



Ref: P0532-15	Issue: /	Date: March 14th, 2016
Title: Comparison between LS14250, LS14500 & LS17500 cells manufactured in Poitiers, South Shields & Zhuhai		

Program : NA	Product : LS14250, LS14500 & LS17500
Customer : NA	Contract : NA
Objective :	
<p>The LS14250, LS14500 & LS17500 Li-SOCl₂ cells are manufactured in three different Saft plants located in France, United Kingdom and China. In order to support the global organization of its customers and in order to secure the supply chain of its customers by leveraging on Saft's redundant industrial lines, the 1/2AA, AA & A designs from Saft South Shields and from Saft Zhuhai were redesigned in 2009 so as to offer the same performances and equivalent mechanical interfaces as the reference cell designs from Saft Poitiers.</p> <p>This document aims at providing a detailed comparison between the cell design in every manufacturing plant.</p>	

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1. Introduction

This document aims at providing a detailed comparison between the LS14250 ½ AA size, the LS14500 AA size and the LS17500 A size Saft cells manufactured in our 3 production sites of Poitiers (France), South Shields (UK) and Zhuhai (China).

2. Main characteristics

Whatever the production site, all ½ AA, AA and A size Saft's products have respectively the:

- Same name LS 14250 for ½ AA size – LS 14500 for AA size and LS 17500 for A size.
- Same nominal capacity: 1.2 Ah for the LS 14250 – 2.6 Ah for the LS 14500 and 3.6 Ah for the LS 17500.
- Same bobbin type construction consisting in a Lithium metal anodic material, and a liquid SOCl₂ based cathode impregnating a porous support carbon block
- Same hermetic construction with stainless steel hardware and glass-to-metal seal
- Same electrolyte.
- Same suppliers and type of materials for critical components: can, glass-to-metal seal, separator, lithium, chemicals.
- Same external dimensions.
- Same max continuous currents.
- Same compliance to quality standards.
- Same standard specification.
- Same datasheet.
- Same visual identity

An overview of the main characteristics and performances common to the cells manufactured in our 3 production sites is provided in the following table:

	LS 14250	LS 14500	LS 17500
Cell size	1/2 AA	AA	A
Cell construction	Bobbin	Bobbin	Bobbin
Nominal voltage	3.6 V	3.6 V	3.6 V
Nominal capacity	1.2 Ah	2.6 Ah	3.6 Ah
Max. continuous current	35 mA	50 mA	100 mA
Max. pulse discharge rate	0.1 A	0.25 A	0.25 A
Max. outside diameter	14.55 mm	14.55 mm	17.13 mm
Max. height	25.15 mm	50.3 mm	50.9 mm
Typical weight	8.9 g	16.7 g	21.9 g
Operating temperature range	- 60 / + 85°C	- 60 / + 85°C	- 60 / + 85°C

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3. Mechanical interface

However, for historical reasons and equipment availability, some mechanical differences remain. They are listed here below.

