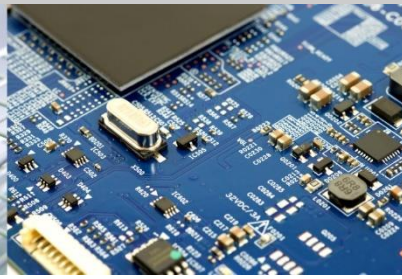
Meter Life Analysis

Service specification

Connected device fleet management

Electrical, chemical, electronical analyses



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04/2023	/	Creation	V. Kokoh B. Larrea

1. Scope

This specification presents the service of analyses proposed by Saft to customers managing fleets of connected devices.

The objectives of this service are to give information on the state of health and the state of charge of a device fleet, and to assess the remaining lifetime, based on analyses of a sample of cells from this fleet.

Customer's benefits are:

- Key information to determine the best metering asset management strategy.
- An easier decision making on asset maintenance.
- Better knowledge of battery ageing.
- Detection and management of key parameters influencing ageing to preserve battery life.

This service is dedicated to primary Lithium-Thionyl Chloride (Li-$SOCl_2$) and Lithium-Manganese Dioxide (Li-MnO_2) cells, all brands.

2. Pack contents

A. Smart check-up

■ Electrical tests

Tests	Knowledge on
OCV / Z 40 Hz	Cell's life history (T°C, storage, full discharge)
Complex impedance	R (Ω) & C (F)*
Delay effect	Passivation

*Electrical and ionic resistance of internal components.

■ Chemical analyses

The following analyses are led on dismantled cells.

Analyses	Knowledge on
Remaining Lithium	Residual Capacity
Discharged Lithium	Discharged Capacity
Passivated Lithium	Self-discharged Capacity

■ Outputs

- State of charge (SOC) and state of health (SOH) of the cells.
- Assessment of any overconsumption in use.
- Determination of remaining lifetime.

B. Electrical screening

■ Electrical tests

Tests	Knowledge on
OCV / Z 40 Hz	Cell's life history (T°C, storage, full discharge)
Complex impedance	R (Ω) & C (F)*
Delay effect	Passivation
Residual discharge	Residual Capacity Discharged Capacity

*Electrical and ionic resistance of internal components.

■ Outputs

- Charge level and state of health of the cells.
- Assessment of any overconsumption in use.

C. Flexibility Option

■ Electronical operating control of customer's device
Saft's electronical experts run customer's profile-based tests on the complete connected system provided by the customer.

D. On request

It is possible to add other electrical tests to complete one of the packs. Please consult Saft.

3. Electrical tests

A. OCV / Z 40 Hz

■ Open Circuit Voltage (OCV) is linked to the electrochemical couple used, Li-$SOCl_2$ or Li-MnO_2. It depends on use and storage conditions of the cells.
■ Impedance at frequency 40 Hz (Z 40 Hz) is the resistance measurement at a frequency of 40 Hz. At this frequency, the value of the resistance is characteristic of the passivation layer present at the surface of the lithium anode.
■ These electrical measurements are performed on the cells supplied by the customer. Then, the OCV and Z 40 Hz values are compared to Saft standard quality criteria. Thanks to its manufacturer knowledge, Saft can make a first evaluation of the history and passivation level of the cells.

B. Complex impedance

■ Complex impedance is representative of ionic and electronic resistance of cell internal components (passivation layer, electrical contacts, electrolyte…).
■ This test is an electrical measurement performed at equilibrium (OCV) by a potentiostatic method, with a frequency analyzer scanning a large frequency range. Fitting of the spectrum by a RC equivalent electrical circuit gives R and C values characteristics of the cell passivation layer. This allows to define the passivation state of the cell.

C. Delay effect

■ The delay effect test is the application of a high current on the cell during a defined time. The voltage profile is recorded with a very high frequency rate to determine the initial voltage drop and the recovery phase at longer times with good accuracy.
■ This voltage drop is called Transient Minimum Voltage (TMV). The TMV value is directly correlated to cell impedance to gives information about the cell passivation. Moreover, the profile of voltage recovery after TMV is indicative of the ability of the cell to be depassivated.

D. Residual discharge

■ The residual discharge test is the application of a low current on the cell until full discharge (Operating voltage CCV ≤ 2 V).
■ This is a simple way to double-check residual and discharged capacities, determined by chemical analyses (described in the following chapter).

4. Chemical analyses

A. Cell dismantling

■ The cell dismantling is made by a specialist, to ensure correct and safe dismantling.

This allows to verify the conformity of the cell mechanical assembly.

B. Remaining Lithium

■ Assessing remaining lithium metal allows to determine the residual capacity of the cell.
■ The measurement of residual lithium found at the anode is based on an in-house Saft tried and tested process.

C. Discharged Lithium

■ The discharge reaction is going from the lithium and electrolyte interface to the porous carbon. Lithium is consumed, the agglomerated carbon mass is filled up by Lithium Chloride (LiCl) discharge products.
■ The determination of LiCl quantity is based on an in-house Saft tried and tested process.

D. Passivated Lithium

■ This analysis is based on the lithium passivation layer, which is the result of the lithium corrosion reaction. This passivation layer is composed of LiCl crystals and formed as soon as the cell is filled in. It will grow depending on use conditions of the cell (temperature, storage time, discharge profile...).
■ The measurement of passivated lithium is based on an in-house Saft tried and tested process.

E. Measurement accuracy

	Precision
Remaining Lithium	99.3 %
Discharged LiCl	98 %
Passivated Lithium	97.3 %

5. Lifetime assessment

Lifetime device conditions and discharge current deduced from chemical analyses are the inputs used in Saft lifetime prediction model. This model was developed by Saft 20 years ago and has been constantly revised based on latest knowledge and new experimental data.

■ The accuracy of the remaining lifetime estimation has been assessed at minimum 95%.

6. Handling

A Battery Information Sheet (BIS) is available on Saft's website, www.saft.com.

Search for:
BIS for Li-$SOCl_2$ cells and batteries or BIS for Li-MnO_2 cells and batteries.

7. Transport

A. Transport of the products to Saft

The customer must organize the shipment of the products to Saft's plant, Poitiers, to the following address:

Saft Poitiers
Laboratoire chimie
Direction Technique CSE
Rue Georges Leclanché
86060 Poitiers Cedex
France

It is strictly forbidden to send to Saft damaged cells (no leakage, no crush). Saft strongly recommends sending the whole device equipped with the cell(s), as it can be dangerous to remove the cell(s) from the potting.

B. Shipping responsibility

When transporting any Lithium battery product, the commitment is upon the shipper to conform with current global, local and modal regulations. According to the Recommendations on the Transport of Dangerous Goods - Model Regulations, Chapter 1.3 - Training, "persons engaged in the transport of dangerous goods shall be trained in the contents of dangerous goods requirements commensurate with their responsibilities."

8. Disclaimer

All results (including battery lifetime estimation) of these electrical, chemical, electronical analyses are given for information only. They do not constitute a binding commitment or any express or implied warranty of performance from Saft.

9. GT&CS

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