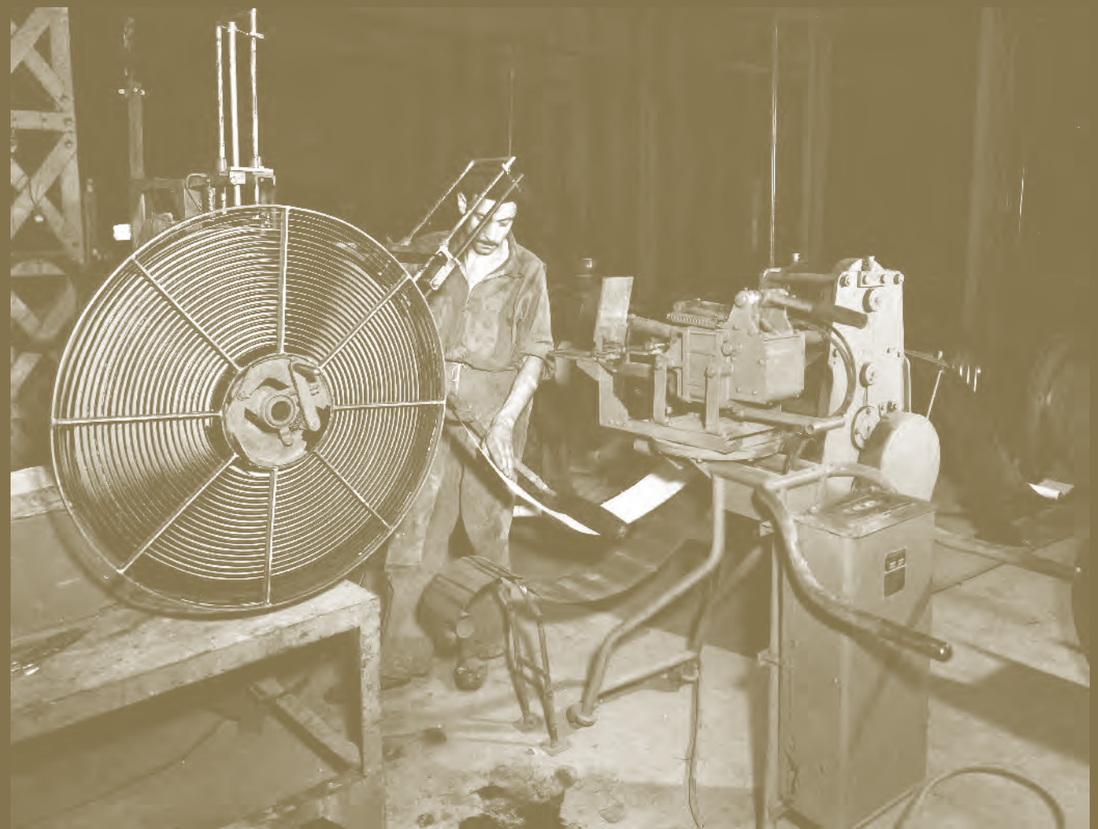
1950

Lamp battery
assembly and casing

Bordeaux

Battery
casing
welding

Factory



Coating and
sintering of
battery strips

How batteries made space travel possible

Mention the words "space exploration" and people will immediately think of the Apollo missions, or a space rocket, or the International Space Station.

A lesser-known part of the story is how these pioneering journeys were powered. At Saft, we know just how important energy supply has been in making space travel happen, and we've been working on it since the earliest days of exploration.

Saft started supplying batteries for satellites back in 1966. The first to be equipped with nickel-cadmium (Ni-Cd) batteries was Diapason 1A, the first French satellite, designed by the Centre National d'Études Spatiales (CNES). It was meant to perform a two-year scientific mission, but remained in operation for six years.

On satellites, batteries are used to provide power at "night", when the satellite passes behind the Earth and is no longer illuminated by the Sun. In the "day" phase, energy is produced by solar panels, which recharge the batteries. Using the power of the Sun in this way is very important because it gives the batteries a long operating life. Batteries designed for space must meet a unique set of demands: they must be reliable, have an operating life of more than 20 years and be able to withstand extreme temperatures and radiation. They must also be strong enough to survive launch vibrations, landing impact and other physical shocks.

Since the success of Diapason, Saft has supplied more than 800 Ni-Cd batteries for satellites in low orbits - military observation satellites such as Helios - and geostationary satellites for telecommunications, meteorological data and television, as well as the 10 largest GPS satellites. We have become so used to these communication tools that it is hard to imagine life without them, yet they are less than 50 years old.