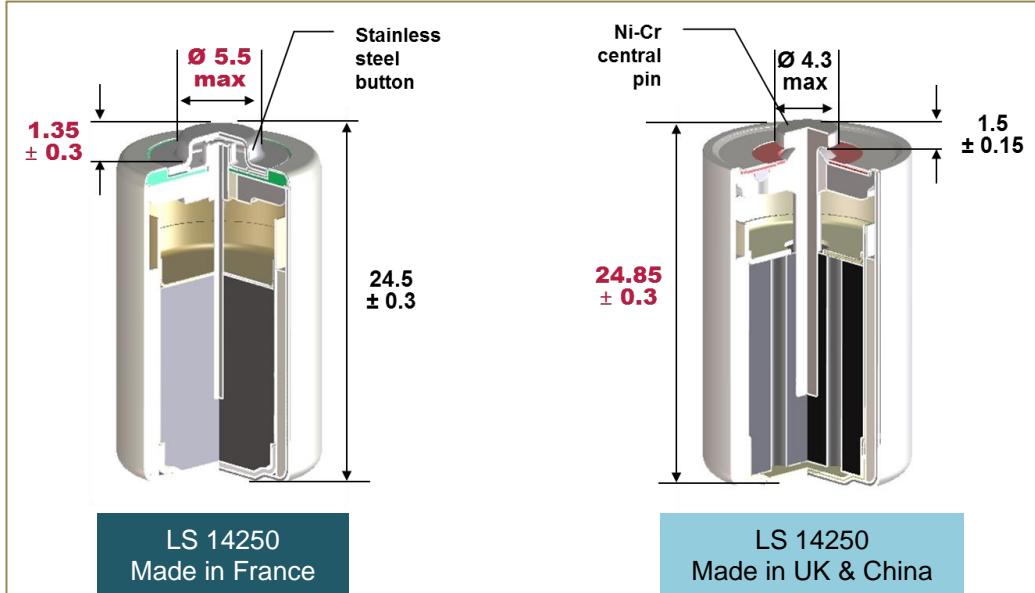


Figure 1: External differences on LS 14250

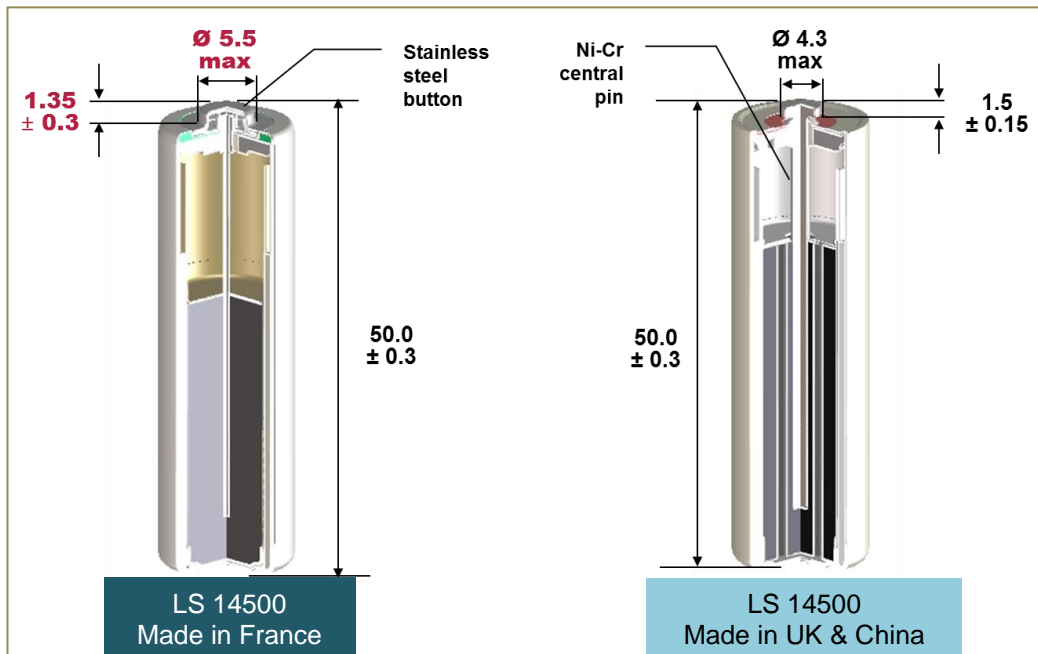


Figure 2: External differences on LS 14500

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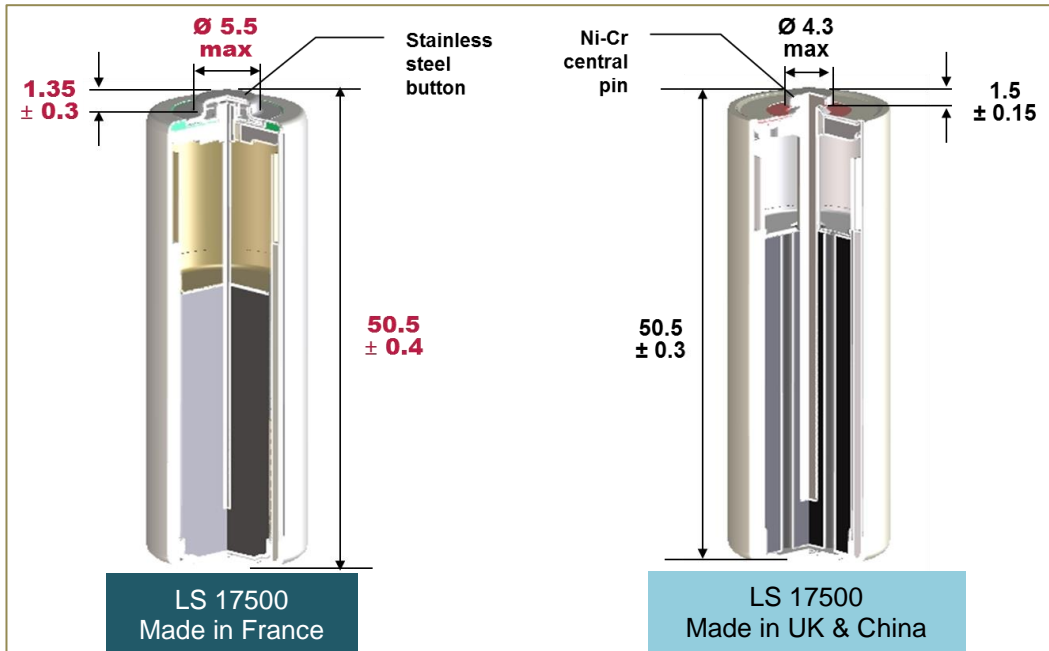
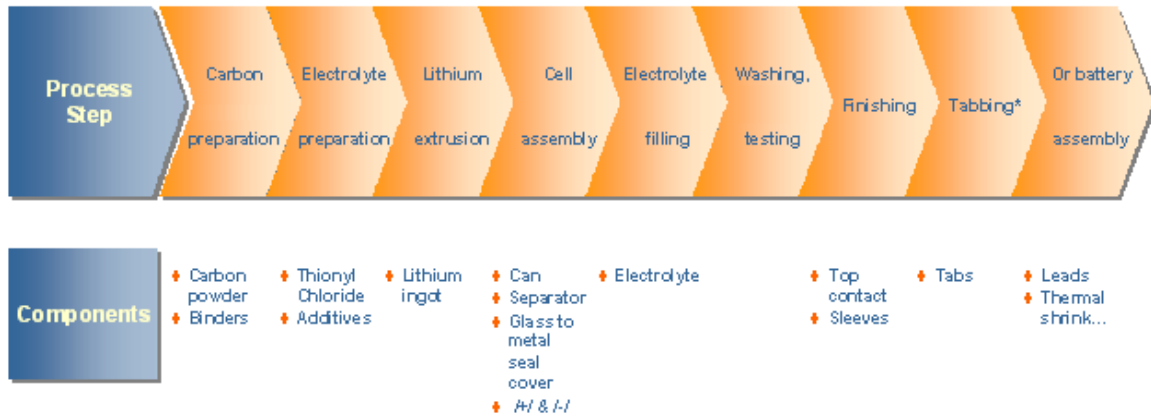


Figure 3: External differences on LS 17500

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4. Industrial means and manufacturing processes

The main steps of the cell manufacturing process are displayed in following chart.



The overall manufacturing flow chart is equivalent between the three production sites, with each step relying on Saft's specific processes.

For historical reasons, the carbon / polymer composite process in Poitiers differs from the process in place for the two other sites: one-part block in China & UK versus compressed grains in France. The resulting cathodes present the same electrical performances under customer's usual operating discharge rates (average discharge rates from few μA up to 1mA) for which the cells are defined.

Also, cells are filled from the center of the glass-to-metal seal for the Poitiers design, whereas the filling hole is offset from the center of the post for the South Shields and Zhuhai design. Such process difference leads to a different mechanical design of the cover and top finishing parts, which has no impact on the performances of the cells.

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5. Electrical performances

The 3 cells from the 3 locations are developed and qualified under the responsibility of one unique entity: the Civil Electronics Technical Team based in Poitiers.

It guarantees the closest definition between them and compliance to the same internal standards.

Same internal procedures have been implemented to ensure the daily quality survey for each product.

Regular follow-up meetings are in place to review battery performances and ensure continuity. These meetings / exchanges are mutually profitable for each site to solve day to day difficulties and all sites apply product and production improvements simultaneously at the same pace.

