

Saft rail batteries

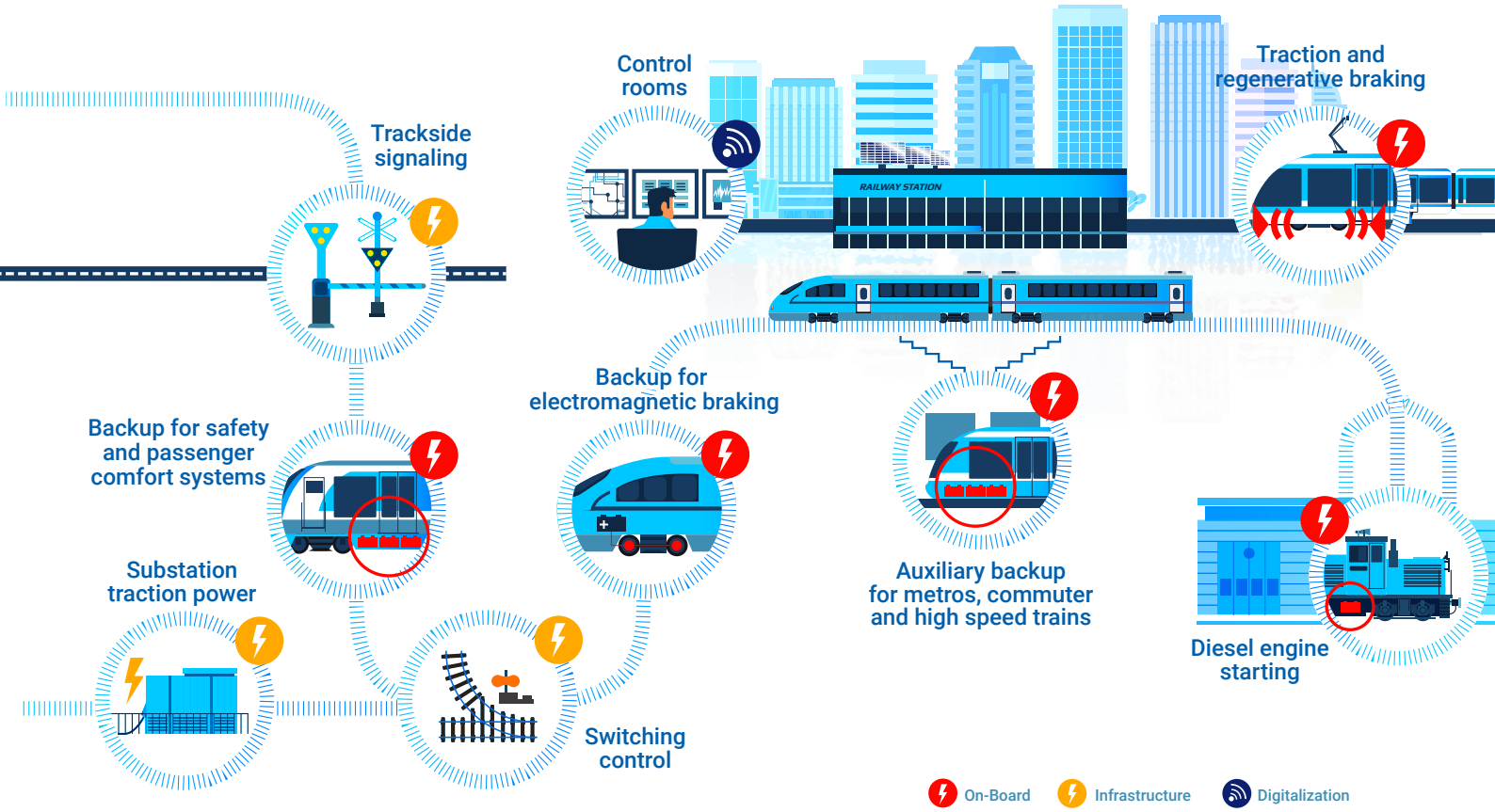
Innovative solutions for a fast-changing world

Saft, a trusted partner and battery solutions expert in mobility -- yesterday, today and tomorrow

At Saft, we developed our first batteries for Paris train stations in 1919. Since then, we have provided rail companies worldwide with unrivalled expertise in design, manufacture and supply of onboard and trackside battery solutions. Our full service ranges from providing individual batteries to serving as a global supplier of fully integrated, turnkey battery systems. Our scope covers both new-build and replacement projects using nickel-based and lithium-ion (Li-ion) battery technologies.

