



# Li-SAFE methodology: User manual

*Lithium-ion Battery Safety Methodology*

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## 1. Introduction

This user manual gives information on the use of the Li-SAFE methodology.

## 2. Login Page

- Open <http://193.104.8.63> in a web browser
- The login screens appears
- Use login info to enter the portal
- The 'Home Page' opens

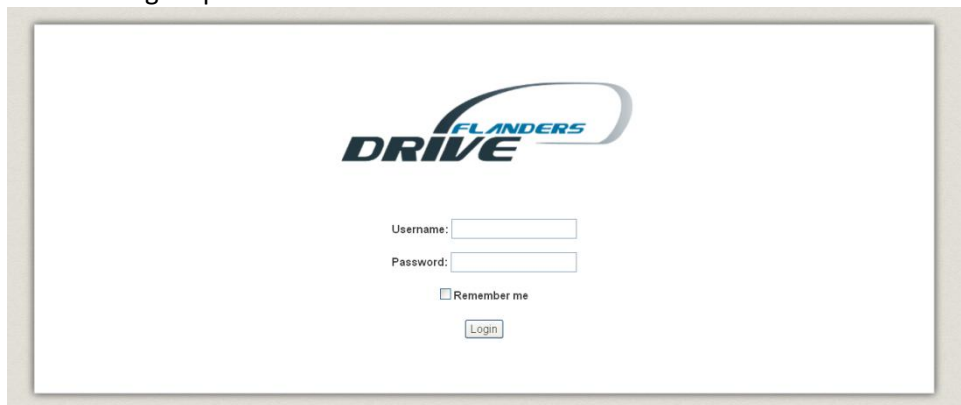


Figure 1: Login page

## 3. Home Page

The home page consists out 3 parts:

1. General introduction to the Li-SAFE portal
2. Left side menu give a list of functionalities:
  - 2.1 Search menu
  - 2.2 Link to the home interface
  - 2.3 Link to the top level interface
  - 2.4 Scaling parameters
  - 2.5 Query interface
  - 2.6 Table of the standard comparison
  - 2.7 Overview of the general information of the standards
  - 2.8 Glossary
  - 2.9 List with symbols and abbreviations
  - 2.10 Feedback function

