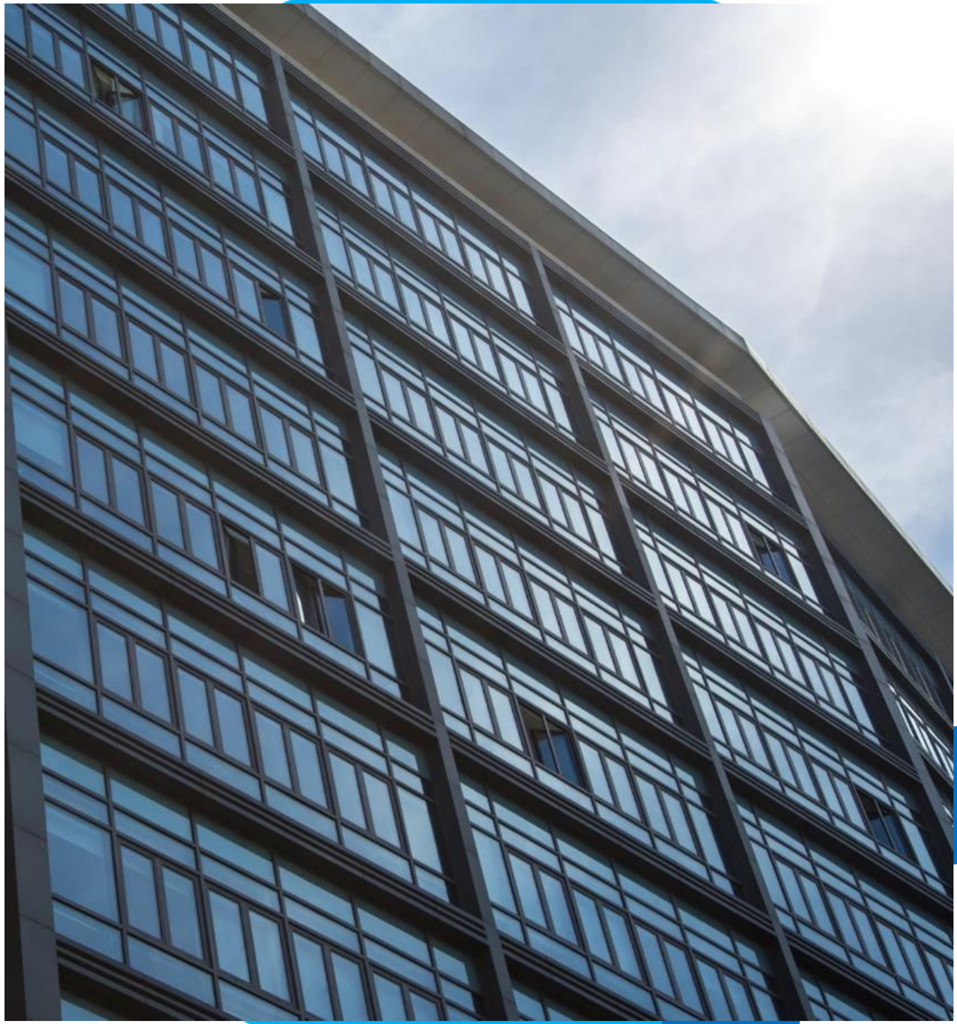
# Hazard-based Classification System for Lithium Batteries