Saft has extensive knowledge of energy storage, combined with a commitment to sustainability. This ensures that manufacturers of rolling stock for passenger and cargo systems can have total confidence in the safety and performance of their battery systems.

Innovative energy storage powers smarter railways



Cost-effective battery solutions for every purpose

Batteries are essential to rail networks and rolling stock – all associated costs such as initial purchase, maintenance, operation and replacement should always be optimized. The true value of Saft's battery solutions are best illustrated by their Total Cost of Ownership (TCO).



Predictable service life: up to 20 years lifetime without risk of sudden death*, i.e. only one battery replacement over a typical rolling stock life of 30 to 40 years



Low maintenance: minimum preventive maintenance required at extended intervals of 5 to 10 years



Total reliability: near zero corrective maintenance costs



Wide temperature range: a broad portfolio of battery solutions for reliable operation at moderate and extreme temperatures

**Saft nickel-based batteries feature a robust construction that ensures a fully predictable and reliable performance over a long service life. For critical installations, this predictability eliminates the risk of 'sudden death' that can affect lead-acid batteries, which deteriorate rapidly in high temperatures or in demanding operating conditions.*

A proven approach to safety and outstanding performance

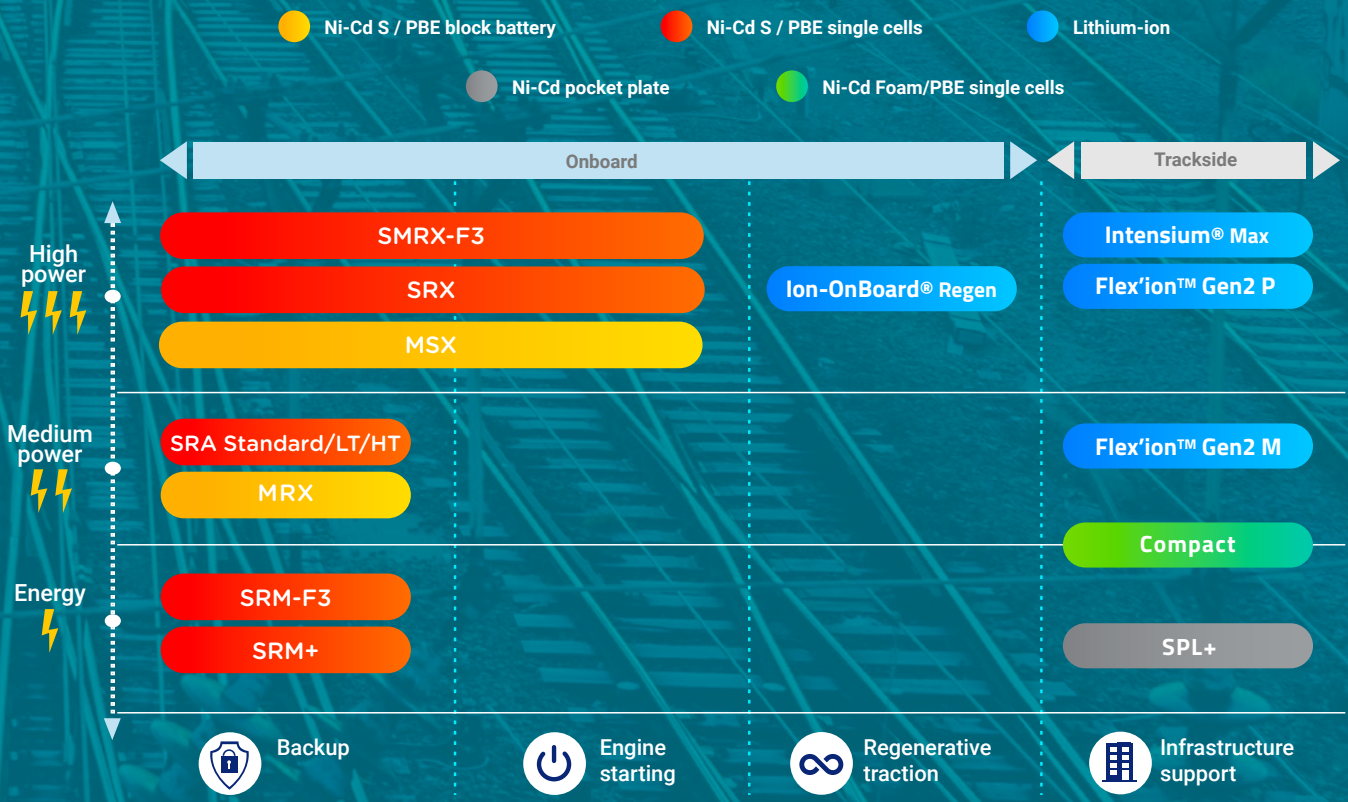
Saft continually strives to develop innovative products to help rail manufacturers and operators meet the latest standards and requirements in the rail industry based on:

