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WORKING PAPER

DANGEROUS GOODS PANEL (DGP) WORKING GROUP MEETING (DGP-WG/26)

Centurion, South Africa, 26 to 30 October 2026

Agenda Item 4: Managing safety risks posed by the carriage of energy storage devices by air (Ref: Job Card DGP.006)

HAZARD-BASED CLASSIFICATION SYSTEM FOR LITHIUM ION, SODIUM ION AND LITHIUM METAL CELLS AND BATTERIES DEVELOPED BY THE UN INFORMAL WORKING GROUP

(Presented by the Secretary)

SUMMARY

This working paper presents proposed amendments to the UN Model Regulations and the UN Manual of Tests and Criteria developed for the consideration of the UN Sub-Committee of Experts on the Transport of Dangerous Goods by its informal working group on lithium batteries. The amendments are intended to support a hazard-based classification system for lithium ion, sodium ion and lithium metal cells and batteries. The system establishes test criteria for assigning cells and batteries to one of five categories based on thermal runaway, propagation, gas generation and temperature increase characteristics. The proposals, including the detailed test conditions, remained subject to validation and possible further modification at the time of their publication. They will be considered for finalization, with any necessary modifications, at the sixty-ninth session of the UN Sub-Committee of Experts on the Transport of Dangerous Goods (Geneva, 23 November to 1 December 2026). The DGP-WG is invited to review the proposals, identify any gaps that could prevent the system from meeting aviation safety needs, and provide feedback for submission by the Secretary to the sixty-ninth session of the UN Sub-Committee.

1. INTRODUCTION

1.1 The need for additional operational controls to mitigate aviation-specific risks posed by lithium batteries was raised by the Air Navigation Commission (ANC) and the Council during their consideration of recommendations that led to the establishment of the initial 30 per cent state-of-charge

limit for UN 3480 — **Lithium ion batteries** and the prohibition on their transport as cargo aboard passenger aircraft. ICAO advised the forty-ninth session of the UN Sub-Committee of Experts on the Transport of Dangerous Goods (subsequently referred to, for the sake of brevity, as the UN Sub-Committee) (Geneva, 27 June to 6 July 2016) of these restrictions and the factors that led ICAO's governing bodies to adopt them, including the lack of a mechanism to identify and communicate to the operator the specific hazards associated with each type of battery and cell offered for transport (ST/SG/AC.10/C.3/2016/39). The Sub-Committee subsequently established an informal working group on lithium batteries and mandated it to consider a hazard-based system for classifying lithium batteries and cells for transport. ICAO hosted the group's first meeting in Montréal from 27 to 29 March 2017. The group has had numerous face-to-face and virtual meetings since then to develop a system.

1.2 An update on the latest version of the system was provided to the sixty-eighth session of the UN Sub-Committee (Geneva, 30 June to 8 July 2026). The system establishes test criteria for assigning cells and batteries to one of five hazard categories according to whether thermal runaway occurs, whether it propagates, the volume of gas generated and the resulting temperature increase. Appendix A contains the report of the Sub-Committee's discussion, including an overview of delegates' comments and references to the documents presented at the meeting. Those documents included an overview of the high-level principles and rationale supporting the system, proposed amendments to the UN Model Regulations, and proposed amendments to the UN Manual of Tests and Criteria. The informal working group has been working to address the comments raised by delegates. Updated proposed amendments to the UN Model Regulations and the UN Manual of Tests and Criteria will be presented to the sixty-ninth session of the UN Sub-Committee (Geneva, 23 November to 1 December 2026), with the objective of finalizing them at that session. The latest version of the proposed amendments to the UN Model Regulations and the UN Manual of Tests and Criteria are presented in Appendices B and C to this working paper, respectively. The latter includes detailed test conditions that remained subject to validation and possible further modification at the time of publication. At its sixty-eighth session, the UN Sub-Committee suggested that the revised proposals be brought to the attention of the DGP for review.

1.3 The new system would have a significant impact on the regulation of the transport of lithium ion, sodium ion and lithium metal cells and batteries under the Technical Instructions. It is essential that the system provide a transparent, straightforward and safe framework that addresses aviation safety needs. In reviewing the proposals, DGP-WG/26 is invited to include the following in its considerations: whether the categories provide sufficient granularity for aviation; whether the proposed tests and state-of-charge controls are practicable and verifiable; whether the hazard information can be communicated clearly to operators; and whether the proposals can be implemented effectively in the Technical Instructions. The Secretary will submit feedback from the discussion of this working paper to the sixty-ninth session of the UN Sub-Committee.

1.4 A presentation was given to panel members, observers and advisers on 29 September 2026 to support their understanding of the new system. The PowerPoint presentation is provided in Appendix D to this working paper.

2. ACTION BY THE DGP-WG

2.1 The DGP-WG is invited to review the proposed amendments to the UN Model Regulations and the UN Manual of Tests and Criteria, presented in Appendices B and C to this working paper, respectively, and to identify any gaps that could prevent the hazard-based classification system from meeting aviation safety needs. In particular, the DGP-WG is invited to consider whether:

a) the categories provide sufficient granularity for aviation;

b) the proposed tests and state-of-charge controls are practicable and verifiable;

c) the resulting hazard information can be communicated clearly to operators;

d) the proposals can be implemented effectively in the Technical Instructions; and

e) any other issues relevant to meeting aviation safety needs.

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APPENDIX A

REPORT OF DISCUSSIONS ON PROPOSED HAZARD BASED CLASSIFICATION SYSTEM FOR LITHIUM BATTERIES AT THE SIXTY-EIGHTH SESSION OF THE UN SUB-COMMITTEE OF EXPERTS ON THE TRANSPROT OF DANGEROUS GOODS

B. Hazard-based system for classification of lithium batteries

Document: ST/SG/AC.10/C.3/2026/34 (Belgium, France and RECHARGE)

Informal documents: INF.13, INF.14, INF.15 (Belgium, France and RECHARGE)
INF.24 (MDTC) and INF.74 (DGTA)

79. The Sub-Committee welcomed the progress made by the informal working group.

80. Divergent views were expressed on the appropriate level of granularity of the system. While some experts considered that categories C and D could be merged to simplify the framework, others supported retaining separate categories to preserve hazard information and to provide sufficient flexibility for modal requirements. The representatives of ICAO and IATA recalled that this work had been undertaken to address the need to introduce greater granularity to support the specific needs of some modes, in particular aviation, risk assessments and operational decision-making, and stressed that simplification should not reduce the information available to operators.

81. Divergent views were also expressed on the most appropriate means of communicating hazard information, including the balance between UN numbers, special provisions and packing instructions. While some experts favoured maintaining a limited number of entries supplemented by transport provisions, others considered that additional UN numbers could provide a clearer and more transparent system.

82. With regard to the proposed interaction between hazard classification, risk considerations and packing provisions, several experts supported the approach linking hazard categories with different levels of risk, but expressed concerns regarding the complexity of the proposed decision trees and tables and their suitability for inclusion in the Model Regulations. Several experts considered that such tools could be retained as guidance to support the development of the provisions, but that the regulatory text itself should remain clear and practicable. It was further emphasized that classification should reflect intrinsic hazards, while mitigation measures such as packing or state of charge should primarily affect transport conditions.

83. Additional comments addressed the need to balance granularity, simplicity and practical implementation; the need for further validation of the proposed test methods; the clarification of parameters such as gas thresholds and state of charge; verification of the state of charge during transport; and implementation aspects, including testing burden. Several experts also highlighted the need for appropriate transitional measures. The Sub-Committee also emphasized the importance of maintaining coherent hazard communication and consistency with the structure of the Model Regulations.

84. With regard to hazard communication, as addressed in informal document INF.74, several experts emphasized the importance of maintaining a clear and consistent system for marks, labels and documentation, noting that the existing provisions are

widely understood. It was also noted that, while comparisons with other hazard classes, in particular Class 4, could be useful for explanatory purposes, such analogies should not lead to inappropriate classification approaches. It was generally considered that any revisions should follow the finalization of the classification framework and remain consistent with the principles of the Model Regulations.

85. The Sub-Committee invited the informal working group to revise the proposals in the light of the comments made, with a view to submitting revised proposals for consideration at its December session. It was noted that the next meeting of the ICAO Dangerous Goods Panel would take place in October, and it was suggested that the revised proposals be brought to their attention.

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APPENDIX B

PROPOSED AMENDMENTS TO THE UN MODEL REGULATIONS PRESENTED IN FORMAL DOCUMENT SUBMITTED TO SIXTY-NINTH SESSION OF THE UN SUB-COMMITTEE

United Nations ST/SG/AC.10/C.3/2026/76

Secretariat

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Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

Sixty-ninth session
Geneva, 23 November-1 December 2026
Item 5 (b) of the provisional agenda
Electric storage systems:
Hazard-based system for classification of lithium batteries

Hazard-based system for classification of lithium ion, sodium ion and lithium metal batteries – amendments to the Model Regulations

Transmitted by the experts from Belgium and France and the Advanced Rechargeable and Lithium Batteries Association (RECHARGE) on behalf of the informal working group*

Introduction

1. This document contains proposed amendments to the *Model Regulations* to introduce a hazard-based system for classification of lithium ion, sodium ion and lithium metal batteries into the regulations.

2. The proposed amendments to the *Model Regulations* reflect discussions of the informal working group (IWG) meeting held from 8 to 10 July, 2026 in Geneva, Switzerland and a subsequent video conference on 13 August 2026.

* A/80/6 (Sect. 20), table 20.7.

Proposal

Chapter 2.9

2.9.2 Add the following new entries in the numerical order under the heading "*Lithium batteries*":

"3601 LITHIUM METAL BATTERIES CATEGORY A or LITHIUM METAL CELLS CATEGORY A (including lithium alloy cells or batteries)

3602 LITHIUM METAL BATTERIES CATEGORY B or LITHIUM METAL CELLS CATEGORY B (including lithium alloy cells or batteries)

3603 LITHIUM METAL BATTERIES CATEGORY C or LITHIUM METAL CELLS CATEGORY C (including lithium alloy cells or batteries)

3604 LITHIUM METAL BATTERIES CATEGORY D or LITHIUM METAL CELLS CATEGORY D (including lithium alloy cells or batteries)

3605 LITHIUM METAL BATTERIES CATEGORY E or LITHIUM METAL CELLS CATEGORY E (including lithium alloy cells or batteries)

3606 LITHIUM ION BATTERIES CATEGORY A or LITHIUM ION CELLS CATEGORY A (including lithium ion polymer cells or batteries)

3607 LITHIUM ION BATTERIES CATEGORY B or LITHIUM ION CELLS CATEGORY B (including lithium ion polymer cells or batteries)

3608 LITHIUM ION BATTERIES CATEGORY C or LITHIUM ION CELLS CATEGORY C (including lithium ion polymer cells or batteries)

3609 LITHIUM ION BATTERIES CATEGORY D or LITHIUM ION CELLS CATEGORY D (including lithium ion polymer cells or batteries)

3610 LITHIUM ION BATTERIES CATEGORY E or LITHIUM ION CELLS CATEGORY E (including lithium ion polymer cells or batteries)"

[The existing note remains unchanged]

Add the following new entries in the numerical order under the heading "*Sodium ion batteries*":

"3606 SODIUM ION BATTERIES CATEGORY A or SODIUM ION CELLS CATEGORY A with organic electrolyte

3607 SODIUM ION BATTERIES CATEGORY B or SODIUM ION CELLS CATEGORY B with organic electrolyte

3608 SODIUM ION BATTERIES CATEGORY C or SODIUM ION CELLS CATEGORY C with organic electrolyte

3609 SODIUM ION BATTERIES CATEGORY D or SODIUM ION CELLS CATEGORY D with organic electrolyte

3610 SODIUM ION BATTERIES CATEGORY E or SODIUM ION CELLS CATEGORY E with organic electrolyte"

2.9.4 Amend the heading and insert a new sub-heading 2.9.4.1 to read as follows:

"2.9.4 Lithium and sodium ion batteries

2.9.4.1 ***Lithium batteries***"

Amend the beginning of the first paragraph to read as follows "Lithium metal, lithium ion, and sodium ion cells and batteries… ".

2.9.4.1 (e) (viii) Delete "and" at the end.