A catalog of 118,200 stars

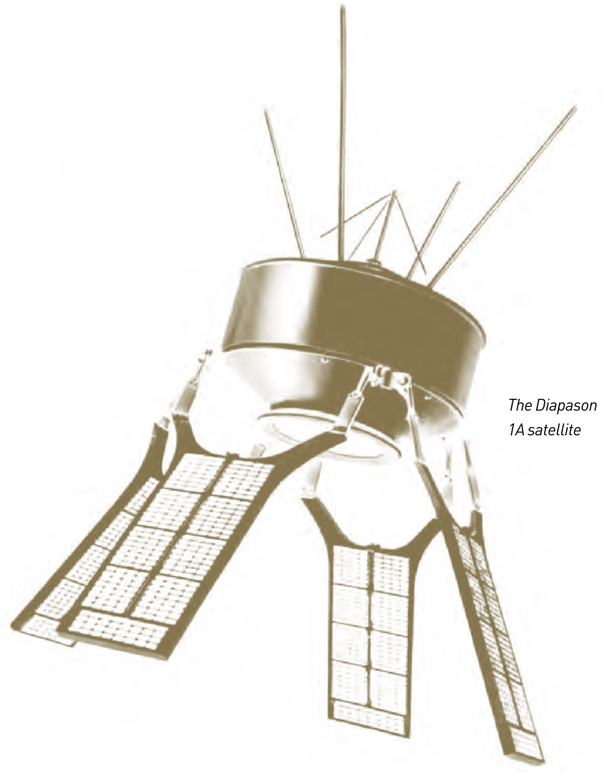
Saft has also played a role in exploration programs such as the Solar Heliospheric Observatory (SOHO) and Hipparcos missions. Launched in 1995, the SOHO satellite came within a short distance of the Sun, enabling hundreds of astronomers to study incredible photos of solar eruptions. Then in June 1998, contact was lost for unknown reasons. The satellite's position in relation to the Sun could no longer be tracked and a month went by before the American and European space agencies were able to locate and reactivate the satellite. The battery managed to withstand enormous temperature fluctuations (-150°C in the Earth's shadow, +200°C in the Sun) and, even more remarkably, it is still operational today. The mission, initially planned for two years, was extended until December 2018.

Hipparcos - the European Space Agency (ESA)'s scientific satellite - was launched in 1989 and remained active until 1993. Its purpose was to precisely measure the position of celestial bodies in space. The Hipparcos catalog, published in 1997, gives the precise coordinates of 118,200 stars.

1960s Saft space workshop

1966 aerospace poster

Space research, which had slowed down somewhat in the 1990s, has once again become an important issue, with successful entrepreneurs such as Richard Branson of Virgin and Elon Musk of SpaceX investing seriously in space travel.



The Diapason 1A satellite

Technology for commercial space

Starting in 1979, Saft also equipped all of Arianespace's satellite launchers, providing each rocket with 15 to 20 Ni-Cd batteries for guidance, telemetry and firing purposes. There have now been more than 240 launches. From 1986 to 1990, Saft developed highly reliable and resistant nickel-hydrogen batteries. More than 60 satellites were equipped with these batteries, at least 20 of which are still operating today.

In the early 2000s, lithium-ion (Li-ion) technology - which significantly reduces the weight of the equipment and therefore its cost - took over. Li-ion was developed and qualified with Stentor, a French communications satellite. It was due to be launched in 2002 as part of the first flight of the Ariane 5 rocket, but unfortunately the rocket failed minutes into the maiden flight. Despite this setback, Li-ion batteries were used again in Smart-1 in 2003. This technology demonstrator was placed in orbit around the Moon by the ESA to test the use of electrical energy for propulsion, in preparation for future interstellar missions using plasma propulsion.