- High cycle life and long storage life
- Rapid recharging capability
- Mature technology
- Full recyclability

While many rail operators rely on batteries from our extensive nickel-cadmium (Ni-Cd) battery portfolio, we also offer Li-ion-based battery solutions with specific benefits for demanding applications.

An impressive track record in rail

Onboard batteries are critical to rolling stock. They provide power for auxiliary backup and emergency traction with the confidence of safe daily operation and low maintenance throughout a long service life. Renowned for robustness, reliability and longevity, our nickel-based batteries operate over a wide temperature range without risk of sudden death.



Comprehensive backup solutions

Saft's energy and medium power products deliver backup power for vital onboard services such as lighting, data and communications systems, ventilation and door opening, as well as safety-critical electromagnetic braking applications.

Energy range
(Continuous current = 1C / Peak current = 2C)



	Main characteristics	Operating temperature range	Capacity range
SRM+	Compact cost-effective solution for onboard comfort and safety	-30°C to +50°C	40 to 360Ah
SRM-F3	Ultralight onboard backup battery housed in a transparent and flame retardant polysulfide container	-25°C to +50°C	80 to 250Ah

Medium power range
(Continuous current = 2C / Peak current = 5C)





	Main characteristics	Operating temperature range	Capacity range
MRX	Lightweight battery providing high energy and power performance for everyday use	-30°C to +50°C	70 to 520Ah
SRA	Outstanding reliability for auxiliary backup with high energy density	-30°C to +50°C	75 to 375Ah
SRA LT (Low Temperature)	Compact battery offering exceptional capacity at low temperatures	-50°C to +40°C	75 to 375Ah
SRA HT (High Temperature)	Optimized battery solution with superior charge efficiency at high temperatures	-20°C to +65°C	70 to 350Ah

Robust support for demanding applications

Saft's high power range of battery solutions is designed to accommodate the different requirements of rolling stock. The batteries offer extra support for demanding critical backup applications, from engine starting to emergency braking.

Our high power batteries are able to meet the peak power requirements of braking and tilting systems on high speed trains, as well as enabling safety functions for emergency and depot traction. They also deliver the exceptionally high cranking currents essential for frequent engine starting on locomotives and Diesel Multiple Units (DMUs) to help train operators save fuel and reduce noise and gas emissions, including CO_2 footprint.

High power range
(Continuous current = 5C / Peak current = 20C)



	Main characteristics	Operating temperature range	Capacity range
MSX	Optimum capability and cycling performance for electromagnetic braking and diesel engine starting	-30°C to +50°C	70 to 260Ah
SRX	Excellent rail starting battery for diesel locomotives and DMUs	-25°C to +50°C	22 to 220Ah (Plastic) 73 to 375Ah (Steel)
SMRX	High power backup battery for starting and supporting the continuity of onboard auxiliary systems (Low Temperature and High Temperature versions are also available)	-30°C to +55°C	70 to 260Ah
SMRX-F3	Compact high-power battery for instant diesel engine starting, housed in a transparent and flame retardant polysulfone container	-30°C to +50°C	80 to 360Ah

Total reliability for trackside communications

In addition to onboard batteries, Saft also offers uninterrupted power solutions for trackside communications and infrastructure to support smooth and safe running of services. To ensure total reliability, our nickel-based batteries are available in high and low current versions to cater for the requirements of trackside equipment and substations. This includes signalling, level crossing and point operation, positive train control, security surveillance and telecommunications equipment.

Energy, medium and high power ranges



	Main characteristics	Operating temperature range	Capacity range
SPL+	Combines reliable backup power with fast, flexible charging	-30°C to +50°C	80 to 510Ah
Compact (CPL, CPM)	Optimized for tight spaces, compatible with VRLA changing systems	-20°C to +50°C	80 to 180Ah



- High power
- Excellent cycling capability
- Long cycle life and calendar life
- High temperature performance
- Recyclable

Li-ion batteries for advanced functions

As a leader in battery technology, Saft has pioneered the development and application of Li-ion batteries for improved safety, reliability, service life and fast charging. Over the last 25 years, we have successfully deployed Li-ion batteries across our portfolio, from aviation to space, and from electric grid energy storage to mobility.