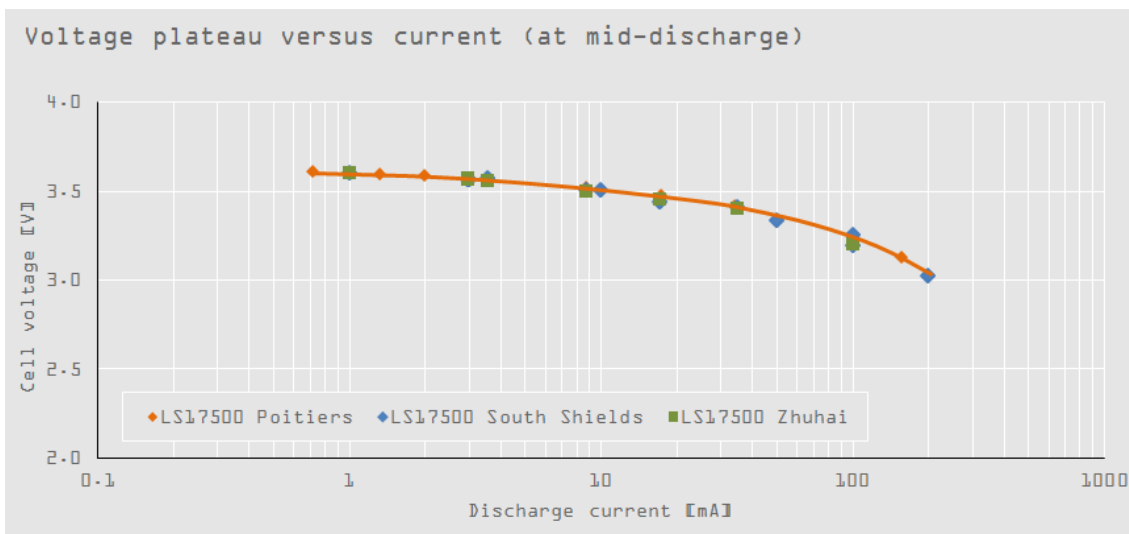


Figure 4: Voltage plateau comparison between Poitiers, South Shields and Zhuhai on LS17500 cells: performances under various discharge rates at RT.

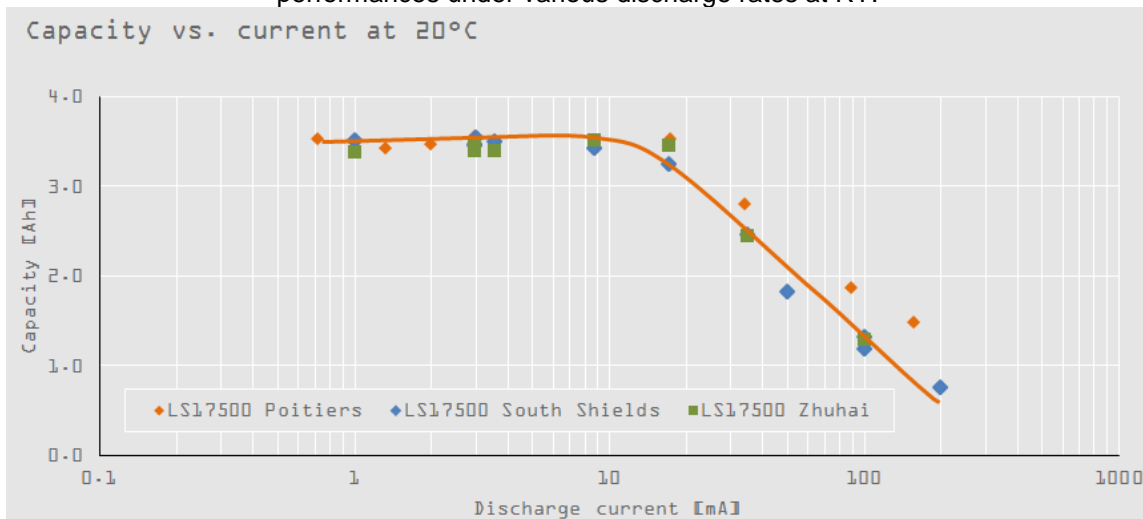


Figure 5: Capacity comparison between Poitiers, South Shields and Zhuhai on LS17500 cells: performances under various discharge rates at RT.