These function are explained in detail in the following chapters

3. Tree-view of all the process of the battery lifecycle. By clicking on the process its information page opens

The version of the portal is indicated at the bottom of the page

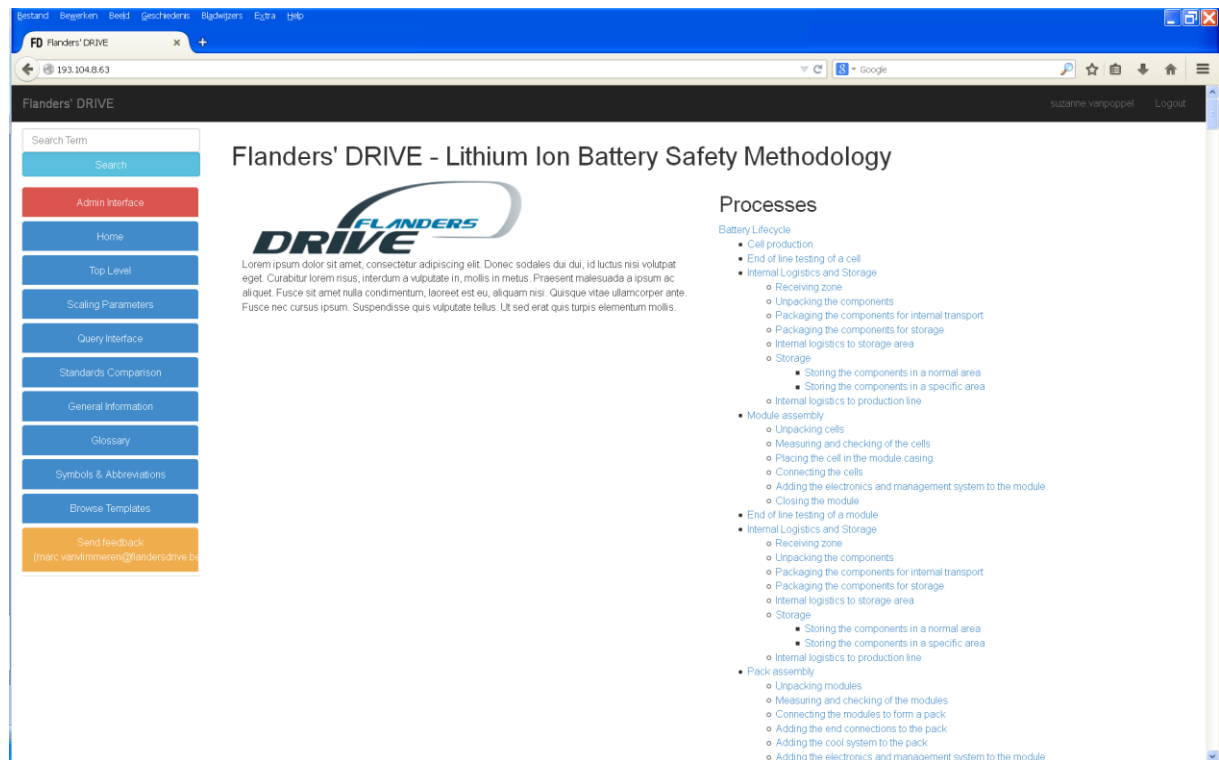


Figure 2: Li-SAFE home page

#### 4. Navigation through the Li-safe Battery lifecycle

The Li-SAFE portal gives for each process in the battery lifecycle relevant safety information from the standards, recommendations, materials and components. Two options are available to navigate through the lifecycle:

- Navigation via the graphs
- Navigation via the list of processes

##### 4.1 Navigation via the graphs

###### 4.1.1 Top level graph

The top level graph can be opened via the 'left side menu'. This graph gives the complete lifecycle. The lifecycle exists of

- Sub flows (rectangles with a dashed line)
- Steps (rectangles with solid lines)
- Decision: red arrow indicates the 'no' path, green arrow the 'yes' path

As an example the following figure gives a part of the complete life cycle

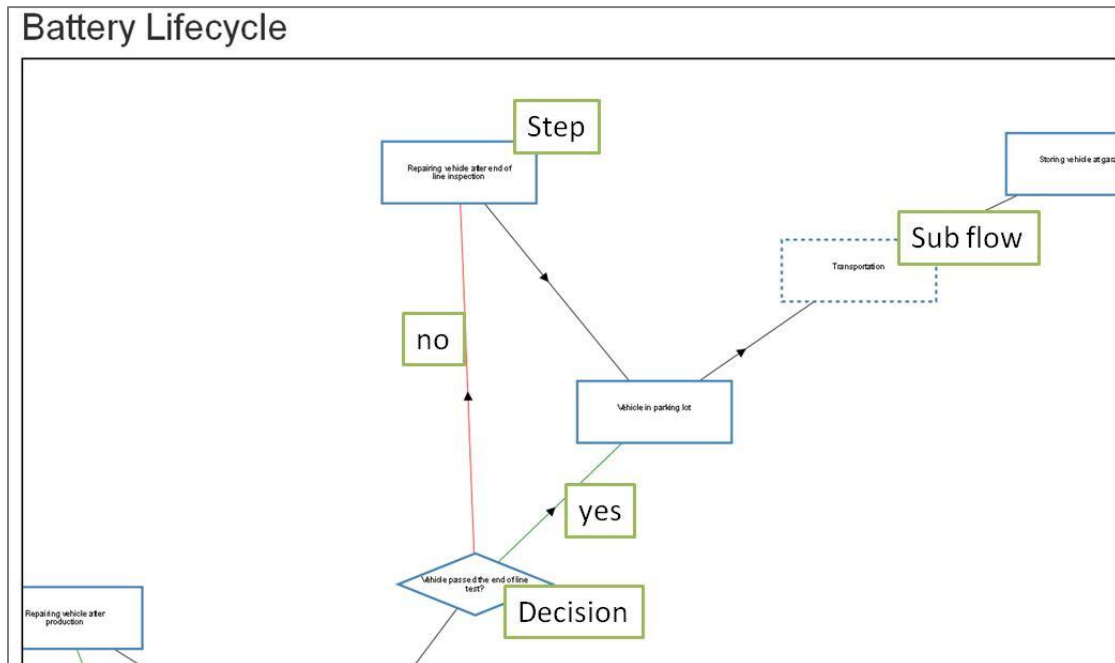


Figure 3: Part of the lifecycle graph with examples of a sub flow, a step and a decision