Ting Xu, Hong-Hui Wang

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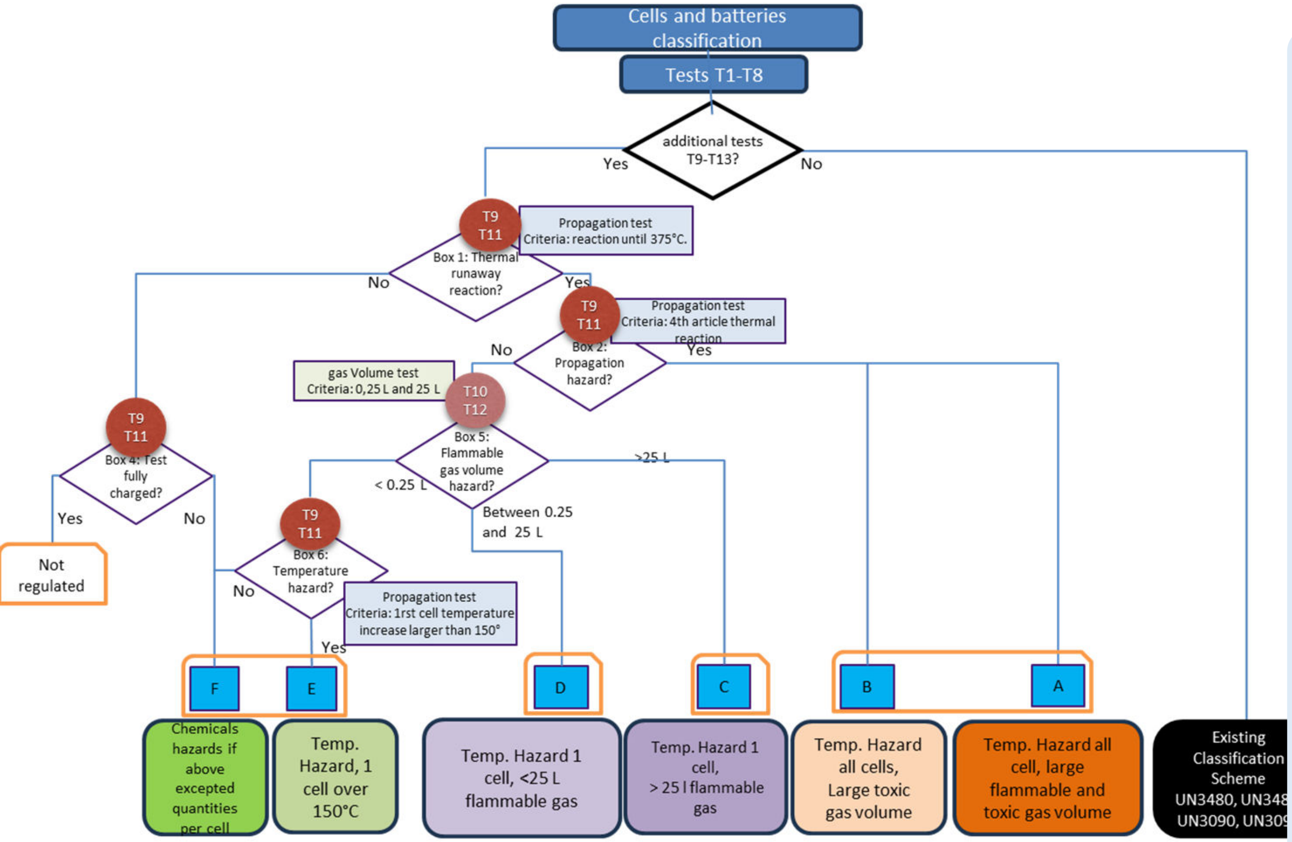
Shanghai Institute of Chemical Industry Testing Co. Ltd.

# Part 3. Packing Instruction

# 3.1 Flowchart

The 6 or more categories (based on gas, temp., TP hazards) can be merged into **3 types** (based on TP hazard)




**3 Hazard factors**

① Thermal runaway & thermal propagation;

② Gas volume: 0.25, 25, 500L;

③ High temperature: ΔT>150℃;