2.9.4.1 (e) (ix) Add "; and" at the end.

2.9.4.1 (e) (x) Add a new sub-paragraph before the existing note which remains unchanged, to read as follows:

"(x) Controls to ensure cells and batteries prepared for transport remain within the designated state-of-charge limits.".

2.9.4.1 (f) In the introductory paragraph, add "or sodium ion cells" after "rechargeable lithium ion cells" .

2.9.4.1 (h) (ii) Replace "2.9.4 (a)" by "2.9.4.1 (a)".

2.9.5 Renumber as "2.9.4.2"

2.9.5 (e) (old, new 2.9.4.2 (e)) Replace "2.9.4 (e) (i)" by "2.9.4.1 (e) (i)".

2.9.4.3 Insert the following new sub-section:

"2.9.4.3 ***Hazard categorization***

2.9.4.3.1 *General requirements*

2.9.4.3.1.1 Lithium metal, lithium ion, and sodium ion cells and batteries are assigned to the category which corresponds to the results of the tests described in the *Manual of Tests and Criteria*, part III, sub-section 38.3.5 and 38.3.6 as follows:

Category A: Cells and batteries undergo thermal runaway with propagation.

Category B: Cells and batteries undergo thermal runaway without propagation and emit greater than 25 L of gas.

Category C: Cells and batteries undergo thermal runaway without propagation and emit between 0.25 L and 25 L of gas.

Category D: Cells and batteries undergo thermal runaway without propagation, emit less than 0.25L of gas and have an observed temperature increase less than 150 °C; or cells and batteries do not undergo thermal runaway, but only when tested at a reduced state of charge.

Category E: Cells and batteries do not undergo thermal runaway at full charge.

2.9.4.3.1.2 Non-rechargeable cells and batteries are assigned a category based on testing conducted in the undischarged state. Rechargeable cells and batteries may be

assigned to a category based on testing conducted at a reduced state of charge. Cells and batteries of a type not tested according to part III, sub-section 38.3.5 and 38.3.6 of the *Manual of Tests and Criteria* are assigned to category A.

2.9.4.3.2 *Transport at a reduced state of charge*

2.9.4.3.2.1 Rechargeable cells and batteries may be offered for transport according to the requirements of a category assigned based on testing conducted at a reduced state of charge provided:

(a) The consignor demonstrates and validates through instrumentation, physical process, inventory control or similar capability, or through a quality management programme mentioned in 2.9.4.1(e) that the cells and batteries offered for transport do not exceed the state of charge used to assign the category; and

(b) The test summary required by 2.9.4.1 (f) and 2.9.4.2 (g) includes the category when the cell or battery is offered at specific state of charge and the category assigned to the cell or battery at full charge."

Chapter 3.2, List of dangerous goods

For UN 3090, UN 3480, and UN 3551, add "41X" in column (6).

Add the following new entries to the dangerous goods list as follows:

(1)	(2)	(3)	(4)	(5)	(6)	(7a)	(7b)	(8)	(9)	(10)	(11)
-	**3.1.2**	**2.0**	**2.0**	**2.0.1.3**	**3.3**	**3.4**	**3.5**	**4.1.4**	**4.1.4**	**4.2.5/ 4.3.2**	**4.2.5**
3601	LITHIUM METAL BATTERIES CATEGORY A or LITHIUM METAL CELLS CATEGORY A (including lithium alloy cells or batteries)	9			310 376 377 384 387 390	0	E0	P903 P908 P909 P910 P911 LP903 LP904 LP905 LP906			
3602	LITHIUM METAL BATTERIES CATEGORY B or LITHIUM METAL CELLS CATEGORY B (including lithium alloy cells or batteries)	9			310 376 377 384 387 390	0	E0	P91X P908 P909 P910 P911 LP903 LP904 LP905 LP906			
3603	LITHIUM METAL BATTERIES CATEGORY C or LITHIUM METAL CELLS CATEGORY C (including lithium alloy cells or batteries)	9			310 376 377 387 390 41y	0	E0	P91X P908 P909 P910 P911 LP903 LP904 LP905 LP906			
3604	LITHIUM METAL BATTERIES CATEGORY D or LITHIUM METAL CELLS CATEGORY D (including lithium alloy cells or batteries)	9			310 376 377 387 390 41y	0	E0	P91X P908 P909 P910 P911 LP903			

(1)	(2)	(3)	(4)	(5)	(6)	(7a)	(7b)	(8)	(9)	(10)	(11)
-	3.1.2	2.0	2.0	2.0.1.3	3.3	3.4	3.5	4.1.4	4.1.4	4.2.5/ 4.3.2	4.2.5
								LP904 LP905 LP906			
3605	LITHIUM METAL BATTERIES CATEGORY E or LITHIUM METAL CELLS CATEGORY E (including lithium alloy cells or batteries)	9			376 387 41z			P908 P909 P910 P911 LP904 LP905 LP906			
3606	LITHIUM ION BATTERIES CATEGORY A or LITHIUM ION CELLS CATEGORY A (including lithium ion polymer cells or batteries) or SODIUM ION BATTERIES CATEGORY A or SODIUM ION CELLS CATEGORY A with organic electrolyte	9			310 348 376 377 384 387 390 400 401 410	0	E0	P903 P908 P909 P910 P911 LP903 LP904 LP905 LP906			
3607	LITHIUM ION BATTERIES CATEGORY B or LITHIUM ION CELLS CATEGORY B (including lithium ion polymer cells or batteries) or SODIUM ION BATTERIES CATEGORY B or SODIUM ION CELLS CATEGORY B with organic electrolyte	9			310 348 376 377 384 387 390 400 401 410	0	E0	P91X P908 P909 P910 P911 LP903 LP904 LP905 LP906			
3608	LITHIUM ION BATTERIES CATEGORY C or LITHIUM ION CELLS CATEGORY C (including lithium ion polymer cells or batteries) or SODIUM ION BATTERIES CATEGORY C or SODIUM ION CELLS CATEGORY C with organic electrolyte	9			310 348 376 377 387 400 401 410 41y	0	E0	P91X P908 P909 P910 P911 LP903 LP904 LP905 LP906			
3609	LITHIUM ION BATTERIES CATEGORY D or LITHIUM ION CELLS CATEGORY D (including lithium ion polymer cells or batteries) or SODIUM ION BATTERIES CATEGORY D or SODIUM ION CELLS CATEGORY D with organic electrolyte	9			310 348 376 377 387 390 400 401 410 41y	0	E0	P91X P908 P909 P910 P911 LP903 LP904 LP905 LP906			
3610	LITHIUM ION BATTERIES CATEGORY E or LITHIUM ION CELLS CATEGORY E (including lithium ion polymer cells or batteries) or SODIUM ION BATTERIES CATEGORY E or SODIUM ION CELLS CATEGORY E with organic electrolyte	9			376 387 400 401 410 41z	0	E0	P908 P909 P910 P911 LP904 LP905 LP906			

Chapter 3.3

188 (c) Replace “2.9.4” by “2.9.4.1” and “2.9.5” by “2.9.4.2”.

301 Add the following at the end of subparagraph (b): "or special provision 41y (a) and (b)".

In the third paragraph after subparagraph (b), insert "or 3601 to 3610" after "3552".

310 In the first paragraph, replace "2.9.4" by "2.9.4.1" (twice); and "2.9.5" by "2.9.4.2" (three times).

Add the following paragraph at the end of the current text:

"Cells and batteries offered for transport in accordance with this special provision are assigned to category A and shall be packed in accordance with packing instruction P910 of 4.1.4.1 or LP905 of 4.1.4.3, as applicable."

328 Amend the fourth paragraph to read as follows:

"When lithium metal, lithium ion or sodium ion batteries are contained in the fuel cell system, the consignment shall be consigned under this entry and under the appropriate entry for lithium metal cells or batteries contained in equipment, lithium ion, or sodium ion cells or batteries contained in equipment."

360 Replace "2.9.4" by "2.9.4.1" (twice).

363 (f) In the first paragraph, second sentence, replace "2.9.4" by "2.9.4.1" and in the third sentence, replace "2.9.4" by "2.9.4.2" (twice).

In the second paragraph, insert "or sodium ion" after "lithium battery".

376 Amend the end of the first paragraph after the note, to read as follows:

"…3551, 3552, 3601 to 3610, as appropriate, except for the requirements of 2.9.4.1 or 2.9.4.2.".

377 In the second paragraph, delete "or 2.9.5".

387 Amend the first sentence to read as follows:

"Lithium batteries in conformity with 2.9.4.1 (f) containing both primary lithium metal cells and rechargeable lithium ion or sodium ion cells shall be assigned to the UN number corresponding to the most severe category of the component cells. If both primary lithium metal cells or batteries and rechargeable lithium ion or sodium ion cells or batteries are of the same category, the battery shall be assigned to the UN number corresponding to the lithium metal battery.

388 In the second, third, sixth, eighth and ninth paragraphs, replace "2.9.4" by "2.9.4.1".

In the ninth paragraph, replace "2.9.5" by "2.9.4.2".

389 In the first paragraph, replace "2.9.4" by "2.9.4.1" and "2.9.5" by "2.9.4.2".

400 (b) Replace "2.9.5" by "2.9.4.2".

401 In the first sentence, replace "3551 or 3552" by "3551, 3552 or 3606 to 3610"

410 Replace "2.9.4" by "2.9.4.1" and amend replace "3481 or 3536" by "3481, 3536 or 3606 to 3610".

Add the following new special provisions:

"41x These entries may continue to be used until 31 December 2032.

41y Cells and batteries of category C or category D are not subject to other provisions of these Regulations if they meet the following:

(a) Each lithium cell or battery meets the provisions of 2.9.4.1 (a), (e), (f) if applicable, (g) and (h) if applicable or for sodium ion cells or batteries, the provisions of 2.9.4.2 (a), (e) and (f);

(b) Cells, batteries, and equipment are packed in accordance with P91X of 4.1.4.1; and

(c) Each package is marked with the appropriate battery mark, as illustrated at 5.2.1.9.

NOTE: *Packages containing lithium batteries packed in conformity with the provisions of part 4, chapter 11, packing instructions 965 or 968, section IB of the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air that bear the mark as shown in 5.2.1.9 (battery mark) and the label shown in 5.2.2.2.2, Model No.9A shall be deemed to meet the provisions of this special provision.*

When packages are placed in an overpack, the battery mark shall either be clearly visible or be reproduced on the outside of the overpack and the overpack shall be marked with the word "OVERPACK". The lettering of the "OVERPACK" mark shall be at least 12 mm high.

41z Cells and batteries assigned to category E are not subject to any other provisions of these Regulations if they meet the following:

(a) Each lithium cell or battery meets the provisions of 2.9.4.1 (a), (e), (f) if applicable, (g) and (h) if applicable or for sodium ion cells or batteries, the provisions of 2.9.4.2 (a), (e) and (f);

(b) Cells and batteries are transported in strong packagings that conform to the provisions of 4.1.1.1 and 4.1.1.2 or unpackaged on pallets when the cells or batteries provide equivalent protection;

(c) Cells and batteries are protected against damage and short circuits that may be caused by the placement or the movement of the cells or batteries within the packaging; and

(d) Each cell, including when it is a component of a battery, only contains dangerous goods that are authorized to be transported in accordance with the provisions of chapter 3.4 and in a quantity not exceeding the quantity specified in column 7a of the Dangerous Goods List of chapter 3.2.".