By clicking on a sub flow or step, the corresponding information page of the sub flow or step opens.

In the graph it is possible to:

- Zoom in and out:
  - o Place pointer on the block on the lifecycle where you want to zoom in and out
  - o Scroll with the 'mouse wheel' to zoom
- Drag the figure in various directions:
  - o Place pointer on a block in the lifecycle
  - o Click and hold left mouse button
  - o Move the mouse to move the graph

#### 4.1.2 Sub flow graph

For each sub flow a graphical representation is given in its information page. Just like the top level flow, a sub flow can exist of sub flows, steps and decision. These elements are represented in the same way as in the top level graph.

By clicking on a sub flow or step, the corresponding information page of the sub flow or step opens. The graph has the same zooming and dragging functionalities

#### 4.2 Navigation via list of processes

At the right side of the home interface a list of the processes is given. By clicking on the step or sub flow, the corresponding information page opens.

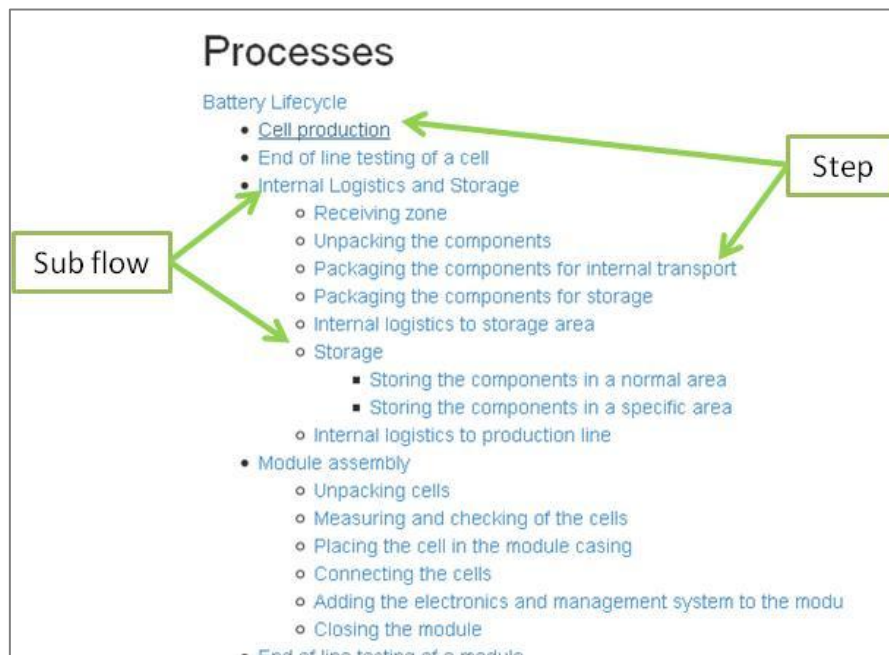


Figure 4: Part of the list of processes in the Home-interface

## 5. Flow and step interfaces

### 5.1 Flow interface

The flow interface consists of the following parts:

1. Description: the description gives detailed information of the flow, the purpose and scope and the structure of the process
2. List of information clauses which are valid for the process. The list of these clauses is divided into 5 parts:
  - Requirements
  - Recommendations
  - Materials
  - Components
  - Test Laboratories

Figure 5 gives an example of a flow interface with only requirements clauses.
3. Graphical representation of the flow.

In the flow interface the 'Export to excel'-function is available (orange button below the description). This function allows the user to export the list of information to an excel file. The information of each of the five parts is stored in a separate excel-sheet.

