Multi-technology battery systems
Integrated solutions for torpedo propulsion
Saft batteries for torpedoes
Meeting the challenge in defence

Saft is a global, multi-technology battery specialist and is the world’s leading manufacturer of high-end batteries for industrial, transportation, space and defence applications.

The company operates at the forefront of innovation, developing and delivering advanced solutions for critical applications that are highly dependent upon integrated technology. As the next generation of intelligent defence systems takes shape, Saft is actively engaged in supporting major international companies leading this change.

Worldwide, world-class capability
Saft’s global reach and vast capability is already able to provide the fast, efficient and professional response necessary for large-scale production. Around 30 navies use Saft batteries to power lightweight and heavyweight torpedoes in training programs and combat roles.

Saft: total reliability
Saft’s modern production facility at Poitiers manufactures standard and advanced solutions on sophisticated production lines employing a large variety of electrochemistries. Saft is qualified as a reliable supplier for all western electrically powered torpedoes.
- providing solutions through technology

A whole range of solutions …

Saft’s extended range of technologies and track-record of reliability enable rapid and targeted response to customers’ requirements. Saft will continue to provide exceptionally reliable solutions and is committed to maintaining the highest international standards.

… to meet any requirement

Saft is present throughout key defence markets and, having earned international recognition, is able to respond to any demand for electric torpedo batteries – for use in training and for deployment in action – in any technology.

Continuous improvement

Saft has invested extensively for over 30 years in advanced production methods, research and product development. Maximised safety in storage and extended shelf life to over 8 years is now achieved – even in diverse environmental conditions.

<table>
<thead>
<tr>
<th>Torpedo type</th>
<th>Size</th>
<th>Torpedo purpose</th>
<th>Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>SST4 &amp; SUT</td>
<td>HWT</td>
<td>Combat/Exercise</td>
<td>Silver-zinc</td>
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<tr>
<td>DM2A3</td>
<td>HWT</td>
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<tr>
<td>MK 37</td>
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<tr>
<td>F17</td>
<td>HWT</td>
<td>Combat/Exercise</td>
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<tr>
<td>Blackshark, F21</td>
<td>HWT</td>
<td>Combat/Exercise</td>
<td>Silver oxide-Aluminium</td>
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<tr>
<td>Tigerfish</td>
<td>HWT</td>
<td>Combat/Exercise</td>
<td>Silver-zinc</td>
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<tr>
<td>A244/A244 Mod 3</td>
<td>LWT</td>
<td>Combat</td>
<td>Seawater-activated</td>
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<tr>
<td>Sting Ray</td>
<td>LWT</td>
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<tr>
<td>MU90</td>
<td>LWT</td>
<td>Combat/Exercise</td>
<td>Silver oxide-Aluminium</td>
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AgO-Al technology

Saft’s AgO-Al batteries have high energy density and power consistent with torpedo range and speed.

This technology provides twice the power and energy of the standard Ag-Zn reaction at the same volume and weight.

Flagship products: MU90, Blackshark, F21.
Full range capability
Broad portfolio of technologies

Seawater-activated

Operating principle The battery is stored without electrolyte and activated by seawater after the torpedo has been launched. Through a scoop located in the hull of the torpedo, a continuous flow of electrolyte removes the heat, gas and mineral mud produced by the discharge and corrosion reactions.

Seawater-activated Type V616 and V616SE batteries are used respectively for A244 and A244 Mod 3 torpedoes. Saft is a sole qualified supplier of the V616 batteries for A244 torpedoes.

Storage conditions: specified storage life 5 years

Silver-zinc

Operating principle The battery is activated by a pyrotechnic device, ignited by an external electrical signal. Pushed by compressing-nitrogen, the electrolyte fills the cells through a distribution system. The battery is then primed. Heating of the electrolyte is possible.

Autonomy: from 13 min (high speed) up to 53 min (low speed)

Concept based on the assembly of multiple prismatic cells connected in series with the electrolyte stored in a separate reservoir.

The energy to transfer the electrolyte from its reservoir into the cells is provided by a pressurized gas tank.

Silver oxide-Aluminium

Operating principle The electrolyte forms when sodium hydroxide powder is dissolved in seawater. Electrolyte circulates through the stack in a closed loop.

Silver oxide positive electrode, aluminium alloy negative electrode and volta pile stack technology was developed in the 1970s in the US and then in France by DCNS and Saft.

High temperature operation (>80°C) and high electrolyte conductivity provide for very good power capability.

Flagship products: AgO-AI stacks for MU90, Blackshark and F21.

Only aluminium/silver oxide truly can provide twice the power and energy of the standard zinc/silver oxide within the same volume and weight allocation.
An efficient solution
- for design flexibility, performance, cost

Lithium-ion

As things stand today, rechargeable Li-ion battery systems represent the most promising solution for both LWT and HWT torpedoes when performance, calendar life and TCO (Total Cost of Ownership) are taken into consideration. Navies throughout the world are placing an ever increasing emphasis on achieving optimum TCO for their exercise torpedo batteries. Li-ion battery technology enables them to address this issue by offering:

- Low life-cycle costs through increased reusability
  - e.g. Ag-Zn batteries can only provide 10 charge/discharge cycles within a period of 12 months from first use, while Li-ion can support over 50 cycles over an extended lifetime
- Performance comparable to combat torpedoes
- Long service life
- Long calendar life
- Safe operation and ease of handling
- Reduced maintenance and logistic costs

Additionally, Li-ion offers a very cost-efficient solution when replacing fuel-propelled torpedoes with electric torpedoes.

### Relative cost of Li-ion versus Ag-Zn

<table>
<thead>
<tr>
<th>Year</th>
<th>Li-ion</th>
<th>Ag-Zn</th>
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<tr>
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### Track record

Saft has been working on the development of Li-ion battery systems for exercise torpedoes since early 2000, when initial prototypes proved capable of providing over 100 charge/discharge cycles for both LWT and HWT configurations. By 2005 the project had resulted in a demonstration battery for LWT torpedoes. More recently, an HWT version has been developed with DCNS.

### LiFePO₄

Saft has developed LiFePO₄ technology to offer a high level capability alternative for customers who have direct-drive DC motors. Since LiFePO₄ presents a flat voltage profile, it enables speed to be maintained when connected directly to the direct-drive DC motor.
About Saft

Saft is a world specialist in the design and manufacture of high-tech batteries for industry. Saft batteries are used in high performance applications such as industrial infrastructure and processes, transportation, space and defence. Saft is the world’s leading manufacturer of nickel-cadmium batteries for industrial applications and of primary lithium batteries for a wide range of end markets. The group is also the European leader for specialised advanced technologies for the defence and space industries. With approximately 4,000 employees worldwide, Saft is present in 18 countries. Its 15 manufacturing sites and extensive sales network enable the group to serve its customers worldwide. Saft is listed in the SBF 120 index on the Paris Stock Market.