Rail manufacturers and operators around the world are focused on improving vehicle performance while keeping rail transport affordable and sustainable. Saft's Li-ion batteries offer significant reductions in both operating costs and emissions by facilitating advanced functions such as regenerative traction, automatic traction systems, trackside protection and safety as well as energy storage.



Ion-OnBoard LTO

Latest addition to Saft's rail battery family

As the rail industry develops rolling stock designed for the journey towards zero emission operations, requirements for onboard batteries are changing. New-generation hybrid and battery-powered trains need batteries to provide more than merely auxiliary or backup power. They must contribute to the reduction of energy consumption, infrastructure costs and environmental impact. The batteries will also enable trains to utilize regenerative traction power for catenary-free operation over a long distance.

Saft's Ion-OnBoard LTO is a prismatic cell based on our Lithium Titanate Oxide (LTO) technology with improved energy density for rolling stock operation. It is ideally suited for applications requiring high power throughput, fast charging and a long cycle life over a wide range of temperatures (from -25°C to +60°C).

Ion-OnBoard LTO	Main characteristics	Operating temperature range
	• Provides regenerative traction power for energy efficiency • Exceptionally long cycle and calendar life • Reduces energy consumption, infrastructure costs and maintenance requirements	-25°C to +45°C (Incl. BTMS)

Flex'ion™ Gen2



Flex'ion™ Gen2 regenerative traction sets a new standard for uninterruptible power supply (UPS)

Fully manufactured by Saft in Europe, Flex'ion™ Gen2 new lithium-ion battery solution provides up to 220 kW per cabinet, boosting power performance by 40% compared with the first generation Flex'ion. It complies to the highest safety standards such as UL 9540A, UL 1973 and IEC 62619.

Designed for demanding industrial requirements and other mission critical UPS applications such as data centers, industrial processes, railway trackside protection and safety, Flex'ion™ Gen2 is compact, lightweight and capable of operating continuously at high temperatures.

Major European railway operators have selected Flex'ion to back-up vital trackside equipment, enhancing their ETCS (European Train control System) to ensure optimum traffic flow and a safe journey for passengers.



Intensium® Max High Energy

Trackside energy storage

Saft's Intensium containerized Li-ion products have established a remarkable track record in utility-scale solutions for grids, renewables and industries. In rail, we deploy advanced Intensium® Max High Energy systems based on our Li-ion technology for hybrid energy storage in trackside applications. This enables the capture, storage and reuse of regenerative energy created by train braking during thousands of daily stops. In addition, through frequency support, this megawatt-scale energy storage system can maintain continuity of energy supply at substations. Furthermore, train operators may also sell excess recovered energy to the local grid to generate additional revenue.

	Main characteristics	Operating temperature range
 Flex'ion™ Gen2	• Compact, lightweight and capable of operating continuously at high temperatures • Ability to discharge even when charging is interrupted • Remote access to battery information and troubleshooting ability	-20°C to +35°C
Intensium® Max High Energy 	• Flexible building blocks for optimizing high-density energy storage systems up to 100's of MW • Remote supervision capability • Integrates advanced thermal and safety management with smoke detection, fire suppression and alarms	-20°C/+45°C (option +50°C)

On track for complete battery management

Saft is more than just a high-performance battery provider. With our extensive knowledge and experience in the rail industry, we simplify integration of batteries into onboard systems. We also help manufacturers and operators to monitor the performance of their batteries.