Flow details: Module assembly

Description

**Purpose and scope**

This process gives all the details of the assembly of a module. The module producer needs to know how to cope with cells and with modules and the risks of these products

**General considerations for the complete assembly process**

For the complete assembly line and area around it (complete factory) shall be as clean and orderly as possible to prevent contamination of the end product which may effect its operations. Contact of foreign objects with circuits or cells shall be avoided. During the assembly precautions shall be taken to avoid damages to cells, battery management circuit, module itself, conductors and insulators, short circuit shall be avoided. Circuits and other devices shall be protected from electrostatic discharge during handling.

All protection functions shall be documented. A quality control and a maintenance plan to control the consistency of the assembly process and adherence to specification shall be available for critical processes

A statistical process control function shall be in place at the module assembler. Complete records of the packs, cells, assembly dates, assembly lines, and pack designs shall be maintained for a minimum of seven years. Manufacturers may standardize lot sizes to simplify record keeping and traceability

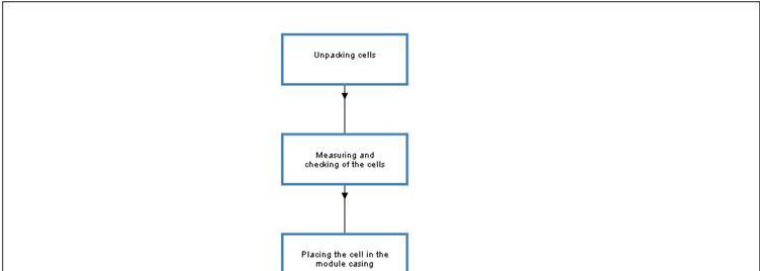
**Structure of the process**

The process starts with the unpacking and checking of the cells. When the cells are good they can be put into a casing. After the connection of the cells electronics and a management system can be added to be able to monitor the module. If necessary the module is closed in the last step.

[Export to Excel](#)

Requirements ( 14 results)

Detail	Tag	Clause Number
<a href="#">Detail</a>	IEEE 1625-2004	6.8.2
<a href="#">Detail</a>	IEEE 1625-2004	6.8.3.2
<a href="#">Detail</a>	IEEE 1625-2004	6.8.3.3
<a href="#">Detail</a>	IEEE 1625-2004	6.8.3.4
<a href="#">Detail</a>	IEEE 1725-2011	6.11.1
<a href="#">Detail</a>	IEEE 1725-2011	6.11.2
<a href="#">Detail</a>	IEEE 1725-2011	6.11.5
<a href="#">Detail</a>	IEEE 1725-2011	6.12.2
<a href="#">Detail</a>	IEEE 1625-2004	6.8.3.5
<a href="#">Detail</a>	IEEE 1625-2004	6.8.3.6
<a href="#">Detail</a>	IEEE 1725-2011	6.12.4
<a href="#">Detail</a>	IEEE 1625-2004	6.10
<a href="#">Detail</a>	IEEE 1625-2004	6.10.1
<a href="#">Detail</a>	IEEE 1625-2004	6.10.2



```

graph TD
    A[Unpacking cells] --> B[Measuring and checking of the cells]
    B --> C[Placing the cell in the module casing]
  
```

Figure 5: example of a flow interface



## 5.2 Step description

The step interface consists of the following parts:

1. Description: the description gives detailed information on the process step
2. List of information clauses which are valid for the process. The list of these clauses is divided into 5 parts:
  - Requirements
  - Recommendations
  - Materials
  - Components
  - Test Laboratories
3. If applicable the following information can be added:
  - Work products and templates which can be used in the process step (eg. Vehicle user manual can be work product from the Vehicle Design and Development process)
  - The roles and responsibilities for the process step can be defined. The following roles can be used:
    - Responsible (R)
    - Accountable (A)
    - Consulted (C)
    - Informed (I)

In the step interface the 'Export to excel'-function is available (orange button below the description). This function allows the user to export the list of information to an excel file. The information of each of the five parts is stored in a separate excel-sheet.