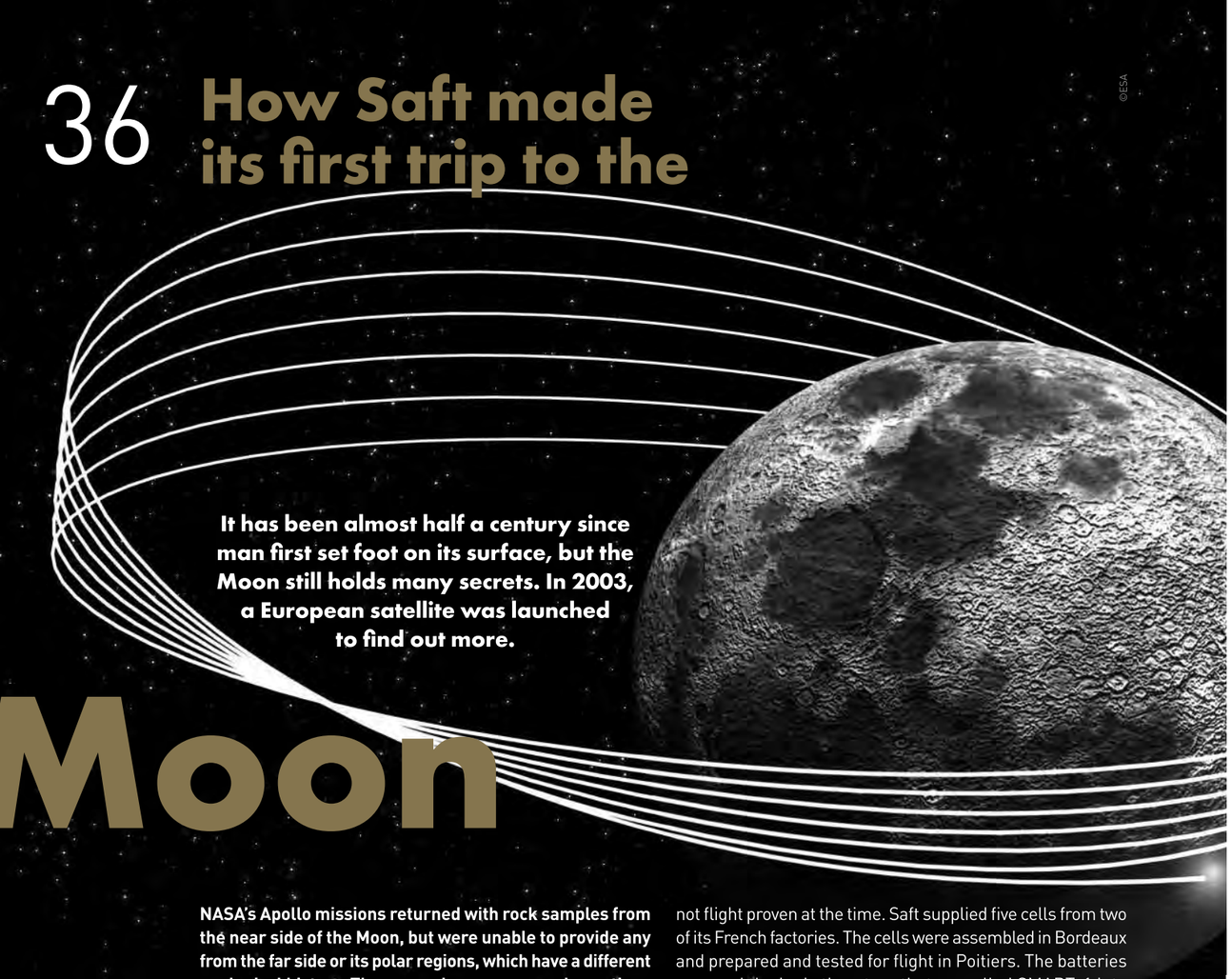
The most resounding success for Saft's Li-ion batteries came with the launch of Airbus' first Eurostar geostationary telecommunications satellite, the W3A. After 13 years in orbit, its Li-ion battery is still going strong, with only 2 percent power loss since the start of the mission.

Since then, some 265 satellites have used Saft's Li-ion battery technology. They have been designed in co-operation with the major players in the space industry: Airbus Defence and Space, Thales Alenia Space, OBH (Germany), SSTL (UK), NASA, the Russian space agency Roscosmos, Boeing, Lockheed Martin, Orbital Sciences Corporation (US), and smaller companies in Russia, China, India, Argentina and other countries.

The most advanced US weather satellites, the GOES-R and S built by Lockheed Martin, have been placed in geostationary orbit respectively in November 2016 and March 2018. The most recent success is the launch of 10 satellites of the Iridium Next program, which will comprise 81 satellites. Built by Thales Alenia Space, this project will provide a telecommunications service through its network of satellites around the planet.

Space research, which had slowed down somewhat in the 1990s, has once again become an important issue, with successful entrepreneurs such as Richard Branson of Virgin and Elon Musk of SpaceX investing seriously in space travel. In 2020, the ESA will launch Euclid, a six-year mission to study dark energy and dark matter. The same year, the ExoMars Rover will be launched to search for signs of life on the Red Planet. Once again, Saft will be on board.

How Saft made its first trip to the Moon



It has been almost half a century since man first set foot on its surface, but the Moon still holds many secrets. In 2003, a European satellite was launched to find out more.

NASA's Apollo missions returned with rock samples from the near side of the Moon, but were unable to provide any from the far side or its polar regions, which have a different geological history. There are also unanswered questions about the origins of the Moon and places where ice might still be hidden. In 2003, the European Space Agency (ESA) sent a satellite into lunar orbit to observe the Moonscape and learn more about its composition. SMART-1 (Small Missions for Advanced Research in Technology 1) was the first probe ESA had ever sent to the Moon. It orbited for three years before plummeting to the surface in September 2006.