**4 Tests**

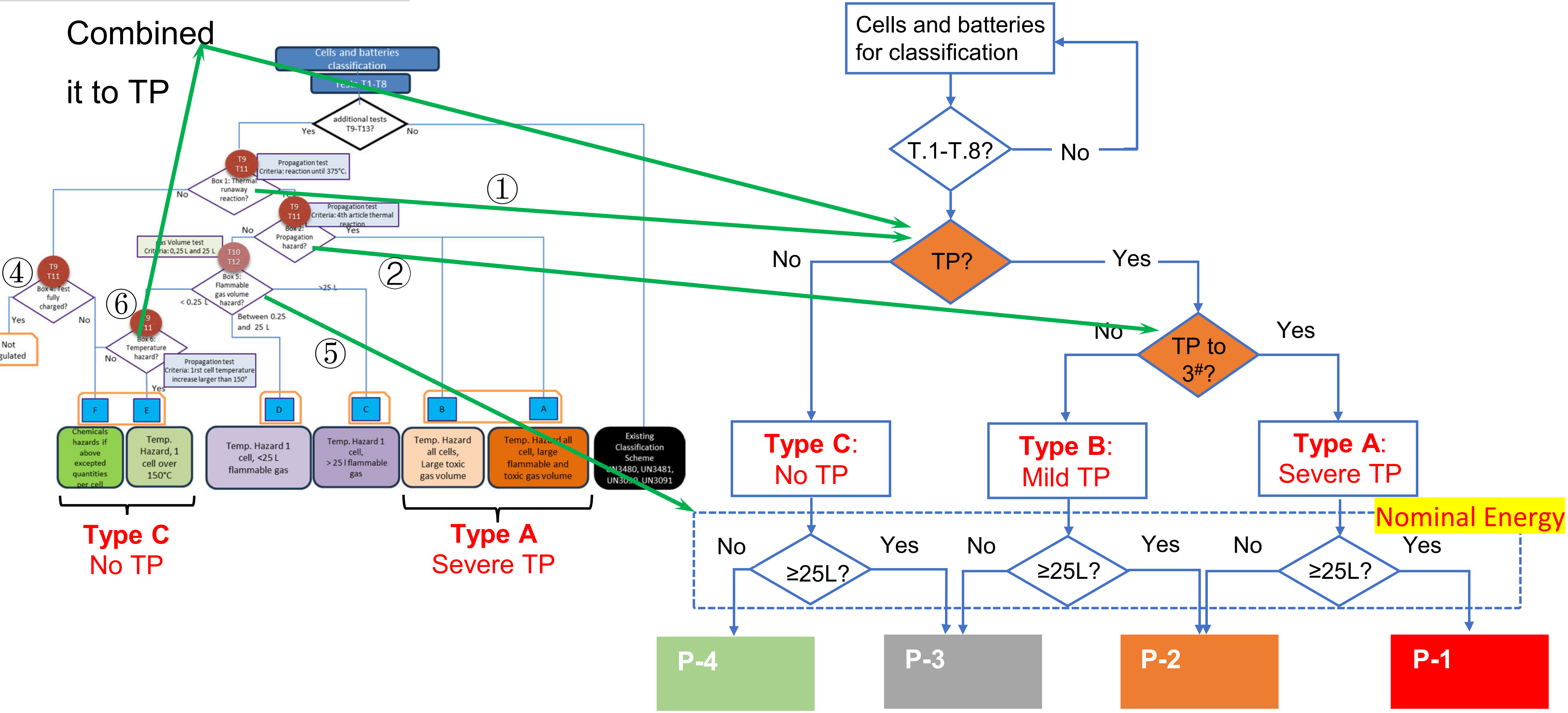
① Test T.9: Cell propagation test

② Test T.10: Cell gas volume determination

③ Test T.11: Battery propagation test

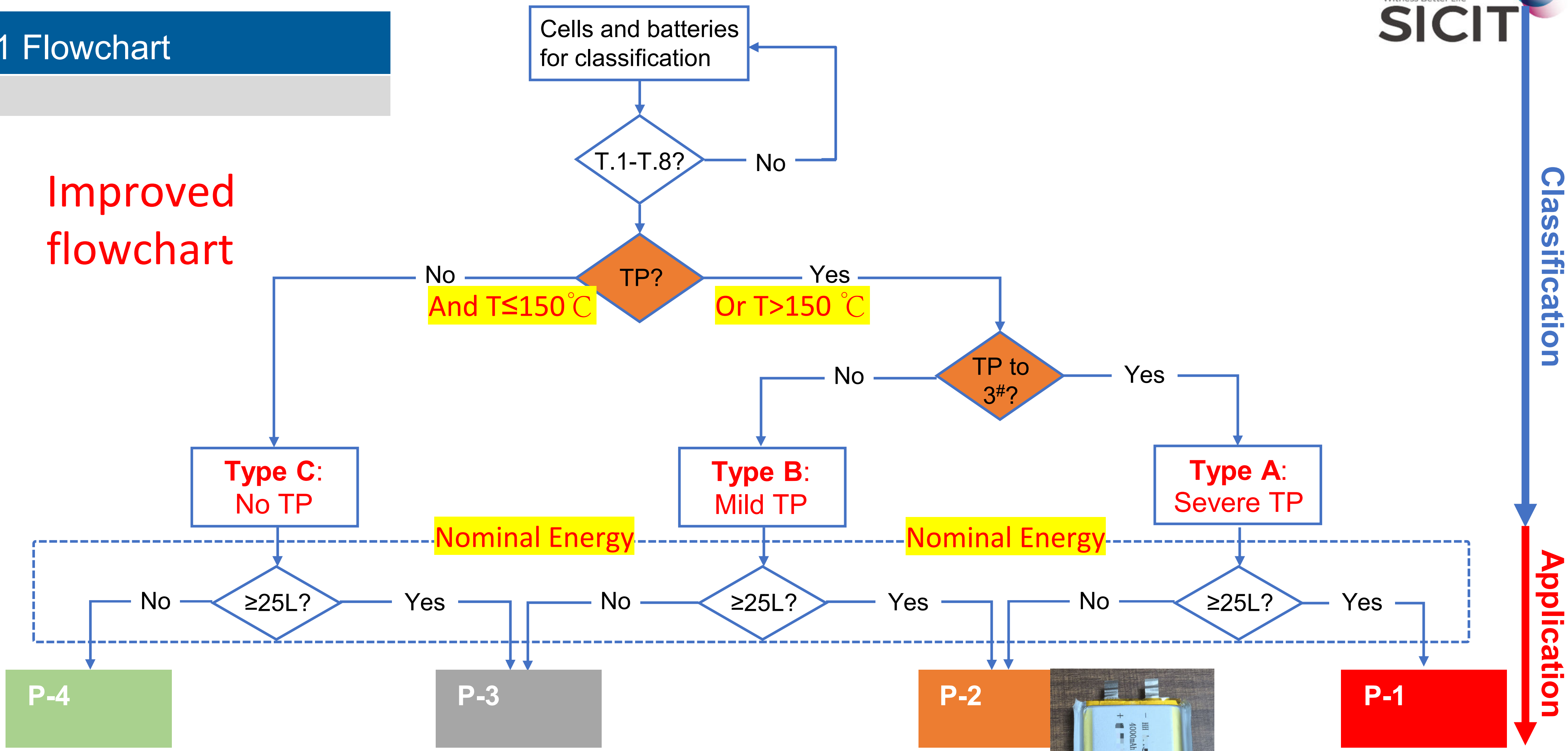
④ Test T.12: Battery gas volume determination

# Comparison of the two flowcharts



# 3.1 Flowchart

Improved flowchart




## 3.1 Flowchart

□ The **constant $\boldsymbol{V_E}$** can be used to evaluate the gas volume by the **nominal energy** very quickly, instead of tests.

e.g. For a lithium-ion cell with $E_n$=80Wh, $\boldsymbol{V}_{E\text{-}NCM}$=0.54L/Wh， $\boldsymbol{V}_{E\text{-}LFP}$=0.25L/Wh;

The generated gas $\boldsymbol{V_g}$ during TR is about

(1) NCM: 80×0.54=**43.2L** (2) LFP: 80×0.25=**20L**

**For ease of calculation:**

$V_{E\text{-}NCM}$=0.50L/Wh， $V_{E\text{-}LFP}$=0.25L/Wh

If the gas volume is limited to 25L, the corresponding limited nominal energy can be calculated easily：

$E_n$=50Wh (NCM)， $E_n$=100Wh (LFP)

## 3.2 Application

Determine the transportation conditions based on the T.9 test results and the gas volume $V_g$ or $E_n$