Alphabetical index

Insert the following entries in the alphabetical order:

Name and description	Class	UN No.
Lithium alloy cells or batteries, see	9	3601 3602 3603 3604 3605
LITHIUM ION BATTERIES CATEGORY A (including lithium ion polymer batteries)	9	3606
LITHIUM ION BATTERIES CATEGORY B (including lithium ion polymer batteries)	9	3607
LITHIUM ION BATTERIES CATEGORY C (including lithium ion polymer batteries)	9	3608
LITHIUM ION BATTERIES CATEGORY D (including lithium ion polymer batteries)	9	3609
LITHIUM ION BATTERIES CATEGORY E (including lithium ion polymer batteries)	9	3610
LITHIUM ION CELLS CATEGORY A (including lithium ion polymer cells)	9	3606
LITHIUM ION CELLS CATEGORY B (including lithium ion polymer cells)	9	3607
LITHIUM ION CELLS CATEGORY C (including lithium ion polymer cells)	9	3608
LITHIUM ION CELLS CATEGORY D (including lithium ion polymer cells)	9	3609
LITHIUM ION CELLS CATEGORY E (including lithium ion polymer cells)	9	3610
Lithium ion polymer cells or batteries, see	9	3606 3607 3608 3609 3610
LITHIUM METAL BATTERIES CATEGORY A (including lithium alloy batteries)	9	3601
LITHIUM METAL BATTERIES CATEGORY B (including lithium alloy batteries)	9	3602
LITHIUM METAL BATTERIES CATEGORY C (including lithium alloy batteries)	9	3603
LITHIUM METAL BATTERIES CATEGORY D (including alloy batteries)	9	3604
LITHIUM METAL BATTERIES CATEGORY E (including lithium alloy cells or batteries)	9	3605
LITHIUM METAL CELLS CATEGORY A (including lithium alloy cells)	9	3601
LITHIUM METAL CELLS CATEGORY B (including lithium alloy cells)	9	3602

Name and description	Class	UN No.
LITHIUM METAL CELLS CATEGORY C(including lithium alloy cells)	9	3603
LITHIUM METAL CELLS CATEGORY D (including lithium alloy cells)	9	3604
LITHIUM METAL CELLS CATEGORY E (including lithium alloy cells)	9	3605
SODIUM ION BATTERIES CATEGORY A with organic electrolyte	9	3606
SODIUM ION BATTERIES CATEGORY B with organic electrolyte	9	3607
SODIUM ION BATTERIES CATEGORY C with organic electrolyte	9	3608
SODIUM ION BATTERIES CATEGORY D with organic electrolyte	9	3609
SODIUM ION BATTERIES CATEGORY E with organic electrolyte	9	3610
SODIUM ION CELLS CATEGORY A with organic electrolyte	9	3606
SODIUM ION CELLS CATEGORY B with organic electrolyte	9	3607
SODIUM ION CELLS CATEGORY C with organic electrolyte	9	3608
SODIUM ION CELLS CATEGORY D with organic electrolyte	9	3609
SODIUM ION CELLS CATEGORY E with organic electrolyte	9	3610

Chapter 4.1

Section 4.1.4.1

P903 Amend the list of UN Nos. at the end the first sentence to read: “3551, 3552, 3601 and 3606”.

P908, P909 and P910 Amend the list of UN Nos in the first row as follows: “…3551, 3552 and 3601 to 3610.”.

P911 Amend the list of UN Nos in the first row as follows: “…3551, 3552 and 3601 to 3610.”.

In note (a) under the table, replacer “2.9.4” by “2.9.4.1”.

P91X Add the following new packing provision:

P91X	**PACKING INSTRUCTION**

This instruction applies UN Nos. 3602 to 3604 and 3607 to 3609.

For the purpose of this packing instruction, "equipment" means apparatus for which the cells or batteries will provide electrical power for its operation.

Cells or batteries shall be packed in packagings so that the cells or batteries are protected against damage that may be caused by the movement or placement of the cells or batteries within the packaging.

(1) For cells and batteries of Categories B, C and D the following packagings are authorized provided that the general provisions of 4.1.1 and 4.1.3 are met:

(a) Drums (1A2, 1B2, 1N2, 1H2, 1D 1G);

(b) Boxes (4A, 4B, 4C1, 4C2, 4D, 4F, 4G, 4H1, 4H2, 4N); and

(c) Jerricans (3A2, 3B2, 3H2).

Packagings shall meet the packing group II performance level.

(2) Alternatively, for cells and batteries of Categories B, C and D with a gross mass of 12 kg or more employing a strong, impact-resistant outer casing:

. (a) Strong outer packagings;

(b) Protective enclosures (e.g., fully enclosed or wooden slatted crates); or

(c) Pallets or other handling devices.

Cells or batteries shall be secured to prevent inadvertent movement, and shall not support the weight of other superimposed elements.

(3) For cells and batteries of Categories B, C and D contained in equipment:

Strong outer packagings constructed of suitable material of adequate strength and design in relation to the packaging's capacity and its intended use unless the battery is afforded equivalent protection by the equipment in which it is contained.

Packagings need not meet the requirements of 4.1.1.3.

Large equipment can be offered for transport unpackaged or on pallets when the cells or batteries are afforded equivalent protection by the equipment in which they are contained.

(4) Alternatively, for cells and batteries of Categories C and D:

. (a) Packagings shall conform to the provisions of 4.1.1.1, 4.1.1.2 and 4.1.1.5(b); and

(b) Packagings are not required to meet the performance tests in chapter 6.1 but shall be capable of withstanding a 1.2 m drop test in any orientation without damage to cells or batteries contained therein, without shifting of the contents so as to allow battery to battery (or cell to cell) contact and without release of contents.

NOTE: *The packagings authorized in (2), (3) and (4) may exceed a net mass of 400 kg (see 4.1.3.3).*

Additional requirements:

Cells and batteries shall be protected from short circuits.

Equipment shall be prepared or packed in such a manner as to prevent accidental operation during transport.

Equipment shall be secured against movement within the outer packaging.

When intentionally active, devices such as radio frequency identification (RFID) tags, watches and

temperature loggers, which are not capable of generating a dangerous evolution of heat, may be transported in strong outer packagings. When active, these devices shall meet defined standards for electromagnetic radiation to ensure that the operation of the device does not interfere with aircraft systems.

Section 4.1.4.3

LP903 Amend the list of UN Nos in the first row as follows: "…3551, 3552, 3601 to 3604, and 3606 to 3609."

LP904 Amend the list of UN Nos in the first row as follows: "…3551, 3552, and 3601 to 3610."

LP905 Amend the list of UN Nos in the first row as follows: "…3551, 3552, and 3601 to 3610."

LP906 Amend the list of UN Nos in the first row as follows: "…3551, 3552, and 3601 to 3610."

Chapter 5.2

5.2.1.9.1 Replace "188 or 400" by "188,, 400 or 41z".

5.2.1.9.2 Amend the first sentence to read as follows:

"The mark shall indicate the appropriate UN number, preceded by the letters "UN", e.g. "UN 3090" for lithium metal cells or batteries, "UN 3480" for lithium ion cells or batteries, "UN 3551" for sodium ion cells or batteries, "UN3603" for lithium metal cells or batteries, Category C, "UN3604" for lithium metal cells and batteries, Category D, "UN3608" for lithium ion or sodium ion cells or batteries Category C, or "UN3609", for lithium ion or sodium ion cells or batteries Category D."

In the second sentence, replace "i.e" by "e.g.".

5.2.2.1.13.1 In the second sentence, replace "a watt-hour rating of 100 Wh or less, the battery mark (figure 5.2.5) shall be affixed" by "a watt-hour rating of 100 Wh or less, and for batteries of categories C or D, the battery mark (figure 5.2.5) shall be affixed"

IN the last sentence replace "a watt-hour rating of more than 100 Wh, the battery label (5.2.2.2.2 No. 9A) shall be affixed" by "a watt-hour rating of more than 100 Wh, and for batteries of categories A or B, the battery label (5.2.2.2.2 No. 9A) shall be affixed".

APPENDIX C

PROPOSED AMENDMENTS TO THE UN MANUAL OF TESTS AND CRITERIA PRESENTED IN FORMAL DOCUMENT SUBMITTED TO SIXTY-NINTH SESSION OF THE UN SUB-COMMITTEE

United Nations ST/SG/AC.10/C.3/2026/77

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Committee of Experts on the Transport of Dangerous Goods and on the Globally Harmonized System of Classification and Labelling of Chemicals

Sub-Committee of Experts on the Transport of Dangerous Goods

Sixty-ninth session
Geneva, 23 November-1 December 2026
Item 5 (b) of the provisional agenda
Electric storage systems: Hazard-based system for classification of lithium batteries

Hazard-based system for classification of lithium ion, sodium ion and lithium metal batteries – Amendments to the Manual of Tests and Criteria

Transmitted by the experts from Belgium and France and the Advanced Rechargeable and Lithium Batteries Association (RECHARGE) on behalf of the informal working group*

Introduction

1. This document contains a proposal for amendments to the *Manual of Tests and Criteria* to introduce a hazard-based system for classification of lithium ion, sodium ion and lithium metal batteries into the regulations. The proposed amendments to the *Model Regulations* reflect discussions of the informal working group (IWG) meeting held from

* A/80/6 (Sect. 20), table 20.7.

8 to 10 July, 2026 in Geneva, Switzerland and a subsequent video conference on 13 August 2026.

2. The detailed test conditions are still being validated through testing, and additional modifications to the test protocol are possible.

3. Text that is newly proposed based on comments received but has not yet been discussed during an IWG is shown in bold between square brackets (see 38.3.6.2.2 and subparagraph "o" in 38.3.7).

I. Proposed amendments to the Manual of Tests and Criteria

Sub-section 38.3

38.3 In the heading, replace "sodium ion" by "sodium ion cells".

38.3.1 Amend as follows (new text is underlined):

"38.3.1 ***Purpose***

This section presents:

(a) The procedures to be followed for the classification of lithium metal and lithium ion and sodium ion cells and batteries (see 2.9.4 and 2.9.5 of the *Model Regulations* as described in 38.3.2, 38.3.3 and 38.3.4; and

(b) The procedure to be followed for the categorization of the lithium metal, sodium and lithium ion cells and batteries according to their hazard as described in 38.3.5 and 38.3.6.

The cells and batteries tested in accordance with the following procedures may be assigned one of the categories described in 2.9.4.3, depending on the test results.

NOTE:*In this section the words "sodium ion cells or batteries" refer to sodium ion with organic electrolyte cells or batteries.".*

38.3.2.1 In the first paragraph, amend the end of first sentence to read as follows: **"…**and T.8, as defined in 38.3.3 and 38.3.4.

Add the following text at the end, as a new third paragraph:

"To allow categorization according to the *Model Regulations*, paragraph 2.9.4.3, lithium metal, lithium ion and sodium ion cell and battery types may be subjected to the tests defined in 38.3.5 and 38.3.6."

38.3.2.2 Amend as follows *(new text is underlined, deleted text is ~~crossed out~~):*

"38.3.2.2 Lithium metal, lithium ion and sodium ion cells and batteries shall be subjected to the tests, as required by ~~special provisions 188 and 230 of chapter 3.3~~ 2.9.4.1 and 2.9.4.2 of the *Model Regulations* prior to the transport of a particular cell or battery type.

Cells or batteries which differ from a tested type by:

(a) [unchanged];

(b) [unchanged];

(c) [unchanged];

shall be considered a new type and shall be subjected to the required tests of 38.3.4.

[current Note, as amended in ST/SG/AC.10/11/Rev.8/Amend.1: unchanged]

Cells and batteries which differ from a tested type by a change in the design that might lead to a change in the result of any of the tests defined in 38.3.5 and 38.3.6 shall be subject to a new testing if hazard categorization is sought. Such testing may be performed to benefit from the categorization.

The type of change that might be considered to differ from a tested hazard category may include hardware or software changes influencing the hazard control features, such as the battery management system, a change in charge and discharge end voltage, minimum and maximum temperatures, minimum and maximum currents.

In the event that a cell or battery type does not meet one or more of the test requirements, steps shall be taken to correct the deficiency or deficiencies that caused the failure before such cell or battery type is retested.".

38.3.2.3 Add the following new definitions in alphabetical order:

"State-of-charge (SOC) means the percentage of the rated capacity contained in a cell or a battery as measured by subjecting it to a load, temperature and voltage cut-off point specified by the manufacturer.

NOTE:*For measurement methods, see the note under the definition of "rated capacity".”*

"Thermal run-away (TR) means the reaction of a cell or battery initiated by an uncontrolled and irreversible exothermic chemical reaction within the cell, causing further reactions that generate more heat and resulting in an accelerating rise of temperature.

"*Non-combustible material* means a material that does not propagate a flame and where the smouldering reaction doesn't progress for more than 200 mm over 20 minutes, after an ignition by a hot flame (minimum temperature 1 000 °C) from a gas burner (minimum diameter 5 mm) during 30 s (see similar method for determination of powder materials flammability in paragraph 33.2.4.3.1)."