## 6. Scaling

One of the main assets of the platform is the possibility to scale the safety-related information with respect to the following parameters:

- Product type: cell, module, pack, vehicle, damaged cell, damaged module, damaged pack
- Application type: automotive, bicycle, portable application, ...
- Activity: assembling, packing, labelling, ...
- Process: cell production, module assembly, storage, transportation, ...
- Region: Europe, US, international, Japan, ...
- Standard body: ISO, IEEE, IEC, ...
- Standard: scaling on specific standard for which info is available in the portal

The scaling has influence on:

- **The graphs:** steps, decisions and flows for containing information which is not applicable for the selected scaling parameters will be greyed out and it is not possible to click on these elements.

Figure 6 gives a part of the top level scaled to product type cell or damaged cell. Almost all processes on module level are scaled out except those in which cells are still handled separately. All processes on 'Cell level' are still 'active'. The greying out is also implemented in the sub flow graphs.

Figure 7 gives as an example the flow 'Module assembly' in which in the first steps cells are handled. The steps in which only modules occur, are scaled out.

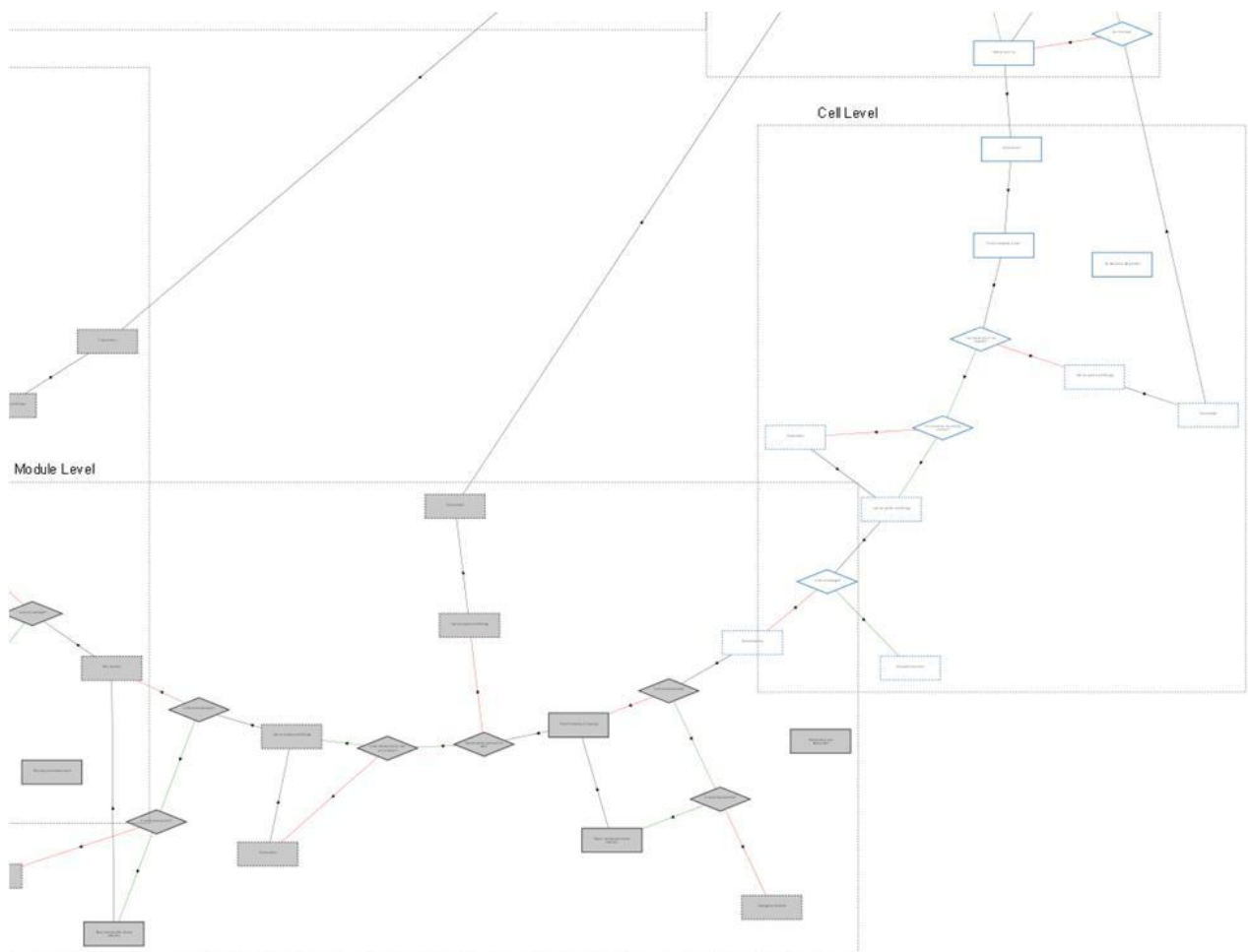
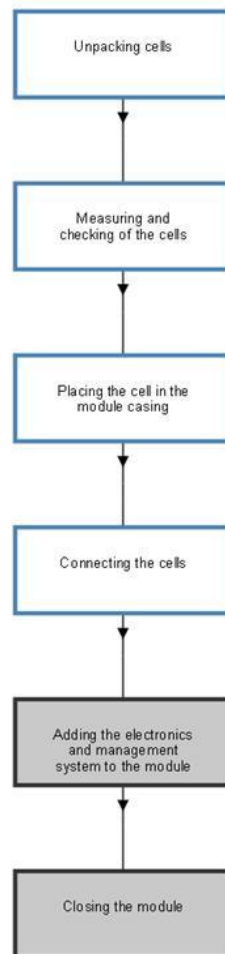