Perfect performance similarity (voltage response and discharged capacity) between the cells is achieved for standard discharge rates. Only extreme conditions show variances but for regimes far beyond the normal conditions of use of this cell.

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Some examples on electrical performances comparisons are shown in figures 6, 7 & 8 here after.

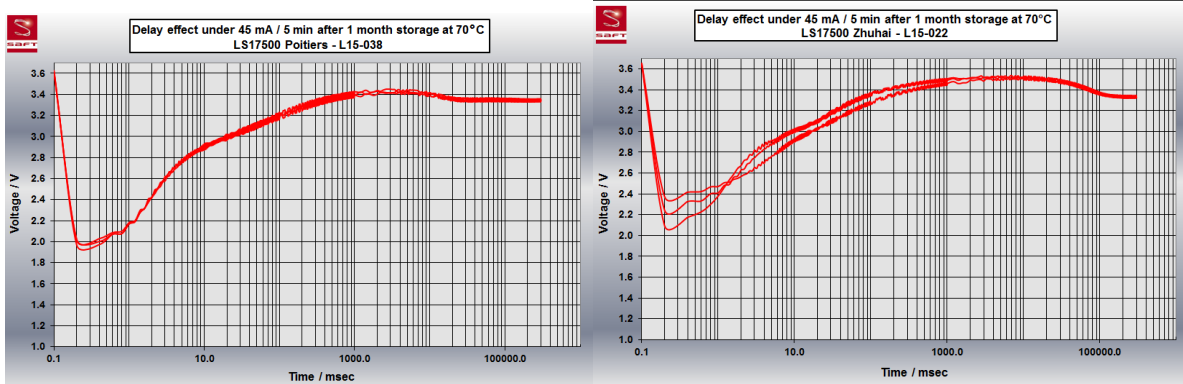


Figure 6: Delay effect comparison between Poitiers and Zhuhai on LS17500 cells during monthly quality survey: delay effect record under 45 mA pulse after 1 month storage at 70°C.

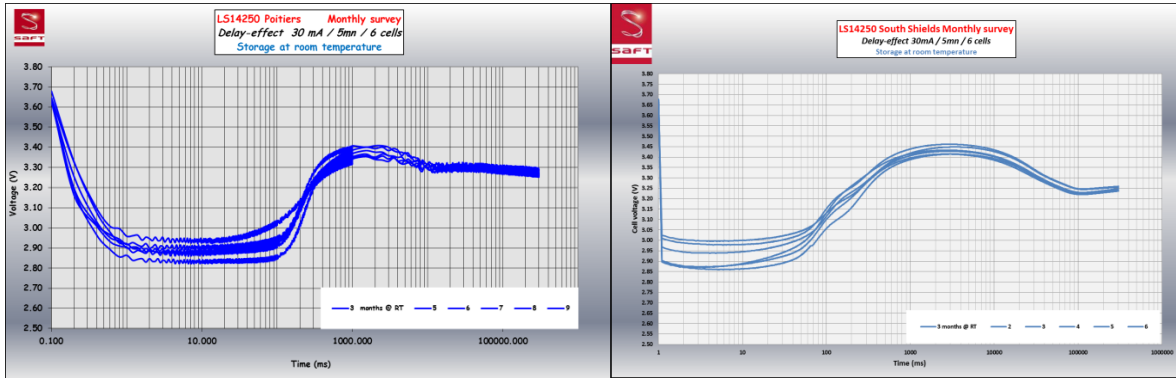


Figure 7: Delay effect comparison between Poitiers and South Shields on LS14250 cells monthly quality survey: delay effect record under 30 mA pulse after 3 month storage at room temperature.