38.3.5 and 38.3.6 Current 38.3.5 becomes 38.3.7. Add the following new sub-sections 38.3.5 and 38.3.6:

"38.3.5 *Required tests for assigning a category*

38.3.5.1 In order to assign a specific cell or battery to a hazard category, three repetitions of the respective tests in 38.3.6 shall be performed. If a test cannot be completed or the resulting data are insufficient to determine the hazard category, additional tests shall be conducted, until a total of three valid tests are obtained. The hazard category shall then be assigned based on the most severe result observed among all valid tests

Primary cells and batteries shall be tested undischarged. Rechargeable cells and batteries transported at a specific state of charge under 2.9.4.3 shall be tested at least at that state of charge.

38.3.5.2 The following hazards are defined by default according to the following calculation methods, unless a specific test is used to demonstrate a different hazard:

(a) Any gas produced during the thermal runaway is recognized by default as flammable and toxic. Additional test results or chemical analysis are needed to demonstrate the absence of gas flammability hazard;

(b) The gas volume generated per cell during the thermal runaway reaction is calculated by default by the cell energy (Wh) multiplied by 0.75 l/Wh and multiplied by the SOC/100 (%). The gas volume per battery is obtained by multiplying the gas volume per cell by the number of cells that undergo thermal runaway in the test T.11.

Gas volume (l) = Cell/battery total energy (Wh) × number of cells/batteries reacting × SOC/100 (%) × 0.75 (l/Wh)

Additional test results applying T.10 for cells and T.12 for batteries are needed to demonstrate a different gas volume value.

38.3.5.3 Testing of the battery to obtain a battery or a battery assembly specific categorization is possible.

Alternatively, when cells or batteries that have been previously categorized through tests (T.9 or T.11) are electrically connected, the resulting battery or battery assembly may be assigned to the same category as the tested component cell or battery without retesting, providing the assembly has been verified as preventing any safety adverse effect as compared to the tested cell or battery.

NOTE: *Examples of design characteristics that may result in an impact to battery categorization may include, but are not limited to:*

(a) Overcurrent, overcharge or over-discharge of any cell or group of cells in case of one cell in the battery is suddenly in short-circuit;

(b) Battery material changing thermal emissions and/or thermal transfer rendering the battery to become more reactive; or

(c) Connections rendering the battery to become more reactive.

A specific test or a calculation based on the battery configuration (number of cells in series and in parallel) may be used for the purpose of this verification.

38.3.5.4 Batteries and batteries packed with equipment are tested with the procedure applicable to batteries.

38.3.6 *Test procedure*

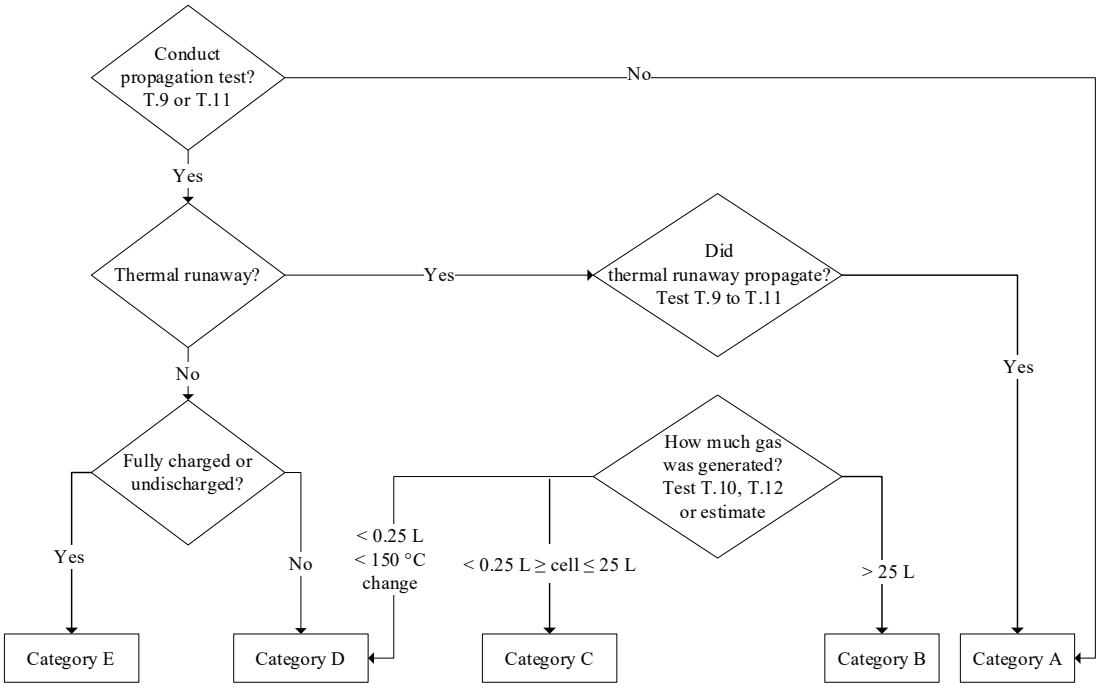
38.3.6.1 *Introduction*

38.3.6.1.1 Category assignment tests (T.9 to T.12)

Cells and batteries, are assigned to one of the categories identified in 2.9.4.3.1 of the *Model Regulations* based on the results of the tests performed according to the following procedures. The testing scheme to arrive at the appropriate category is shown in the figure 38.3.6.1.

Tests may be performed at 100% SOC or any reduced SOC. The cell or battery will be assigned the hazard category corresponding to the respective test results. Cells and batteries not tested are assigned to category A.

Figure 38.3.6.1: Categorization criteria for lithium metal, lithium ion and sodium ion cells and batteries



The tests are designed to force a single cell into thermal runaway through the application of heat on the surface of a cell or a cell in a battery until the thermal runaway reaction is initiated inside the cell or the cell surface temperature has reached 375°C. An alternative appropriate initiation method may be used for batteries.

NOTE:*When cells or batteries have been demonstrated to be more reactive during test T.9 or T.11 due to their high SOC (e.g. 100% SOC), which causes a thermal run-away, then the cells or batteries may be categorized according to the test result at a chosen lower SOC, e.g. 30 % SOC. This is also applicable if cells or batteries do not undergo thermal runaway at the lower SOC.*

38.3.6.2 Test T.9: Cell propagation test

38.3.6.2.1 Purpose

The purpose of the test is to create a worst-case testing condition to evaluate cell thermal runaway behaviour, including propagation to neighbour cells, flame generation and the maximum temperature in the case of thermal runaway propagation.

38.3.6.2.2 Test procedure

The test fixture and the tested cells shall be at ambient temperature (20°C ± 5 °C).

The propagation test is conducted by placing 4 identical cells inside a thermally insulated test fixture designed to tightly maintain the 4 cells in a row. The initiation cell shall be placed at one end of the row, with the heater on the side of the initiation cell that is not adjacent to the next cell in the row. All other cells will be placed side by side, with the larger side used as the contact surface, or the longer side for cylindrical cells. Primary cells shall be tested undischarged. Rechargeable cells may be tested fully charged or at a specific state of charge. There shall not be any additional material inserted between the cells. The quality of direct contact will be ensured by use of rigid test fixtures, or in the case of flexible material, by use of a compression force of the row of 10 N for cylindrical cells or a compression pressure of 1000 N/m^2 of cell surface for other cell formats

The test fixture must have 6 sides to maximize heat containment. The test fixture shall have the required mechanical robustness to contain mechanical ejections, including through the lid, but allow for gas and flame exit. Additionally, ~~v~~arious heating rates may be used to avoid core ejection when possible. The distance between the cells and the lid shall be limited in a way to avoid cell core ejection but leaving appropriate room for the gas discharge. The gas discharge position shall be placed at the end of the row opposite the initiation cell and shall be of an appropriate size to prevent overpressure inside the test fixture. The first and last cell in the row shall be equipped with a thermocouple.

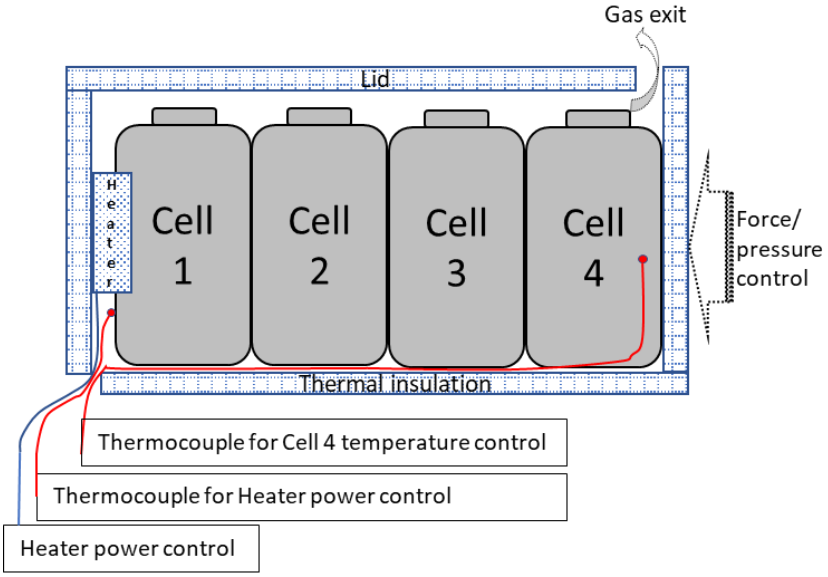


Figure 38.3.6.2: Diagram of a test set-up example

The initiation cell shall be heated with a system/set-up/equipment enabling a heat transfer to the cell. The size of the contact surface between the cell and the device shall not exceed 20% of the total cell surface for cylindrical cells, or 20 % of the face for prismatic and pouch cells. The minimum size of the heating area is 10 mm^2. The efficiency of the heat transfer shall be controlled by a thermocouple placed at 5 ± 2 mm of the side of the heating device. For small cells with the larger face below 50 mm^2, the complete face of the cell can be in contact with the heater.

The heating rate for the initiation cell shall be at minimum 10 °C per minute**,** based on the measure of the control thermocouple placed on the initiation cell.

For cells with a larger heat transmission to the neighbour cells, such as large prismatic cells with a thick can, or thin pouch cells, the heater power may be increased in order to reduce the heating time and therefore the heat transferred to the neighbour cells until thermal run away is observed.

The power of the heater shall be controlled manually or electronically to maintain the heating rate (in °C/min) as constant as possible during the whole test duration. (small temperature fluctuations such as the one generated by cell venting, as represented in figure 38.3.6.3 at 250 seconds are acceptable). The heater power shall be cut off when a thermal runaway is detected

If the initiation cell exhibits an increasing temperature slope without an increase in heater power, this shall initially be considered as the detection of the thermal runaway initiation reaction. The heater power shall then be progressively reduced, manually or automatically, in order to maintain the selected heating rate.

If a clear thermal runaway is observed, characterized by a rapid and accelerating temperature increase of the initiation cell with a slope larger than 1 °C/s for more than 3 seconds, the heater power shall be switched off immediately and thermal runaway shall be confirmed. (see example case 1 of strong thermal runaway in figure 38.3.6.3).