Figure 6: Part of the top level flow scaled on 'prodType = cell or damaged cell'



**Figure 7: Flow 'Module assembly' scaled on prodType = cell**

- The **list of information clauses** in the flow and step interface: only those clauses for which the scaling parameters are valid will be shown.
- The **description** of the process: parts of the description which are not valid for the scaling parameters will be removed.

Example: Step 'Connecting the cells'

Figure 8 gives as example the step 'Connecting the cell' scaled on product type cell. The top of the figure gives the not scaled content of the steps with the requirements and recommendations. The second part shows how this information is scaled. The requirements are concerning modules so they are scaled out and description which gives information on handling modules after the cells are connected is removed.

- **Exporting function**: only the scaled set of information will be exported to excel
- **Search and query function** will only use the scaled set of information
- **Standard comparison table** will be scaled down. If scaled on 'cell', only those standards which are applicable on cells will be shown.

## Step details: Connecting the cells

### Description

The electrical connection between the cells can be made when the cells are in the casing. To avoid leakage from the cells or from the resulting module, no blunt tooling shall be used. The cells and the resulting module form can be external short circuited. Precautions to avoid this shall be taken: covering one current connector of a cell but also of the module once all cells are connected.

To avoid decrease the severity of injuries caused by electrical short circuit or leakage, safety gloves and glasses shall be used.

When connections are soldered, precautions shall be implemented to ensure sufficient solder flux activation to avoid incomplete solder connections.

During welding and other operations, no damage to cell container and critical cell design elements may occur.

Samples from the tab welding station shall be taken and subjected to a pull test.

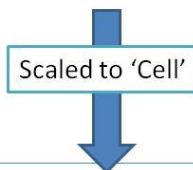
[Export to Excel](#)

### Requirements (6 results)

Detail	Tag	Clause Number
<a href="#">Detail</a>	IEEE 1625-2004	6.8.3.1
<a href="#">Detail</a>	IEEE 1625-2004	6.8.3.7
<a href="#">Detail</a>	IEEE 1625-2004	6.12.5.4
<a href="#">Detail</a>	IEEE 1725-2011	6.11.3
<a href="#">Detail</a>	IEEE 1725-2011	6.12.1
<a href="#">Detail</a>	IEEE 1725-2011	6.12.5

### Recommendations (4 results)

Detail	Name
<a href="#">Detail</a>	Cover current collector
<a href="#">Detail</a>	Use safety gloves and glasses when handling cells
<a href="#">Detail</a>	Cell enclosure resistant against mechanical abuse
<a href="#">Detail</a>	Avoid blunt tooling



## Step details: Connecting the cells

### Description

The electrical connection between the cells can be made when the cells are in the casing. To avoid leakage from the cells or from the resulting module, no blunt tooling shall be used. The cells and the resulting module form can be external short circuited. Precautions to avoid this shall be taken: covering one current connector of a cell but also of the module once all cells are connected.

