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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 1 December 2016

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Item 2 (d) of the provisional agenda
Recommendations made by the Sub-Committee on its forty-seventh, forty-eighth and forty-ninth sessions and pending issues: electric storage systems

Transport of damaged/defective Lithium Batteries, Step I

Transmitted by the expert of RECHARGE and OICA

After the presentation and the discussion of the working paper **ST/SG/AC.10/C.3/2016/67** at the fiftieth session of the ECOSOC Sub-Committee of Experts on the Transport of Dangerous Goods RECHARGE and OICA submitted the INF50 and had a discussion in the Thursday lunchtime with interested delegates. As a result of this RECHARGE and OICA are submitting this Informal Document according to the comments of the delegates during this discussion. The changes in comparison to the WP67 are highlighted in yellow.

SP376

"Lithium ion cells or batteries and lithium metal cells or batteries identified as being damaged or defective such that they do not conform to the type tested according to the applicable provisions of the Manual of Tests and Criteria shall comply with the requirements of this special provision.

For the purposes of this special provision, these may include, but are not limited to:

- Cells or batteries identified as being defective for safety reasons;
- Cells or batteries that have leaked or vented;
- Cells or batteries that cannot be diagnosed prior to transport; or
- Cells or batteries that have sustained physical or mechanical damage.

***NOTE:** In assessing a battery as damaged or defective, the type of battery and its previous use and misuse shall be taken into account.*

Cells and batteries shall be transported according to the provisions applicable to UN 3090, UN 3091, UN 3480 and UN 3481, except Special Provision 230 and as otherwise stated in this special provision.

Cells and batteries shall be packed in accordance with packing instructions P908 of 4.1.4.1 or LP904 of 4.1.4.3, as applicable.

Cells and batteries identified as damaged or defective and liable to rapidly disassemble, dangerously react, produce a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive or flammable gases or vapours under normal conditions of transport shall be transported in accordance with packing instructions P9XX of 4.1.4.1 or LP9XX of 4.1.4.3.

Alternative packaging and/or transport conditions may be authorized by the competent authority.

Packages shall be marked "DAMAGED/DEFECTIVE" in addition to the proper shipping name, as stated in 5.2.1.

The transport document shall include the following statement: "Transport in accordance with special provision 376".

If applicable, a copy of the competent authority approval shall accompany the transport.

P9XX	***PACKING INSTRUCTION***	***P9XX***

This instruction applies to damaged or defective cells and batteries of UN Nos. 3090, 3091, 3480 and 3481 liable to rapidly disassemble, dangerously react, produce a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive or flammable gases or vapours under normal conditions of transport.

The following packagings are authorized, provided that the general provisions of 4.1.1 and 4.1.3 are met:

For cells and batteries and equipment containing cells and batteries:

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

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

Jerricans (3A2, 3B2, 3H2)

The packagings shall conform to the packing group I performance level.

(1) The packaging has to be capable of meeting the following additional performance requirements in case of rapid disassembly, dangerous reaction, production of a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive or flammable gases or vapors of the cell or battery:

(a) The outside surface temperature of the completed package shall not have a temperature of more than 100°C. A momentary spike in temperature up to 200°C is acceptable.

(b) No flame will occur outside,

(c) No projectiles will exit the package,

(d) Maintain the integrity of the packaging.

The packagings shall have a gas management system (e.g. filter system, air circulation, containment for gas, gas tight packaging etc.), as appropriate.

(2) The additional packaging performance requirements shall be verified by a test as specified by the competent authority.*

A verification report shall be available on request. As a minimum requirement, the cell and battery name, the cell and battery number, the weight, type, energy content of the cells and batteries, the packaging identification and the test data according to the verification method as specified by the competent authority shall be listed in the verification report.

(3) When dry ice or liquid nitrogen is used as a coolant, the requirements of section 5.5.3 shall apply. The inner packaging and outer packaging shall maintain their integrity at the temperature of the refrigerant used as well as the temperatures and the pressures which could result if refrigeration were lost.

Additional requirements:
Cells and batteries shall be protected against short circuit.

**Note:*
The competent authority may use the following criteria, as relevant, to assess the performance of the packaging:

(a) The test and calculation shall be done under a quality management system (as described e.g. in section

2.9.4. (e)) allowing for the traceability of tests results, reference data and characterization models used.

(b) *The list of hazards expected in case of thermal runaway of the battery type, in the condition it is transported [e.g. usage of an inner packaging, SOC, usage of sufficient non-combustible, non conductive and absorbent cushioning material etc.) , shall be clearly identified and quantified: the reference list of possible hazards for Lithium batteries (rapidly disassemble, dangerously react, produce a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive or flammable gases or vapours)can be used for this purpose. The quantification of this hazards shall rely on available scientific literature*

(c) *The mitigations effects of the packaging shall be identified and characterized, based on the nature of the protections provided and the construction material properties. A list of technical characteristics and drawings shall be used to support this assessment (Density [kg·m^{-3}], specific heat capacity [J·kg^{-1}·K^{-1}], heating value [KJ·kg^{-1}], thermal conductivity [W·m^{-1}·K^{-1}], melting temperature and flammability temperature [K], heat transfer coefficient of the outer packaging [W·m^{-2}·K^{-1}], ...)*