[**Alternatively, if the heater power has been reduced to zero and the initiation cell temperature continues to increase for more than 180 seconds, the reaction shall be considered self-sustaining and thermal runaway initiation detection shall be confirmed (see example case 2 of limited thermal runaway in figure 38.3.6.3).**]

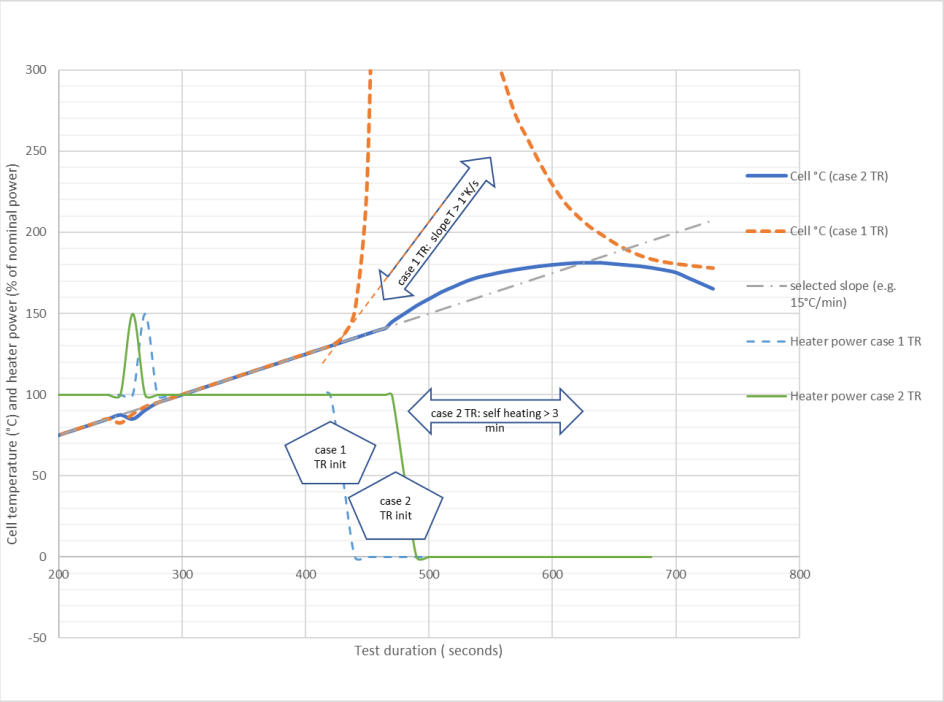


Figure 38.3.6.3: diagram of two tests results examples: case 1 - Cell with strong thermal runaway (TR)and case 2 - cell with limited TR initiation, and the applicable detection criteria

If thermal runaway initiation is not achieved, the heater power shall be completely switched off when:

(a) The initiation cell temperature has reached 375 °C for at least 1 minute; and

(b) The total energy delivered by the heater during the test is larger than two times the electrical energy content of the cell at the tested SOC (percentage of SOC × cell energy in Wh).

The data is recorded for 6 hours after stopping power to the heater, or 1 hour after a thermal runaway of all cells has been detected, if applicable.

The maximum temperature shall be determined from the thermocouple on the last cell of the row placed on the surface of the cell that is furthest away from the initiation cell and insulated from any test fixture contact. The thermocouples shall be thermally protected against direct ambient gas temperature measurement.

38.3.6.2.3 Test outcome

Provided the test fixture remains intact, a partial core ejection or gas ejection does not invalidate the test. The following hazards are characterized:

(a) Thermal runaway and thermal runaway propagation: the surface temperature of the cells in the row will be used to detect the initiation and the propagation of the thermal runaway. The test will demonstrate

the absence of thermal runaway when the initiating cell does not experience thermal runaway. The test will demonstrate the absence of propagation when the 4th cell in the row does not experience thermal runaway. The test result is to be expressed as either:

(i) No thermal runaway;

(ii) Thermal runway without propagation; or

(iii) Thermal runaway with propagation.

(b) Temperature: the recording of the cells temperature during the test may be analysed to detect the maximum temperature of the 4th cell for a period of 3 minutes. The test result will be expressed as a cell property: maximum temperature observed on the 4th cell during the test either exceeds a 150 °C increase above the temperature at the time the heater is stopped, or is below a 150 °C increase. The test result is to be expressed as either:

(i) Temperature increase less than 150 °C;

(ii) Temperature increase exceeds 150 °C.

38.3.6.3 Test T.10: Cell gas volume determination

38.3.6.3.1 Purpose

The purpose of the test is to determine the quantity of gas generated in the case of thermal runaway of a cell. It is considered by default that all lithium cells generate flammable and toxic gas. This can be used as an alternative method to the calculation method presented in 38.3.5.2

38.3.6.3.2 Test procedure

The test method used to determine the quantity of gas generated by a single cell in thermal runaway is based on capturing of the gas generated inside an enclosure, equipped either with a gas pressure and temperature measurement, or with a volumetric gauge.

The thermal runaway is initiated in the same manner as for the propagation test, except that it applies to a single cell.

The chamber for gas volume measurement shall be a tight enclosure, filled with inert gas (nitrogen or argon) enabling the measurement of the gas volume released in the absence of combustion. The chamber size will be determined based on the size of the cell, and the potential maximum volume of gas released.

The necessary time for temperature and pressure to stabilize and homogenize must be allowed before making the pressure and temperature measurements.

The gas pressure measurement sensitivity should be better than 1 %.

38.3.6.3.1.3 Test outcome

The result of the test will be expressed as a volume of gas in liters, at ambient temperature and normal pressure. The result could be expressed either as:

(a) No gas volume measured when the gas volume is less than 0.25 litres;

(b) Total gas volume between 0.25 litres and 25 litres; or

(c) Total gas greater than 25 litres.

38.3.6.4 Test T.11: Battery propagation test

38.3.6.4.1 Test T.11.a.

38.3.6.4.1.1 Purpose

The purpose of the test is to create a worst-case testing condition to evaluate the thermal runaway initiation and propagation inside the battery, and from battery to battery, based on the battery surface temperature.

38.3.6.4.1.2 Test procedure T11.a

The test for the hazard categorization of a battery is based on the initiation of thermal runaway on one cell inside the battery, using the same initiation method as in T.9, or an alternative initiation method.

The selected cell should be the one providing the highest likelihood of propagation. Particularly, the selected cell should fulfill the following conditions, as far as applicable:

(a) be adjacent to the battery casing, in a position enabling the application of the heater, or the alternative method;

(b) be at the shortest distance to neighbouring cells, considering the general battery design; and

(c) be away from thermal masses or cooling systems when compared to other cells, considering the general battery design.

In the cases where the application of the heater requires the opening of a battery casing, the opening shall be closed again while allowing external wiring, and prevent gas leakage as far as possible, in order to limit potential differences in the test result due to the opening (such as gas leakage).

In the cases where the application of a heater on a cell is not possible, or interferes with the safety mechanisms, or the construction of the battery, other equivalent thermal runaway initiation methods may be applied (e.g. overcharge of one cell, overcharge of a module, use of a laser, use of specially prepared cells with internal short circuit system). Features of the battery like distance between cells, fire protections, plastic parts, gas venting channels and other similar features shall not be modified for the test. This alternative method would only be acceptable in the case it generates a thermal runaway on the initiation cell or complies

with the above requirement of a cell temperature of 375 °C for at least 1 minute.

NOTE: *For the purpose of the 3 tests repetition, the same battery may be reused provided the battery has not sustained damage by the test in a way that may change the test result and identical cells in an equivalent position as the selected initiation cell are still available.*

The test fixture and the tested battery shall be at ambient temperature (20°C ±5 °C)

Similar to the T.9 test performed on cells, the initiation cell shall be heated at a minimum rate of 10 °C per minute, based on the measurement of the thermocouple placed on the initiation cell. The heater power shall be cut off, or the alternative method interrupted, and the test terminated based on the same criteria as presented in test T.9, paragraph 38.3.6.2.2.

The battery shall be equipped with external thermocouples on at least 3 external surfaces of the battery, in addition to the surface of the initiation cell. For placing the thermocouples, positions for the respective side of the battery should be selected, to represent the maximum expected temperature on the surface of the battery.

The application of the thermocouples shall not interfere with the pack construction or its safety features.

In the case of batteries without casing, the thermocouples shall be placed on the outer surface available (plastic sleeve or cell casing).

38.3.6.4.1.3 Test outcome

(a) Thermal run away and thermal runaway propagation: The test will demonstrate the absence of thermal runaway when no cell is exhibiting thermal runway. The test will demonstrate the absence of propagation when the 3 external battery surfaces exhibits a temperature increase below 150 °C, except momentary spike no longer than 3 minutes and below 200 °C, after the heater or the alternative initiation method is stopped. The test result is proposed to be expressed as either:

(i) No thermal runaway;

(ii) Thermal runway without propagation; or

(iii) Thermal runaway with propagation.

(b) Temperature: the temperature recording of the test will be analysed to detect the maximum temperature for a period of 3 minutes. The test result will be expressed as a battery property: the maximum temperature observed on any of the 3 external surfaces during the test either exceeds a 150 °C increase above the temperature at the time the heater or the alternative initiation method is stopped, or is

below a 150 °C increase. The test result is to be expressed as either:

(i) Temperature increase less than 150 °C;

(ii) Temperature increase exceeds 150 °C;

(c) For the purpose of gas volume determination from T.11 test, the number of cells reacting during the test can be calculated when needed. The identification of the cells with no reaction may require the opening of the batteries to observe the condition of the cells after the test. A cell is non-reactive if there is no leakage, disassembly or rupture, and the voltage after testing not less than 90% of the voltage immediately prior to the test. The number of cells reacting is the difference between the total number of cells in the test minus the cells with no reaction, applied for the test repetition where the minimum number of cells with no reaction is observed.

38.3.6.4.2 Battery propagation test, alternative test procedure T.11b

38.3.6.4.2.1 Purpose

Alternatively to method T.11.a, a method using several batteries, similar to the cell propagation test T.9, but with two batteries inside the fixture, may be performed to evaluate the propagation between batteries in the following cases:

(a) Batteries where the casing is hot or melting, but does not propagate the thermal runaway to a neighbour battery of the same type;

(b) Batteries without casing

38.3.6.4.2.2 Test procedure T.11.b

The initiation cell in the battery shall be selected in the same way as described for the test T.11.a, and the test conduct will follow the same procedure.

In the cases where the application of a heater on a cell is not possible, or interferes with the safety mechanisms or the construction of the battery, other equivalent thermal runaway initiation methods may be applied, as described in the test procedure T.11.a.

38.3.6.4.2.3 Test outcome

The following hazards are characterized:

(a) Thermal run away and thermal runaway propagation: The test will demonstrate the absence of thermal runaway when no cell is exhibiting thermal runway. The test will demonstrate the absence of propagation when no cell from the second battery demonstrates thermal runaway. The test result is proposed to be expressed as either:

(i) No thermal runaway;

(ii) thermal runway without propagation; or

(iii) thermal runaway with propagation.

(b) Temperature: the temperature recording of the test may be analysed to detect the maximum temperature for a period of 3 minutes, The test result will be expressed as a battery property: the maximum temperature of any of the external surfaces of the first battery during the test either exceeds a 150 °C increase above the temperature at the time the heater or the alternative initiation method is stopped, or is below a 150 °C increase. The test result is to be expressed as either:

(i) Temperature increase less than 150 °C;

(ii) Temperature increase exceeds 150 °C.

(c) For the purpose of gas volume determination from T.11 test, the number of cells reacting during the test can be calculated when needed. The identification of the cells with no reaction is requiring the opening of the test fixture and of the batteries, and the observation of the cells after the test. A cell is not reacting if there is no leakage, disassembly or rupture, and with the voltage after testing is not less than 90% of the voltage immediately prior to the test. The number of cells reacting is the difference between the total number of cells in the test minus the cells with no reaction, applied for the test repetition where the minimum number of cells with no reaction is observed.

38.3.6.5 Test T.12: Battery gas volume determination

38.3.6.5.1 Purpose

The purpose of the test is to determine the quantity of gas generated in the case of thermal runaway of a cell or cells inside a battery. It is considered by default that all lithium and sodium battery cells generate toxic and flammable gas. It can be used as an alternative method to the calculation method presented in 38.3.5.2.

38.3.6.5.2 Test procedure

One of the two procedures may be applied for the determination of gas quantities:

(a) Apply test T.10 on a single cell or using the test results for the gas quantity of one cell of the battery according to test T.10 when available from the original cell manufacturer, and multiplying by the number of propagating cells observed in test T.11; or

(b) Apply test T.10 to the complete battery, the heater being applied to a single cell in the battery, or an alternative method as described in the test T.11.

38.3.6.5.3 Outcome

The result of the test will be expressed as a volume of gas in litres, at ambient temperature and normal pressure, calculated as follows:

(a) if a single cell has been tested, then the measured volume of gas shall be multiplied by the number of cells that have reacted during the thermal runaway propagation test of the battery (test T.11), or by the total number of cells in the battery if no result for the propagation test is available;

(b) if the test has been performed on the whole battery, the result of the test is the total measured volume of gas. The result could be expressed as either:

(i) No gas volume measured when the gas volume is less than 0.25 litres;

(ii) Total gas volume between 0.25 litres and 25 litres; or

(iii) Total gas volume greater than 25 litres.