To avoid decrease the severity of injuries caused by electrical short circuit or leakage, safety gloves and glasses shall be used.

[Export to Excel](#)

### Recommendations (4 results)

Detail	Name
<a href="#">Detail</a>	Cover current collector
<a href="#">Detail</a>	Use safety gloves and glasses when handling cells
<a href="#">Detail</a>	Cell enclosure resistant against mechanical abuse
<a href="#">Detail</a>	Avoid blunt tooling

**Figure 8: Example of scaling of description and list of clauses**

## 7. Functionalities in 'Left side menu'

This chapter describes the functions in the 'Left side menu'

### 7.1 Search

Search functionality which search in the content of the 5 information clauses, steps and flows. The search functionality doesn't search in the database of the glossary, symbols and abbreviations lists and also not in the document (work products or guidelines). The results are grouped per type and are exportable to excel.

The results are affected by the scaling parameters

### 7.2 Admin interface

*Note: this button is only available for users with administrator privileges*

Via this link, the administrator can open the administrator interface. In this interface the admin can:

- Add or delete user
- Add new information clauses
- Define new flows and steps
- Add content to the description of the flows and steps

### 7.3 Add note

The 'Add note'-button appears when a step or flow interface is opened. The function allows the user to add notes to a step or a flow, to edit the note and to remove it.

- Adding a note: when clicking on the 'Add note'-button, a text field appears with 'Note content'.



Figure 9: text field to add a note

- The user can type a note in the field and this note can be saved via the 'Save note'-button.



Figure 10: Adding and saving a note

- When the user reopens the step or flow, the note will be displayed directly and not the 'Add note'-button
- To remove the note, the user needs to delete the text and press 'Save note'. The note is deleted and the text field will be replaced by the 'Add note'-button

Notes are only viewable by the user who has made them.

#### **7.4 Home**

Link to go to the home page.

#### **7.5 Top level**

Link to go to the top level flow

#### **7.6 Scaling parameters**

This is the function in which the users can select the scaling parameters. For each scaling parameter a list with possible values is given. The values for the parameters can be selected, deselected as follows

- The user can select a value by 'left-clicking' on the wanted value.
- Multiple values can be selected by 'Ctrl + left-clicking' on the wanted values
- Values can be removed by 'Ctrl + left clicking' on the already selected values
- The new set of values (selected or deselected) need to be saved by clicking the 'Save' button at the end of the page
- All selected values can be removed by clicking the 'Reset button at the end of the page. This results in a none scaled process.

Some notes:

- If no scaling values are selected, the portal is not scaled and all information is available
- It is possible to scale only on 1 scaling parameters. Information which doesn't have a value for that parameter will still be shown.

Example:

The portal is scaled to Region = US, materials don't have a parameter 'region'. They will not be scaled out.

#### **7.7 Query interface**

The query page is another type of search page in which the user can look for requirements concerning the same topics. The user can select the standard, the requirement type, requirement sub type, test type and clause type. The possible values for these query parameters depend on the scaling and the selected values of the previous query parameters.

#### **7.8 Standard comparison**

The standard comparison gives an overview of all tests and standards described in the portal. For each type of test it indicates which standards give a procedure for this test type. Figure 11 shows a part of this table. The columns give the standards and the rows the tests.