(d) *The supporting test or calculation shall assess the result of a thermal run-away of the battery inside the packaging in the representative conditions of transport.*

(e) *In case the SOC (state of charge) of the battery is not known, the assessment used, shall be done with the higher possible state of charge corresponding to the battery usage conditions.*

(f) *The surrounding conditions in which the packaging may be used / transported shall be described (including possible consequences of gas or smoke emissions on the environment such as ventilation or other methods) according to the gas management system of the packaging.*

(g) *The tests or the model calculation shall consider the worst case scenario for the thermal runaway triggering and propagation inside the battery: this scenario includes the worst possible failure more in the transport condition, the maximum heat and flame emissions for the possible propagation of the reaction.*

(h) *The scenario consequences shall be assessed over a period covering all possible consequences (i.e. a period of 24 hours).*

LP9XX ***PACKING INSTRUCTION***
LP9XX

This instruction applies to single damaged or defective batteries of UN Nos. 3090, 3091, 3480 and 3481 liable to rapidly disassemble, dangerously react, produce a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive or flammable gases or vapours under normal conditions of transport.

The following large packagings are authorized, provided that the general provisions of 4.1.1 and 4.1.3 are met:

For batteries and equipment containing batteries:

steel (50A)
aluminium (50B)
metal other than steel or aluminium (50N)
rigid plastics (50H)
plywood (50D)
rigid fibreboard (50G)

The packagings shall conform to the packing group I performance level.

(1) The packaging has to be capable of meeting the following additional performance requirements in case of rapid disassembly, dangerous reaction, production of a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive or flammable gases or vapors of the cell or battery:

(a) The outside surface temperature of the completed package shall not have a temperature of more than 100°C. A momentary spike in temperature up to 200°C is acceptable.
(b) No flame will occur outside,
(c) No projectiles will exit the package,
(d) Maintain the integrity of the packaging.

The packagings shall have a gas management system (e.g. filter system, air circulation, containment for gas, gas tight packaging etc.), as appropriate.

(2) The additional packaging performance requirements shall be verified by a test as specified by the competent authority.*

A verification report shall be available on request. As a minimum requirement, the cell and battery name, the cell and battery number, the weight, type, energy content of the cells and batteries, the packaging identification and the test data according to the verification method as specified by the competent authority shall be listed in the verification report.

(3) When dry ice or liquid nitrogen is used as a coolant, the requirements of section 5.5.3 shall apply. The inner packaging and outer packaging shall maintain their integrity at the temperature of the refrigerant used as well as the temperatures and the pressures which could result if refrigeration were lost.

Additional requirements:
Batteries shall be protected against short circuit.

Protection against short circuits includes, but is not limited to:
- *individual protection of the battery terminals,*
- *inner packaging to prevent contact between cells and batteries,*
- *batteries with recessed terminals designed to protect against short circuits, or*
- *the use of a non-conductive and non-combustible cushioning material to fill empty space between the cells or batteries in the packaging.*

*Note:
The competent authority may apply the following criteria, as applicable, to approve the test conditions and/or the calculation method as well as additional requirements for the use of the packaging:

(a) The test and calculation shall be done under a quality management system (as described e.g. in section 2.9.4. (e)) allowing for the traceability of tests results, reference data and characterization models used.

(b) The list of hazards expected in case of thermal runaway of the battery type, in the condition it is transported [e.g. usage of an inner packaging, SOC, usage of sufficient non-combustible, non conductive and absorbent cushioning material etc.) , shall be clearly identified and quantified: the reference list of possible hazards for Lithium batteries (rapidly disassemble, dangerously react, produce a flame or a dangerous evolution of heat or a dangerous emission of toxic, corrosive or flammable gases or vapours)can be used for this purpose. The quantification of this hazards shall rely on available scientific literature

(c) The mitigations effects of the packaging shall be identified and characterized, based on the nature of the protections provided and the construction material properties. A list of technical characteristics and drawings shall be used to support this assessment (Density [$kg \cdot m^{-3}$], specific heat capacity [$J \cdot kg^{-1} \cdot K^{-1}$], heating value [$KJ \cdot kg^{-1}$], thermal conductivity [$W \cdot m^{-1} \cdot K^{-1}$], melting temperature and flammability temperature [K], heat transfer coefficient of the outer packaging [$W \cdot m^{-2} \cdot K^{-1}$], ...)

(d) The supporting test or calculation shall assess the result of a thermal run-away of the battery inside the packaging in the representative conditions of transport.

(e) In case the SOC (state of charge) of the battery is not known, the assessment used, shall be done with the higher possible state of charge corresponding to the battery usage conditions.

(f) The surrounding conditions in which the packaging may be used / transported shall be described (including possible consequences of gas or smoke emissions on the environment such as ventilation or other methods) according to the gas management system of the packaging.

(g) The tests or the model calculation shall consider the worst case scenario for the thermal runaway triggering and propagation inside the battery: this scenario includes the worst possible failure more in the transport condition, the maximum heat and flame emissions for the possible propagation of the reaction.

(h) The scenario consequences shall be assessed over a period covering all possible consequences (i.e. a period of 24 hours).