Battery System



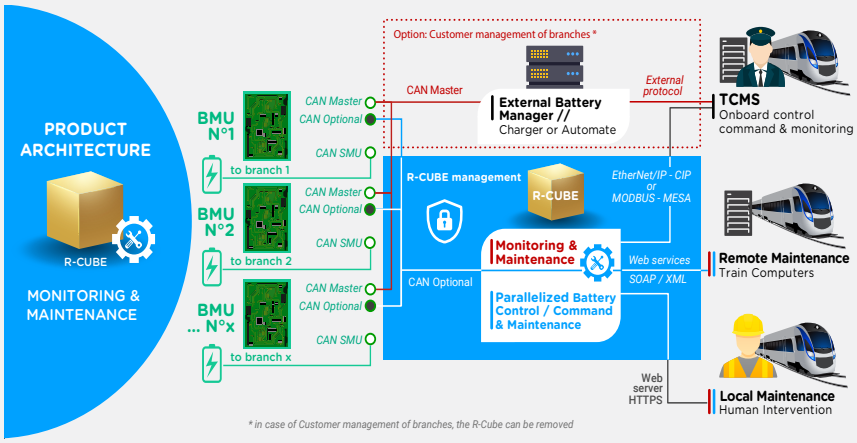
With more than 20,000 rail battery systems installed globally, Saft has consolidated this experience into the development of nine standard pre-designed systems. They include batteries, rafts, trays, access mechanisms, water filling systems, isolators, fuses, connectors, and battery management control (BMC). Furthermore, we design and manufacture custom-made rafts to cater for the needs of different vehicle manufacturers. Our service to supply and fit battery systems reduces the weight and volume of the total assembly, improves energy efficiency and offers more passenger space.

Battery Thermal Management System (BTMS)

For better energy efficiency, many vehicle makers are adopting Li-ion and even introducing battery- or hybrid-powered trains. A Battery Thermal Management System (BTMS) enables operators to monitor the temperature and thermal behavior of battery cells during operation. Through control of heating and cooling, the BTMS optimizes the battery temperature to maximize power output while reducing the potential for temperature-induced safety hazards.

Battery Management System (BMS): R-CUBE

System architecture for maintenance & monitoring



To take rail battery monitoring and maintenance to a new level, Saft has introduced the R-CUBE, a real-time battery control, supervision and big-data platform specially designed for the rail industry.

Operators can now oversee and inspect the train control system and onboard maintenance server remotely. R-CUBE's powerful functions include external communication, battery container parallelization, remote monitoring and supervision and data management with a high cybersecurity level for enhanced analytics and services. Hence, it helps operators to save operation and maintenance costs.

Saft's batteries in global rail networks



1. Backup for electro-magnetic braking



2a. Traction & regenerative braking



2b. Traction & regenerative braking



3a. Auxiliary backup for metros, commuter and high-speed trains



3b. Auxiliary backup for metros, commuter and high-speed trains



4. Diesel engine starting



5. Backup for safety and passenger comfort systems



6. Backup and Emergency Traction



7a. Resilient to extreme temperatures



7b. Resilient to extreme temperatures



8a. TCO/Low Maintenance



8b. TCO/Low Maintenance



9. Replacement



10. Digital trackside backup



Case studies



1. Backup for electro-magnetic braking

PROJECT: Germany | Karlsruhe Tramway Network
PRODUCT: MSX **YEAR COMMISSIONED:** 2012
TRAIN MANUFACTURER: Bombardier (now part of Alstom group)

Bombardier selected Saft's MSX batteries for the transition from lead-acid to nickel-based batteries on the dual-system tram-train fleet in Karlsruhe, Germany. The objective was a substantial reduction in battery size and weight, as well as reliable high power performance.

The batteries provide emergency backup power for critical systems (such as lighting, communications and door operation). They are sized to operate the electro-magnetic braking system for up to 12 seconds, even in the coldest winter conditions and after the designated backup period.



2a. Traction & regenerative braking

PROJECT: UK | Birmingham Network | West Midlands
PRODUCT: Modul'ion **YEAR COMMISSIONED:** 2019
TRAIN MANUFACTURER: CAF

CAF introduced the UK's first commercial tram line operating without catenary for the city of Birmingham. In addition to aesthetic harmony, catenary-free operation also eliminated the need for expensive overhead electrification equipment. This is feasible thanks to

Saft's onboard Li-ion battery, which charges on parts of the network where catenaries are available and provides traction power on catenary-free sections. Saft's Li-ion battery solutions are designed for a service life of at least 7 years to optimize the fleet's maintenance and operational schedule.



2b. Traction & regenerative braking

PROJECT: Qatar | Doha's Education City Tram
PRODUCT: Ion-Onboard **YEAR COMMISSIONED:** 2015
TRAIN MANUFACTURER: Siemens

Saft's Ion-OnBoard Regen Li-ion battery system is deployed on Avenio trams in Doha's Education City. By utilizing efficient regenerative braking and rapid charging at each stop, the tram system operates autonomously without the need for catenaries. The trams are enabling a shift from

road to rail transportation, showing the potential for sustainable urban development and CO_2 reduction, while maintaining architectural aesthetics in Doha's higher education hub. Saft's solution includes an advanced Battery Monitoring System (BMS) and Battery Thermal Management System (BTMS).