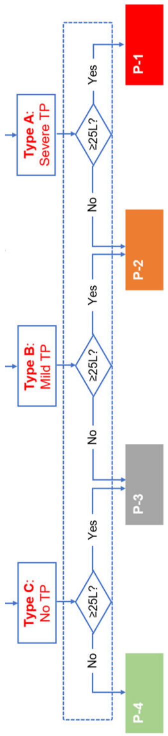
| Type | $V_g \leq 25L$ Equivalent to $E_n \leq 50Wh$ (NCM) $E_n \leq 100Wh$ (LFP) | | |
|---|---|---|---|
| | |  | P-1 |
| A | **UN4000**<br>**UN PG II→P-2, PXX** |  | P-2 |
| B | UN3480<br>PG II→P-3, P903 |  | P-3 |
| C | Non-restricted goods<br>P-4, SP188 |  | P-4 |

| Type | $V_g > 25L$ Equivalent to $E_n > 50Wh$ (NCM) $E_n > 100Wh$ (LFP) |
|---|---|
| A | **UN4001**<br>**UN PG→P-1, P911** |
| B | **UN4000**<br>**UN PG II→P-2, P9XX** |
| C | UN3480<br>PG II→P-3, P903 |

Note: Gas volume generated from cell/battery TR, $V_g = V_E \times E_n$

## 3.3 Packing Instruction

Based on the TP capability and gas volume(or nominal energy) , **4** levels of the packaging (from **P-1 to P-4**) is required with **4** kinds of packing instructions (**only 1 new PI should be added**).




| Packing Instruction | Test items | Requirements |
|---|---|---|
| P911 | Drop test<br>Stack test<br>Additional tests | ① Heat insulation<br>② Toxic gas absorption<br>③ No flame and projectiles<br>④ Flame retardancy<br>⑤ Pressure relief |
| New PI<br>P9XX | Drop test<br>Stack test<br>Additional tests | ① .<br>② .<br>③ .<br>④ Pressure relief<br>⑤ Flame retardancy |
| P903 | Drop test<br>Stack test | ① .<br>② .<br>③ .<br>④ Pressure relief<br>⑤ . |
| SP188 | Drop test | / |



P-1
P-2
P-3
P-4

# P 911 & P-1 package

**P911 for P-1 package** applied to lithium ion/metal, sodium ion cell or battery of **Type A** with **$V_g$≥25L**

☐ **PG I** performance level.

① **Heat insulation**, the outside surface temp.≤100°C, the temp. at the exhaust outlet ≤200 °C; with full load of 100%SOC cells or batteries.

② **Toxic gas filtration system**, $c_{HF}$ at the exhaust outlet ≤ 45ppm;

③ **No flame and projectiles** come out from the package;

④ **Flame retardancy**, the inner packaging material should be non-combustible sufficient.

⑤ **Explosion prevention** and **pressure relief**, the average internal pressure ≤ 1bar during TR.

⑥ The **high structural integrity** of the package shall be maintained;

# P903 & P-2 package

**P922 for P-2 package** applied to lithium ion/metal, sodium ion cell or battery of **Type A** with **$V_g$<25L** or **Type B** with **$V_g$≥25L**

- **PG II** performance level.

③ **No projectiles** come out from the package;

④ **Flame retardancy**, the exterior and inner the inner packaging material should be non-combustible sufficient.

⑤ **Pressure relief**: A venting device when appropriate.

⑥ The **high structural integrity** of the package shall be maintained;

## 3.5 Brief summary

- In summary, we propose a new set of packing instructions—comprising four package types (P-1 to P-4)—for the safe transport of lithium batteries. It aligns well with existing regulations.
- The classification is based on the outcomes of the T.9/T.11 tests (Types A, B, C) combined with the gas volume (or the nominal energy) of the cells.
- Based on the TP capability and gas volume(or nominal energy), it is easy to set the testing items (drop test, stack test…) and requirements (heat insulation, toxic gas absorption…) for each package level.

As time was limited, this content may not be exhaustive and can be refined further in the future.

Thanks for your listening!

Ting Xu xt@ghs.cn
+86 158-0061-6132
Hong-Hui Wang whh@ghs.cn
+86 130-7213-9895