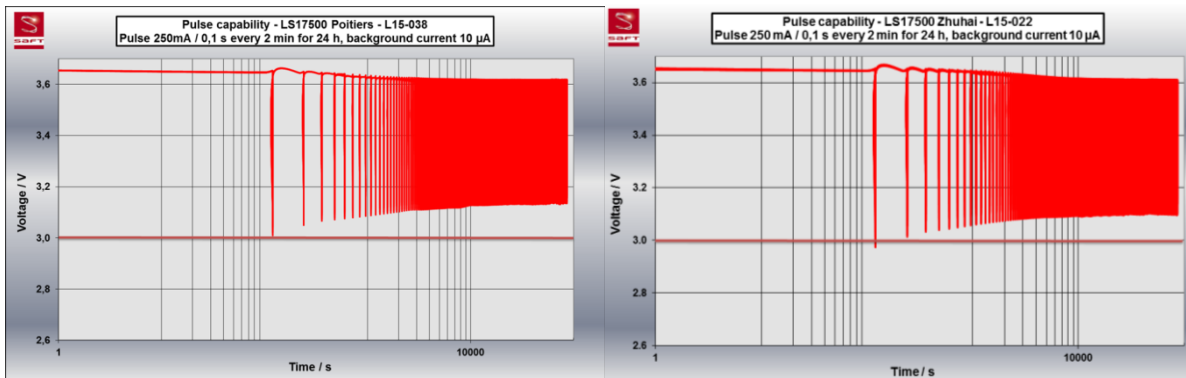


Figure 8: Pulse capability comparison between Poitiers and Zhuhai on LS17500 cells: 250 mA pulse response on fresh cells at RT (extreme conditions test).

Same behavior for the cells from the 3 locations.

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6. Compliance to standards

All cells comply with the applicable standards:

- ⇒ Safety:
 - UL: UL 1642 “Standard for lithium batteries”. All cells are recognized as "Technician Replaceable" by the Underwriters Laboratories Inc. under the file number MH 46911 (China plant), MH 12802 (U.K. plant), MH 12609 (France plant);
 - IEC 60079-11 intrinsic safety standard (compliant):
LCIE report N° 86372/577489 Cr – 14/06/2012

	Test ambient temperature (°C)	Cell	OCV (V)	Icc (A)	Ri (W)	Temperature rise (°C)
LCIE test	+40	LS17500	3.6	3.8	1	95
Saft internal test	+60	LS17500 France	3.70	3.4	1.13	114
		LS17500 UK	3.70	3.5	1.65	95
		LS17500 China	3.71	4.1	1.61	90

Table 1: IEC60079-11 3mOhm short-circuit test results comparison

- ⇒ Transport
 - All cells are non-restricted for transportation
 - All cells comply with UN recommendations for the transport of dangerous goods – Part III sub-section 38-3 of Manual of tests and Criteria
- ⇒ Environment
 - All cells are RoHS compliant
 - All cells are REACH compliant

7. Quality

On the 3 production sites we apply / use the same high quality standards for implementing new equipment, operating the production lines, controlling the processes and products.

The production plants are certified under:

- ISO9001 for France, China and UK plants
- ISO14001 for France and China plants.

The 3 plants undergo the same Saft “word class” program.



8. Life time duration

With the same technical specifications, same technical results during qualification and quality survey we were able to use the same mathematical models for life time estimation without any adjustment to the models for the products coming from the 3 factories.

Previous life time evaluations done on LS from Poitiers apply today with the same accuracy to batteries from South Shields or Zhuhai using the same revision of the model.

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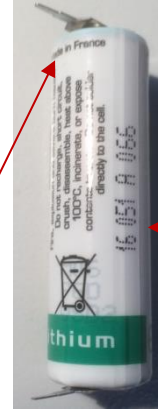
9. Traceability

Same internal rules for downstream (from battery assemblies to cells batches and raw material) and upstream (from raw materials to cells batches and battery assemblies) traceability applies in the 3 production sites, so as to be able to trace the root cause up to components level or raw material batch level in case of a problem with battery or cell.

Labelling rules are identical. Only slight differences are found regarding date code: goal is to identify country of origin without doubt.

The shrink sleeve basically displays:

- Cell designation: SAFT LITHIUM LS 14250 / LS 14500 / LS17500 according to type
- Nominal voltage: 3.6V
- +/- polarities
- UL logo
- Safety warning
- Crossed-out wheeled refuse bin logo
- Made in China or U.K. or France according to country of origin.
- Also the finish date code with :



Country	China	UK	France
Description	Year/Month/Day	Year/Day	Year/Day/traceability code
Example	16 02 23A	16 054	16 054 A023
Meaning	Cell finished the 23 rd February of year 2016. Internal batch code (A)	Cell finished the 54 th day of year 2016 (Feb 23)	Cell finished the 54 th day of year 2016 (Feb 23). Internal batch code (A023)

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