3a. Auxiliary backup for metros, commuter and high-speed trains

PROJECT: South Africa | Gautrain
PRODUCT: MRX **YEAR COMMISSIONED:** 2010
TRAIN MANUFACTURER: Bombardier (now part of Alstom group)

South Africa's Gautrain is a safe and rapid transport link for Johannesburg, Pretoria and O.R. Tambo Airport. Bombardier equipped the trains with Saft's MRX battery systems for reliable onboard backup power to support emergency lighting, air conditioning and door operation. The turnkey package is ideal for rapid transit applications thanks to high performance and reliability, long service life and low Total Cost of Ownership (TCO).



3b. Auxiliary backup for metros, commuter and high-speed trains

PROJECT: UK | Hitachi Class 800 and 801 trainsets
PRODUCT: MSX **YEAR COMMISSIONED:** 2014
TRAIN MANUFACTURER: Hitachi

Hitachi selected Saft to supply turnkey, fully integrated battery systems for vital backup power on their Class 800 trains for the UK's Great Western Main Line and East Coast Main Line. For safety, each of the 122 electric and bi-mode trains is equipped with at least two lightweight MSX systems to ensure up to three hours of backup power to support passenger safety and comfort functions, such as lighting, ventilation, door opening and communications.



4. Diesel engine starting

PROJECT: Brazil | MRS Logistica | Southeastern Federal Railroad Network
PRODUCT: SRX **YEAR COMMISSIONED:** 2019
TRAIN MANUFACTURER: General Electric

Brazil is transitioning its freight transportation from road to rail for greater efficiency and reduced CO_2 emissions. During the upgrade of their General Electric diesel-electric locomotive fleet, MRS Logistica selected Saft's SRX battery system for its long life, low maintenance, and reliable onboard starting and backup power. The battery systems deliver the cranking power to start the massive diesel engine up to 14 times a day.

Case studies



5. Backup for safety and passenger comfort systems

PROJECT: USA | Chicago Transit | Authority Series 7000
PRODUCT: SMRX-F3 **YEAR COMMISSIONED:** 2018
TRAIN MANUFACTURER: CRRC Sifang America

CRRC Sifang America's new Series 7000 trains are enhancing the passenger experience and boosting Chicago's economy. Saft has provided a comprehensive battery solution based on its SMRX-F3 batteries. It met the technical specifications, as well as US National Fire Protection Association's NFPA 130 standards. The battery systems supply backup power to essential onboard passenger comfort and safety functions, including heating, lighting, door control, security cameras and communication systems.



6. Backup and Emergency Traction

PROJECT: China | Shanghai Metro | Lines 3 & 4
PRODUCT: MSX **YEAR COMMISSIONED:** 2018
TRAIN MANUFACTURER: CRRC Puzhen

Shanghai has the second largest metro system in the world. MSX was selected by the metro operator to support emergency traction after successful deployment of the batteries on Line 11. Eventually, MSX was adopted in multiple metro lines in Shanghai. Apart from onboard backup power, MSX can deliver sufficient traction power for stranded trains to travel up to two kilometers without an external electricity supply so that passengers can evacuate safely.



7a. Resilient to extreme temperatures

PROJECT: Estonia | Tallinna Linnatranspordi Aktsiaseltsm
PRODUCT: SRA LT (Low Temperature) **YEAR COMMISSIONED:** 2015
TRAIN MANUFACTURER: CAF

Tallinn has extremely cold winters, where the temperature can fall as low as -50°C. Hence, vehicle builder CAF selected Saft's SRA LT batteries for fully reliable backup power for its new tram system. The batteries deliver a greater capacity than standard batteries at low temperatures owing to optimized electrical performance and very high energy density. The robust and reliable construction also ensures a long and predictable service life regardless of the challenging weather conditions.



7b. Resilient to extreme temperatures

PROJECT: India | Lucknow Metro
PRODUCT: SRM+
TRAIN MANUFACTURER: Alstom

YEAR COMMISSIONED: 2016

Alstom selected Saft's SRM+ to provide up to 90 minutes of onboard back-up power for critical control and passenger safety functions on their Lucknow Metro trains. The city's summer temperatures can reach 45°C, hence high temperature resistance was a key requirement. Furthermore, SRM+ offers a service life of more than 15 years.



