

This instruction applies to damaged or defective cells and batteries of UN Nos. 3090, 3091, 3480, 3481, 3551 and 3552 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 authorised, 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 must conform to the packing group I performance level.

- (1) The packaging must 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 vapours of the cells or batteries:
 - (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 shall occur outside the package;
 - (c) No projectiles shall exit the package;
 - (d) The structural integrity of the package shall be maintained;
 - (e) 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.

A verification report shall be available on request. As a minimum requirement, the cell or battery name, the cell or battery number, the mass, type, energy content of the cells or 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 requirement:

Cells or batteries must be protected against short circuit.

Table Notes:

- a. *The following criteria, as relevant, may be considered to assess the performance of the large packaging:*
- (a) *The assessment must 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 characterisation models used;*
 - (b) *The list of hazards expected in case of thermal runaway for the cell or battery type, in the condition it is transported (e.g. usage of an inner packaging, state of charge (SOC), use of sufficient non-combustible, electrically non-conductive and absorbent cushioning material etc.), must be clearly identified and quantified; the reference list of possible hazards for lithium cells or 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 these hazards must rely on available scientific literature;*
 - (c) *The mitigating effects of the packaging must be identified and characterized, based on the nature of the protections provided and the construction material properties. A list of technical characteristics and drawings must be used to support this assessment (Density [$\text{kg}\cdot\text{m}^{-3}$], specific heat capacity [$\text{J}\cdot\text{kg}^{-1}\cdot\text{K}^{-1}$], heating value [$\text{kJ}\cdot\text{kg}^{-1}$], thermal conductivity [$\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$], melting temperature and flammability temperature [K], heat transfer coefficient of the outer packaging [$\text{W}\cdot\text{m}^{-2}\cdot\text{K}^{-1}$], ...);*
 - (d) *The test and any supporting calculations shall assess the result of a thermal runaway of the cell or battery inside the large packaging in the normal conditions of transport;*
 - (e) *In case the SOC of the battery is not known, the assessment used, must be done with the highest possible SOC corresponding to the cell or battery use conditions;*
 - (f) *The surrounding conditions in which the packaging may be used and transported must be described (including for 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 must consider the worst case scenario for the thermal runaway triggering and propagation inside the cell or battery: this scenario includes the worst possible failure in the normal transport condition, the maximum heat and flame emissions for the possible propagation of the reaction;*
 - (h) *These scenarios must be assessed over a period of time long enough to allow all the possible consequences to occur (e.g. 24 hours).*
 - (i) *In the case of multiple batteries and multiple items of equipment containing batteries, additional requirements such as the maximum number of batteries and items of equipment, the total maximum energy content of the batteries, and the configuration inside the package, including separations and protections of the parts, must be considered.*