38.3.7 (new, old 38.3.5) Amend as follows (new text is <u>underlined</u>):

"38.3.7 ***Cell and battery test summary***

The following test summary shall be made available:

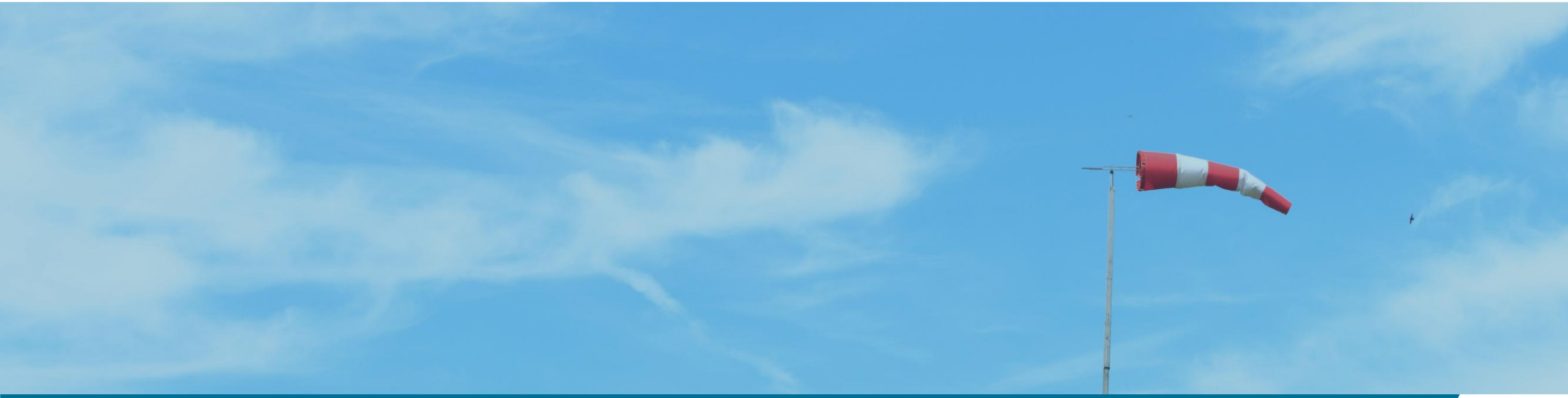
Cell or battery test summary in accordance with subsection 38.3 of the *Manual of Tests and Criteria*
The following information shall be provided in this test summary: (a) Name of cell, battery, or product manufacturer, as applicable; (b) Cell, battery, or product manufacturer's contact information to include address, phone number, email address and website for more information; **<u>Tests T.1 to T.8</u>** (c) Name of the test laboratory to include address, phone number, email address and website for more information; (d) A unique test report identification number;

Cell or battery test summary in accordance with subsection 38.3 of the *Manual of Tests and Criteria*
(e) Date of test report; (f) Description of cell or battery to include at a minimum: (i) Lithium ion, lithium metal or sodium ion cell or battery; (ii) Mass of cell or battery; (iii) Watt-hour rating, or lithium content; (iv) Physical description of the cell/battery; and (v) Cell or battery model number or, alternatively, if the test summary is established for a product containing a cell or battery, the product model number. (g) List of mandatory tests conducted under 38.3.4 and results (i.e., pass/fail); (h) Reference to assembled battery testing requirements, if applicable (i.e. 38.3.3 (f) and 38.3.3 (g)); (i) Reference to the revised edition of the *Manual of Tests and Criteria* used and to amendments thereto, if any; and (j) Name and title of responsible person or unique identifier of responsible person as an indication of the validity of information provided. **Tests T.9 to T.12** (k) Name of the test laboratory to include address, phone number, email address and website for more information; (l) A unique test report identification number; (m) Date of test report; (n) Identification of the hazard category obtained indicating if obtained by test or by default, and when applicable list of tests conducted under 38.3.5 for categorization purpose; (o) When applicable, SOC at which the cell or battery was tested according to 2.9.6.3 and respective applicable hazard category **[and other relevant information including methods for validation of the SOC (e.g. by the value of the maximum voltage at that SOC or other criteria and instruction how this information can be obtained.]** (p) Reference to the revised edition of the *Manual of Tests and Criteria* used and to amendments thereto, if any; and (q) Name and title of responsible person or unique identifier of responsible person as an indication of the validity of information provided.

APPENDIX D

OVERVIEW OF HAZARD-BASED CLASSIFICATION SYSTEM FOR LITHIUM AND SODIUM ION BATTERIES: PRESENTATION PROVIDED TO DGP MEMBERS, OBSERVERS AND ADVISERS ON 29 SEPTEMBER 2026

FPS **MOBILITY AND TRANSPORT**
BELGIAN CIVIL AVIATION AUTHORITY



Hazard Based Classification of Lithium and Sodium Ion Batteries

29/09/2026

Remko Dardenne – BCAA Dangerous Goods Coordinator

.be

AGENDA

- World of dangerous goods
- Lithium battery hazard based classification working group background
- New proposed test and classification system
- Transport provisions
- Conclusion

WORLD OF DANGEROUS GOODS

Multimodal, all modes: classification, UN-packages, UN-gascylinders and mobile tanks, bulkcontainers, labelling and marking, documentation, limited and excepted quantities, …

Multimodal ADR/RID/ADN: safety advisors, non UN cilinders and tanks, bulkwagons, incident reporting, multilateral agreements, exceptions, …

Specific ADR: drivers, tunnelcodes, vehicle prescriptions, …

Specific ADN: crew, stability, ship certification, …

Specific RID: crew, wagon certification, …

Specific IMDG: crew, segregation, prescriptions on board, …

Specific ICAO TI: crew, segregation, prescription on board, …

LITHIUM BATTERIES: NEW CLASSIFICATION

- 2016 request of the ICAO Dangerous Goods Panel the UN Sub-Committee of Experts on the Transport of Dangerous Goods started a working group with the following mandate:
  - Prepare a hazard-based system to classify lithium batteries for transport
  - Determine the inherent hazards represented by lithium batteries and the types of reaction that may result
  - Current system uses battery size (grams of lithium or Wh rating)

IWG PARTICIPANTS

- The IWG included representatives from:
  - Competent Authorities at the UN
  - Battery manufacturers
  - Battery test labs
  - Device makers
  - Shippers
  - Packaging manufacturers

- Meetings in person and virtually

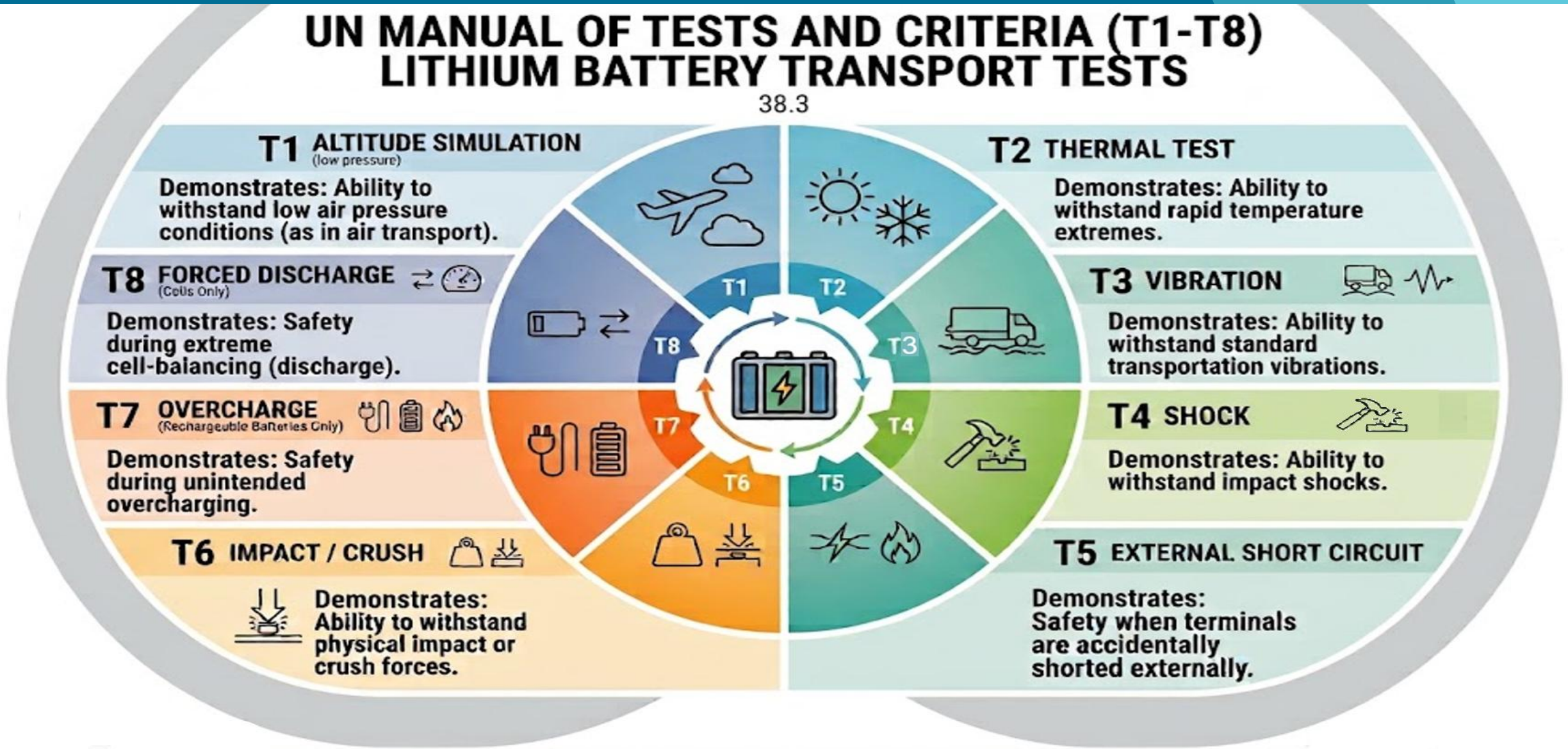


BASIC PRINCIPLES

- Initially work focused on testing
  - Thermal runaway
  - Thermal runaway propagation
  - High temperature reaction
  - Significant quantities of toxic and/or flammable gas

- Based on these hazards a new testing protocol and classification scheme was proposed