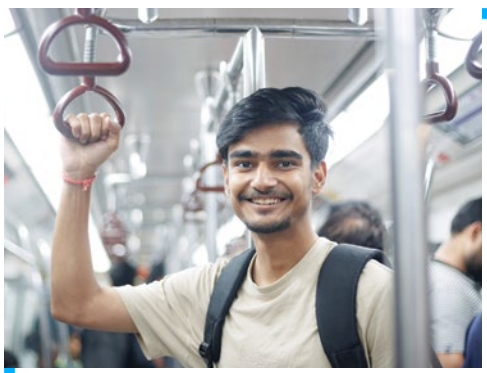
8a. TCO/Low Maintenance

PROJECT: Finland | VR Group
PRODUCT: SRM
TRAIN OPERATOR: VR Group

YEAR COMMISSIONED: Late 1990s

Saft's advanced nickel-based technology has successfully served on VR Group's electric double-decker passenger trains for over two decades. Operated close to the Arctic Circle, the Finnish rail operator relies on Saft's SRM batteries for comfort, convenience and safety The batteries provide backup power for three hours of autonomous operation, without the risk of 'sudden death' failure.

Twenty years after installation, tests showed the battery capacity was still perfect – a 33 percent gain in anticipated service life!



8b. TCO/Low Maintenance

PROJECT: Various metro lines including Delhi Metro, Bangalore Metro and Chennai Metro
PRODUCT: Ni-Cd batteries

YEAR COMMISSIONED: Since 2002

Saft's high performing Ni-Cd batteries are engineered to provide safe and reliable backup power with a long operation lifetime of up to 15 to 20 years, even under extreme climates. As an ideal choice for diverse landscapes, Saft has delivered over 2000 battery systems to different railway operators across India, including Delhi Metro, Bangalore Metro and Chennai Metro, from early 2000s.

The first SRM batteries were delivered to Delhi Metro in 2002. After 2 decades, they are still in operation today despites the city's hot temperatures.

Case studies



9. Replacement

PROJECTS: France | SNCF TER (Replacement)

PRODUCT: MRX **YEAR COMMISSIONED:** 2015

TRAIN OPERATOR: SNCF

France's national state-owned rail operator, SNCF, replaced the time-expired lead-acid batteries with Saft's MRX batteries on more than 200 new generation double-decker trains (TER 2N NG) on regional routes. The transition delivered improved battery performance and reliability over a long service life. MRX plays a critical role as backup power for control, safety and communications functions when the main power supply is interrupted.



10. Digital trackside backup

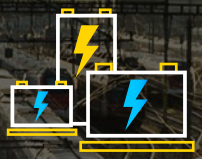
PROJECTS: Digital signalling systems for improved safety and train management for several rail infrastructure operators in Europe

PRODUCT: Flex'ion™ Gen2 **YEAR COMMISSIONED:** 2023

The digitalization of signalling and interlocking applications in European railways requires high-tech backup batteries with a successful track record in the industry. Saft's Flex'ion™ Gen2 System provides continuous and uninterrupted operation for the key digital trackside railway systems and integrated equipment, as well as optimizes rail traffic and passengers' safety.

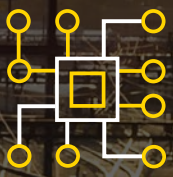


A rail battery expert that truly understands your needs at every stage



One stop battery solutions partner

- Full range of battery solutions
- High performance cells, batteries and accessories with a proven track record
- Experienced across established and growing rail markets with our battery development and rail engineering centers in three continents: Europe (Bordeaux), Asia (Zhuhai and Bangalore) and North America (Jacksonville)



Expertise

- Capability to support OEM projects in different regions and expertise in managing cross-regional projects, from 31 sales offices worldwide (as of 2024)
- Battery system design and integration support via our rail battery manufacturing hubs, with over 20,000 rail battery systems installed around the world
- Broad knowledge in local and international rail standards and rolling stock requirements



Service

- Installation and commissioning
- Spare part supply
- Aging assessment
- Training programs
- Recycling



Ongoing assistance

- Dedicated support teams: project management for system development, application engineering, quality assurance and customer service
- International sales network
- Strong logistics support for local delivery



Innovation

- Expert and technology leader in some of the world's most advanced technologies
- Cross-platform applications to enhance battery performance
- On-going investment in new product development



Battery retrofit: promoting the circular economy

- Rejuvenation of spent batteries through remanufacture, reuse and recycling
- Thorough inspection and guidance on reconditioning of used batteries and battery systems

Since 2013, the sustainability performance of Saft has been reviewed by “Ecovadis”, a leading Environment and Social Responsibility rating agency. This evaluation focuses on the following matters: environment, labor and human rights, ethics as well as sustainable procurement.