Low-cost space probe

As well as learning more about the Moon, the mission tested advanced technologies that would be necessary for future scientific planetary missions and that could be used to create smaller, cheaper probes. Two instruments measured propulsion, for example, while another looked at the efficiency of the communications systems. SMART-1 also carried two miniaturized cameras: one to take color images of the Moon and the other to map its mineral resources. All of this equipment needed power, of course, and that was a challenge given budgetary and size constraints. SMART-1 measured just one cubic meter overall and was intended to be a low-cost space probe.The only way to resolve the concern of mass was to use a lithium-ion battery, which was not flight proven at the time. Saft supplied five cells from two of its French factories. The cells were assembled in Bordeaux and prepared and tested for flight in Poitiers. The batteries powered the ionic thrusters that propelled SMART-1 into lunar orbit, after a journey that lasted more than a year. This was the first time a battery had been used to power ionic thrusters - previously they relied on chemical propulsion - and paved the way for the full electric satellite technology in use today. The batteries also powered the electric propulsion engine every three or four days, whenever SMART-1's trajectory took it out of sight of the solar rays that usually powered it.

A trove of knowledge

The Ariane 5 rocket that launched SMART-1 into space was also, like its predecessors, powered by Saft nickel-based batteries, giving Saft a vital role in both stages of the project. SMART-1's mission was intended to end in August 2005, but was extended by a year so that more observations could be completed. The final stage was a deliberate crash on to the Moon's surface that enabled scientists to study the composition of lunar dust.The knowledge gained from SMART-1 includes close-up photographs and a complete lunar cartography that has advanced our understanding of the Earth's only natural satellite. It has also provided data that will be invaluable for future missions.

Mars attracts: exploring the Red Planet

After the Moon, Mars is the next destination for space exploration. Humans have actually been sending probes to Mars for more than 50 years.

Mars exploration began in the 1960s with flybys. Early attempts by the US and USSR failed, but in July 1969 Mariner 6 was the first US probe to reach Mars - 10 days after man landed on the Moon.

It wasn't until the 1990s that the first rover was sent there. Unlike stationary landers, rovers are, as their name suggests, mobile. That greatly broadens the scope of possible exploration. Such an advance in technology was not possible without challenges. The main one was finding a way to land safely on the planet's surface, but another was about power.

Exploring the surface

Saft's first collaboration on Mars missions was with Pathfinder, which landed on July 4, 1997, using a parachute and a system of giant airbags to ensure it arrived undamaged. The lander was powered by primary lithium-sulfur dioxide ($Li-SO_2$) cells manufactured in the US at Saft's Cockeysville facility - and its rover, Sojourner, was the first on the Martian surface.

Outfitted with instruments to analyze the planet's atmosphere, climate and geology, Sojourner and Pathfinder delivered a lot of data and helped to develop exploration techniques that were used on later missions.

Six years after the end of the Pathfinder mission, NASA launched two new rovers destined for Mars: Spirit and Opportunity. Though the rovers did not use Saft batteries, each was carried by a lander that relied on Saft $Li-SO_2$ batteries for the critical entry, descent and landing phases. After entering the planet's atmosphere, the batteries provided the power to slow the lander from 12,000mph to 1,000mph over four minutes, deploy a parachute to further slow the craft to 200mph and then fire retro-rockets and deploy airbags.

The lander hit the surface of Mars at 30mph, bouncing several times, but remaining well protected thanks to its airbags. Spirit and Opportunity both landed in January 2004, on opposite sides of the planet, and rolled out over Martian soil. The twin rovers were more mobile than their predecessor and it is due to them that we discovered the first evidence of water.

Life on Mars?

Saft batteries will visit the planet again in 2020 as part of the ExoMars mission. The goal of that mission will be to search for evidence of current or extinct life on the Red Planet through signs of bacterial cultures. For that reason, everything constructed for the mission, including the battery, is being made to exceptionally high standards of cleanliness, to avoid contaminating any complex organic molecules that may be discovered.

The battery cells that Saft has developed for the mission are compact and lightweight, so that more of the mission payload can be used for scientific instruments, and are designed to survive extreme temperature fluctuations, from -30°C to +65°C, during the nine-month journey and at least two years on the planet.

We've got it covered

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Acknowledgements

Thanks to: Tom Alcide, Patrick Bernard, Yannick Borthomieu, François Bouchon, Michel Broussely, Georges-Christian Chazot, Jean-Pierre Descroix, Richard Doisneau, Philippe Fredon, Jacques Herold, Serge Llompart, Stéphane Maréchal, Khushrow Press, David Reulier, Patrick Sanchez, Lasaundra Sirmans, Jim Snyder, Chip Wildes and all the other people who contributed to this magazine.

Throughout our 100-year history we've played a key role in some of the world's most important developments. Today, the world is changing rapidly, and customers' requirements are evolving at a similar fast pace. Saft continues to work on technology for the world's newest markets, always pushing the boundaries of what is possible. Together with Total, we are energizing the world - on land, at sea, in the air and in space. And we hope to continue to do so for the next 100 years.

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