EXISTING TEST PROTOCOL



EXISTING TEST PROTOCOL

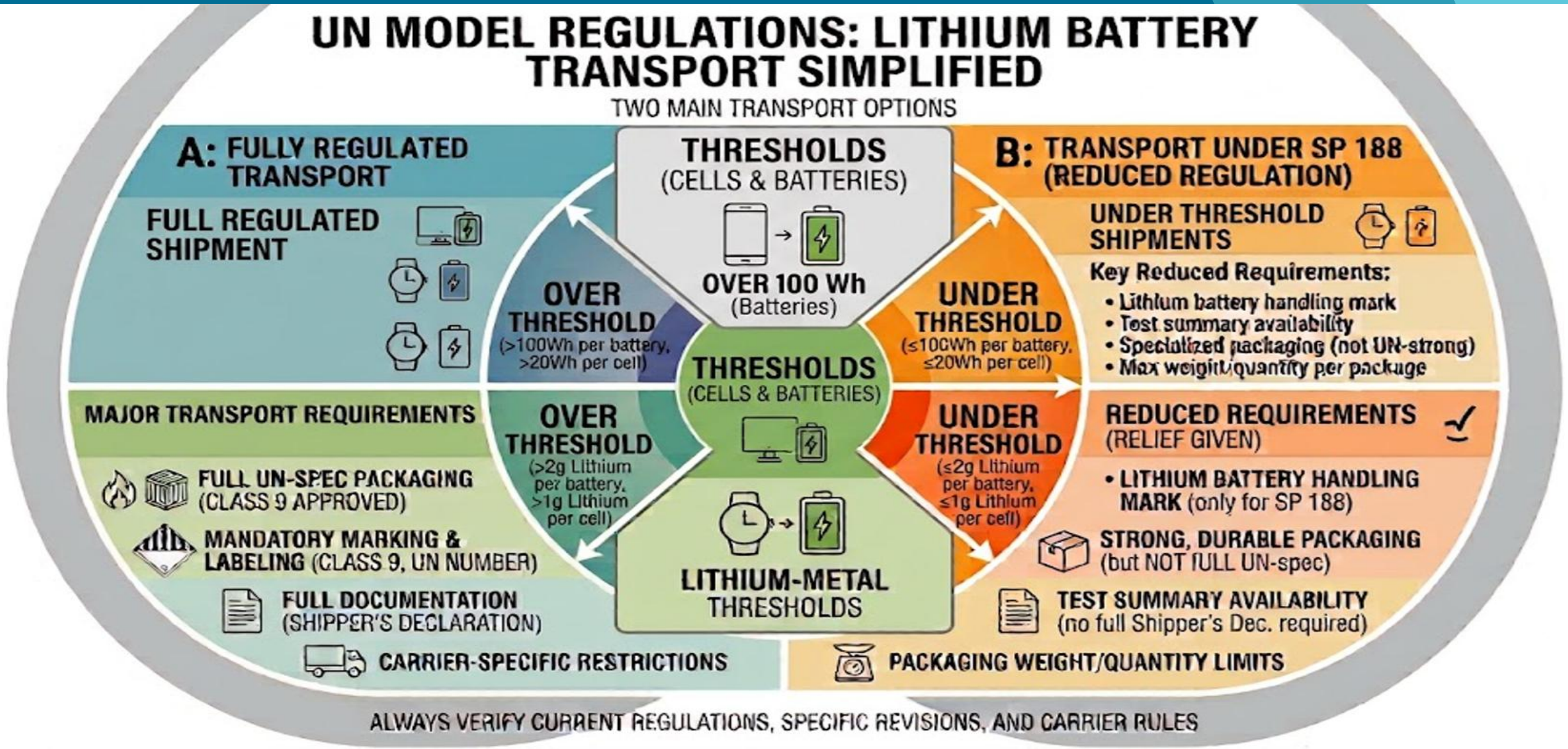
UN MANUAL OF TESTS AND CRITERIA 38.3

Lithium Battery Test Protocols & Pass/Fail Criteria

TEST	TEST NAME	PASS / FAIL CRITERIA
T1	**Altitude Simulation**	PASS No mass loss, leakage, venting, disassembly, rupture, or fire. Residual OCV ≥ 90% of pre-test voltage.
T2	**Thermal Test**	PASS No mass loss, leakage, venting, disassembly, rupture, or fire. Residual OCV ≥ 90% of pre-test voltage.
T3	**Vibration**	PASS No mass loss, leakage, venting, disassembly, rupture, or fire. Residual OCV ≥ 90% of pre-test voltage.
T4	**Shock**	PASS No mass loss, leakage, venting, disassembly, rupture, or fire. Residual OCV ≥ 90% of pre-test voltage.
T5	**External Short Circuit**	PASS External case temperature does not exceed 170°C; no disassembly, rupture, or fire within 6 hours.
T6	**Impact / Crush**	PASS External case temperature does not exceed 170°C; no disassembly or fire within 6 hours.
T7	**Overcharge**	PASS No disassembly or fire observed during test and over a 7-day post-test monitoring period.
T8	**Forced Discharge**	PASS No disassembly or fire observed during test and over a 7-day post-test monitoring period.

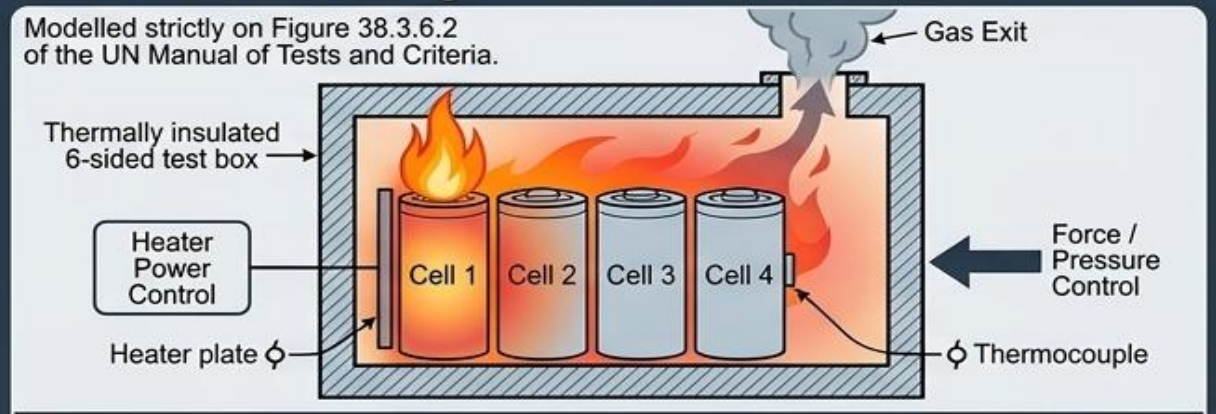
Universal Baseline: Disassembly or fire at any point constitutes an immediate failure. Tests T1 through T5 must be conducted sequentially on the same sample set.

EXISTING TRANSPORT PROVISIONS



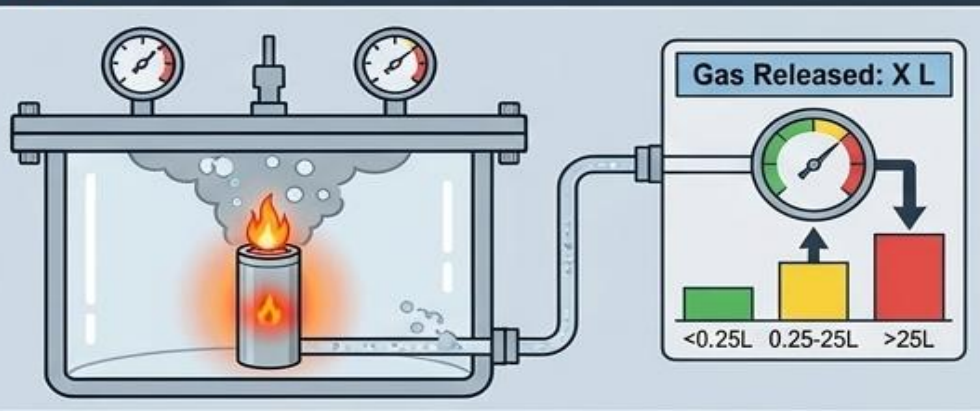
NEW TEST PROTOCOL – IN ADDTION TO T1-T8

Test T.9: Cell Propagation Test



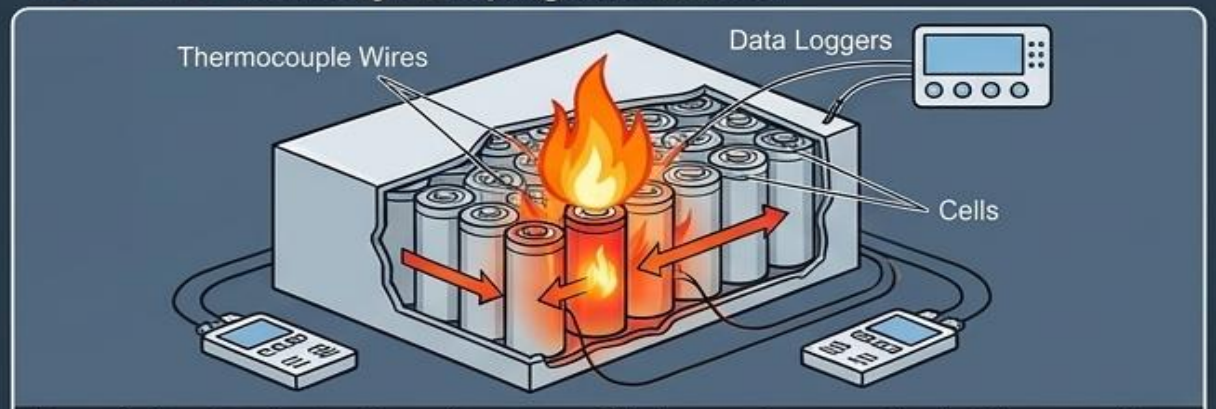
Description: Evaluates single-cell thermal runaway, flame generation, maximum surface temperature, and thermal propagation across adjacent cells in a row.

Test T.10: Cell Gas Volume Determination



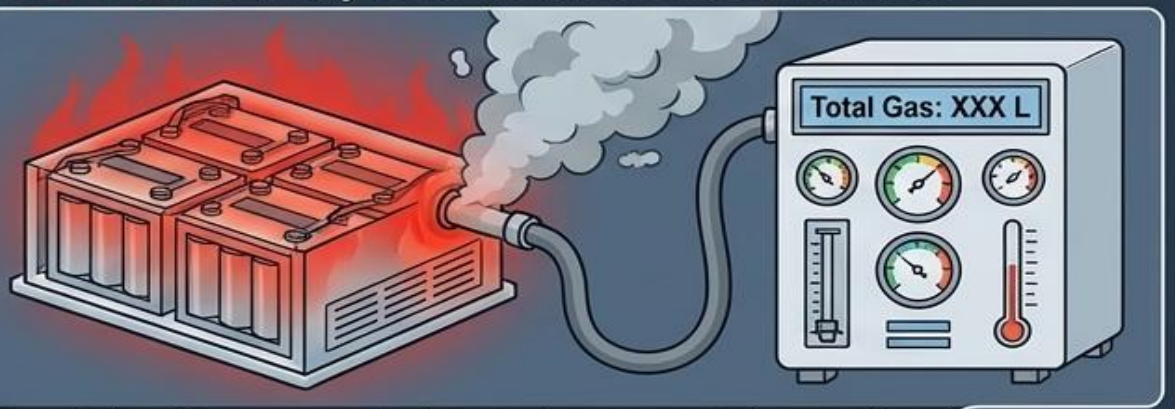
Description: Measures specific gas volume released by a single cell in thermal runaway (<0.25L, 0.25-25L, >25L).

Test T.11: Battery Propagation Test



Description: Evaluates thermal runaway initiation and propagation inside a complete battery pack or between neighboring batteries.

Test T.12: Battery Gas Volume Determination



Description: Measures or calculates total gas generated across all reacting cells in a full battery pack during thermal runaway.