Saft obtained the Platinum rating in 2023, and is ranked within the top 1% of companies involved in the manufacture of batteries and accumulators.

Program Net Zero

Goal

- Reduce our environmental impact
- Implement circular economy throughout our operations
- Help our customers decarbonize
- Procure sustainably
- Develop people and contribute to society

In 2023

- **6million Litre** recycled
- **- 3.6%** carbon intensity/ unit produced
- **60%** of waste recycled

Batteries facilitate the shift towards clean energy, but there is much work to do to achieve Net Zero. That’s why Saft is committed to reducing its impact.

Full conformity with quality, safety and environment standards

Company certifications / standards:

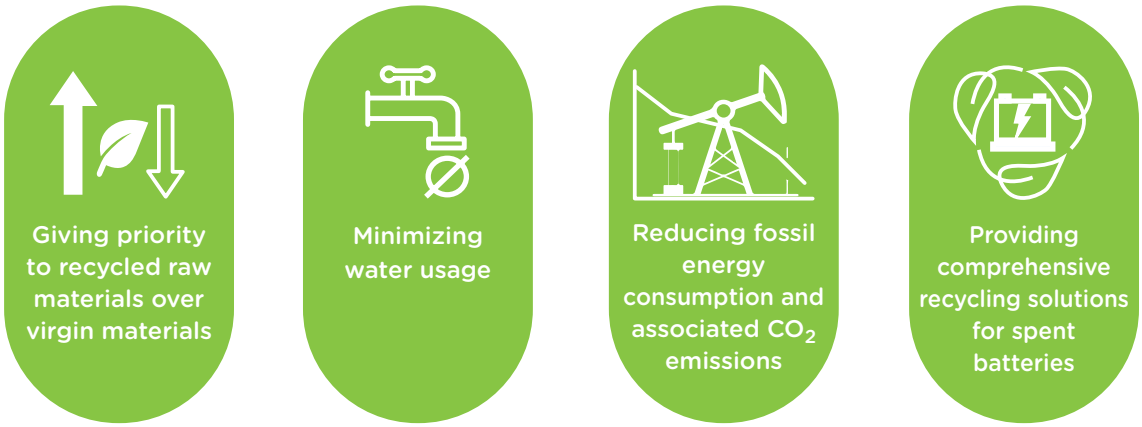
- **Quality ISO 9001, ISO / TS 22163 (IRIS),** Saft's world class continuous improvement program
- Environment fully recyclable, **ISO 14001, RoHS, REACH**

Product certifications / standards

- Saft's nickel-based batteries exceed the "M" and "H" type requirements of **IEC 60 623 and also significantly exceed UIC 854 requirements**
- Integration **EN 50547 and IEC 62973-2** railway auxiliary onboard battery, fire & smoke **NFF 16101-16102, NFPA 130 (ASTM E 162 & ASTM E 662), DIN 5510, UNI IEC 11170-3, UL 94-V0, shocks & vibrations IEC 61 373**
- **CE 548** Compliant batteries, aligned with the new European battery regulation **EU 2023/1542**

At Saft, we are committed to a more sustainable planet

Saft's philosophy has always been to offer battery solutions that make life easier. As batteries are becoming more sophisticated, they will play a crucial role in the evolution of future power ecosystems with the critical goal of reducing carbon emissions. That is why our scientists and engineers are motivated to work on the next breakthroughs in battery technology.



For industrial Ni-Cd batteries, Saft collaborates with collection companies across the world to receive and dispatch customers' batteries at the end of their lives to fully approved facilities, in compliance with the laws governing trans-boundary waste shipments.

Also, Saft assists users of its batteries in finding environmentally sound recycling solutions. Please contact your nearest Saft representative for further information.



Saft keeps the world moving towards a resilient future

With net-zero as our target, Saft is prioritizing developments that contribute to carbon neutrality. We are also focused on sustainability by using recycled raw materials over virgin raw materials in all manufacturing processes. At the same time, we prioritize reducing air and water emissions from our plants, minimizing water usage, reducing fossil energy consumption, and ensuring that all our customers have access to recycling solutions for their spent batteries.

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