Test Type	ISO 12405	ISO 6469	IEC 62660	IEC 60068	IEC 62281	IEC 62133	SAE J2464	SAE J1798	SAE J2380	SAE J2929	NEN-EN 15194	UL s1642	UL s2054	UL 2580	IEEE 1625	IEEE 1725	JIS C 8714	UN Regulation No. 100	UN Manual of Tests and Criteria
Dewling (temperature change)	X									X									
Temperature cycling	X		X		X		X			X		X	X	X				X	X
Vibration	X		X	X	X				X	X		X	X	X	X			X	X
Shock	X	X	X		X		X			X		X	X	X				X	X
External short circuit	X	X	X		X	X	X			X	X	X	X	X	X	X	X	X	X
Abnormal charge	X		X		X	X	X			X		X	X	X		X	X	X	X
Insulation resistance		X												X				X	

Figure 11: Part of the comparison table

When the user clicks on a standard name the general information is shown for this standard. This information gives the scope, the normative references and the general requirements of the standard. When the user clicks on the test type, all clauses of all the standards considering this test type are listed. The user can also click on a specific test-standard combination. This gives directly the list of clauses from the selected standard for the specific test.

The comparison table is influenced by the scaling parameters. It only gives those standards which are valid for the chosen set of parameters.

## 7.9 General information

For every standard a general information page is made. This gives information on the scope, the normative references and the general requirements of the standard. The list gives the titles of all standards. By clicking on the detail-button, the page with the general information opens.

## 7.10 Glossary

Link to the glossary list. By clicking on the detail button next to the term, the glossary for that term from the different standards is given.

Flanders' DRIVE - Glossary	
Detail	Term
<a href="#">Detail</a>	Battery electric vehicle
<a href="#">Detail</a>	Hybrid electric vehicle
<a href="#">Detail</a>	Rated capacity
<a href="#">Detail</a>	Capacity
<a href="#">Detail</a>	Reference test current
<a href="#">Detail</a>	Room temperature
<a href="#">Detail</a>	Secondary lithium ion cell

Flanders' DRIVE - Glossary - Rated capacity				
Standard	Term	Src	Description	Explanation
Li-SAFE	Rated capacity		capacity value of a battery determined under specified conditions and declared by the manufacturer	
IEC 62660 - 1	Rated capacity	3.3	quantity of electricity C3 Ah (ampere-hours) for BEV and C1 Ah for HEV declared by the manufacturer	
IEC 62660 - 2	Rated capacity	3.3	quantity of electricity C3 Ah (ampere-hours) for BEV and C1 Ah for HEV declared by the manufacturer	
IEC 62133	Rated capacity	3.17	quantity of electricity C5 Ah (ampere-hours) declared by the manufacturer which a single cell can deliver when discharged at the reference test current of 0,2 It A to a specified final voltage, after charging, storing and discharging under specified condi	
IEC 60050 482	Rated capacity	482-03-15	capacity value of a battery determined under specified conditions and declared by the manufacturer	
IEC 62281	Rated capacity	3.24	capacity value of a cell or battery determined under specified conditions and declared by the manufacturer	Note 1 to entry: The following IEC rated capacity: IEC 61960, IEC 62 modified – inclusion of "a cell or b
ISO 12405 - 1	Rated capacity	3.12	supplier's specification of the total number of ampere hours that can be withdrawn from a fully charged battery pack or system for a specified set of test conditions, such as discharge rate, temperature and discharge cut-off voltage	
ISO 12405 - 2	Rated capacity	3.13	supplier's specification of the total number of ampere hours that can be withdrawn from a fully charged battery pack or system for a specified set of test conditions such as discharge rate, temperature, and discharge cut-off voltage	
UN 38.3	Rated		the capacity, in ampere-hours, of a cell or battery as measured by subjecting it to a load,	

Figure 12: Glossary list and example of description list for 'Rated capacity'

### 7.11 Symbols and abbreviations

Link to the list of symbols and abbreviations. By clicking on the detail button next to the symbol or abbreviations, information of the standards on the selected symbol or abbreviation is given.

### 7.12 Browse templates

A link to an interface which gives a complete overview of the work products, templates and guidelines. Every document is downloadable.

### 7.13 Send feedback

When the user encounters problems or bugs, this feedback can be given via a mail to the administrator. By clicking on the feedback button, an email opens automatically in which the information can be filled in.