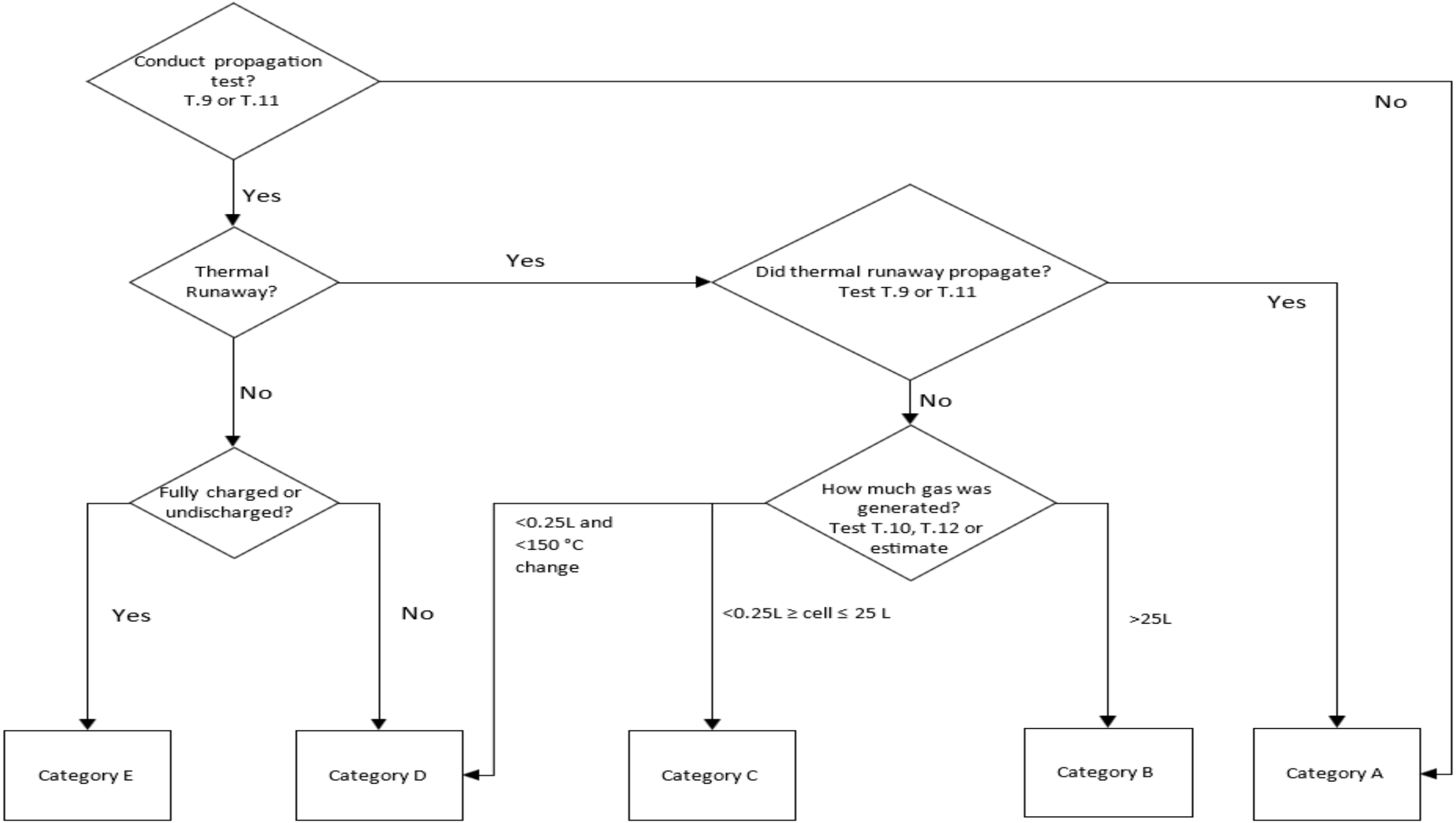
Gemini
Gemini Notebook

TEST PROTOCOL

5 Basic Classification Results

A. Thermal runaway **&** propagation
B. Thermal runaway with **no** propagation w/ over 25 liters of flammable gas (per cell/battery)
C. Thermal runaway with **no** propagation with flammable gas between .25 and 25 liters (per cell/battery)
D. No thermal runaway (or propagation) but only through a reduced state of charge*
E. No thermal runaway at full charge

*Or thermal runaway with no propagation and less than .25 liters of flammable gas


Conduct propagation test?
T.9 or T.11
No
Yes
Thermal Runaway?
Yes
Did thermal runaway propagate?
Test T.9 or T.11
Yes
No
No
Fully charged or undischarged?
How much gas was generated?
Test T.10, T.12 or estimate
Yes
No
<0.25L and <150 °C change
<0.25L ≥ cell ≤ 25 L
>25L
Category E
Category D
Category C
Category B
Category A

CLASSIFICATION

Cells and batteries not tested via T.9 to T.12 are assigned to Category A

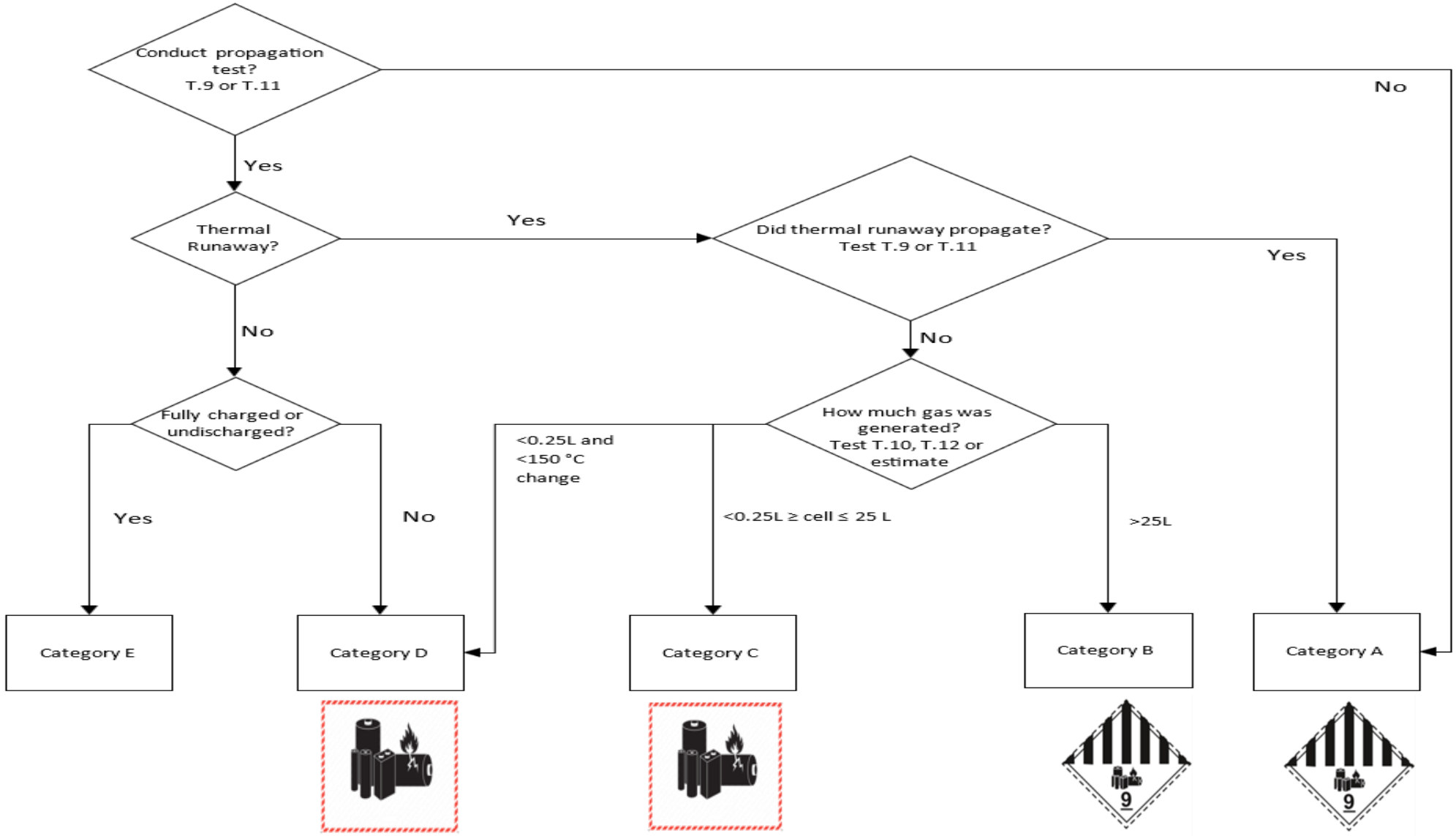
Cells and batteries can be tested at alternate states of charge (SOC) and assigned to hazard categories = test results

Results in 10 new UN Numbers:
UN 3601 – UN 3610

5 for lithium metal cells and batteries

5 for lithium ion and sodium ion cells and batteries

TRANSPORT PROVISIONS



TRANSPORT PROVISIONS

CATEGORY	CLASSIFICATION CRITERIA (Tests T.9-T.12)	UN NUMBERS (Lithium Metal / Li-ion & Na-ion)	TRANSPORT PROVISIONS
A	Thermal runaway **WITH** propagation across adjacent cells.	UN 3601 / UN 3606	**FULLY REGULATED** Full DG Regulations, Class 9 Label 9A, Declaration, P903/P910/P91X
B	Thermal runaway **WITHOUT** propagation; Gas Volume > 25 L.	UN 3602 / UN 3607	
C	Thermal runaway **WITHOUT** propagation; Gas Volume 0.25 L to 25 L.	UN 3603 / UN 3608	**SP 188-LIKE PROVISIONS** Special Provision 41y Exemption, P91X / 1.2m drop-tested packaging, Battery Mark, Quality Mgmt
D	Thermal runaway **WITHOUT** propagation; Gas Volume < 0.25 L & Temp Rise < 150 °C.	UN 3604 / UN 3609	
E	**NO** thermal runaway initiated at 100% SOC.	UN 3605 / UN 3610	**RELIEF (SP 41z)** Special Provision 41z Relief, Exempt from other DG rules, Strong packaging, Short circuit/damage protection







Gemini Notebook

Additional proposed transport provisions

- Transport at a reduced SOC provided:
  - Consignor demonstrates and validates through instrumentation, physical process, inventory control or similar capability, or through a quality management programme mentioned in 2.9.4.1(e) that the cells and batteries offered for transport do not exceed the state of charge used to assign the category; and
  - Test summary includes the category the cell or battery is offered at a specific SOC and the category assigned to the cell or battery at full charge

TRANSITION PERIOD

LEGACY UN NUMBERS & IMPLEMENTATION TIMELINE

LEGACY SYSTEM

- **UN 3480 / UN 3481** (Lithium Ion Cells & Batteries)
- **UN 3090 / UN 3091** (Lithium Metal Cells & Batteries)
- **UN 3551 / UN 3552** (Sodium Ion Cells & Batteries)

⚠ SPECIAL PROVISION 41x

Existing battery entries remain valid in the Dangerous Goods List. Shippers may continue using legacy classifications, marks, and UN numbers under Special Provision 41x through December 31, 2032.

TRANSITION TIMELINE

Jan 1, 2029 – Dec 31, 2032

VOLUNTARY TRANSITION WINDOW

Early adoption of Hazard Categories A–E (UN 3601–3610) and new classification criteria is optional & permitted

On & After Jan 1, 2033

MANDATORY ENFORCEMENT

Legacy Special Provision 41x provisions sunset.
Full compliance with Hazard Categories A–E (UN 3601–3610) required.

BATTERY APPLICATIONS NOT ADDRESSED



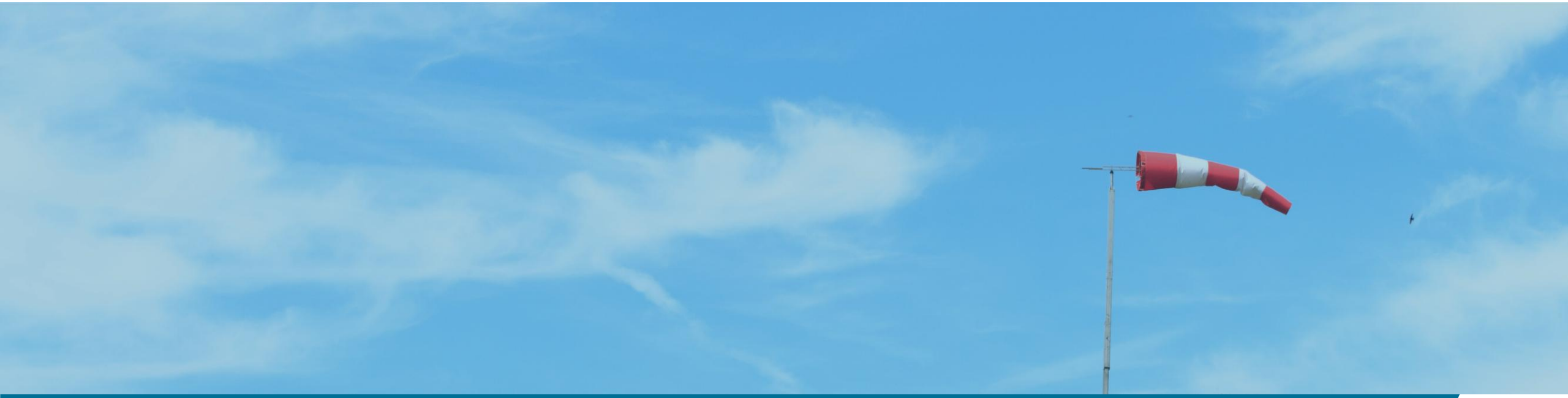




CONCLUSION

- Unique battery testing protocol based on failure
- State of charge can determine transport conditions
- 5 Different Categories (A-E)
- Transition period through 31 December 2032
- Additional work for batteries contained in equipment
- More granularity to allow for safe transport of lithium batteries by all modes

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Thank you for your attention!

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