

Lithium Batteries in Multimodal Transport

Ground, sea and air transport of Lithium-batteries

08/31/2010 - WORKSHOP ON TRANSPORT REGULATION FOR USED LITHIUM BATTERIES, Bruessel

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Introduction

Li-ion Batteries for automotive Applications

- Modular concept: Cell → Module → Battery System (Battery Pack)
- Weight and volume of automotive batteries much higher than for consumer applications.
E.g.:
 - HEV Battery system 5 kg – 25 kg
 - EV Battery system 200 kg – 400 kg

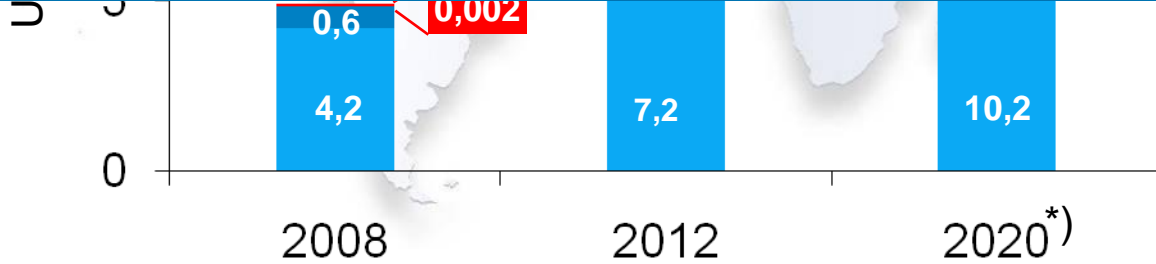


Electrification

Overall market: 70 Mio. 82 Mio. 103 Mio.



Multimodal transport of new, used and defect automotive batteries including batteries integrated in vehicles is an important topic for the electrification of the worldwide automotive market



*) Estimated total production

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Legal basis for the transport of Lithium-batteries

Lithium-batteries (type)





Shipping labeling / description	UN No.	Definition
Lithium- ion -batteries (including Lithium-ion-polymer-batteries)	UN3480	Secondary Lithium-batteries (rechargeable)
Lithium- ion -batteries (including Lithium-ion-polymer-batteries) packed WITH equipment	UN3481	
Lithium- ion -batteries (including Lithium-ion-polymer-batteries) IN equipment	UN3481	
Lithium- metal -batteries	UN3090	Primary Lithium-batteries (<u>non</u> -rechargeable)
Lithium- metal -batteries packed WITH equipment	UN3091	
Lithium- metal -batteries IN equipment	UN3091	

Note: the word "Lithium-batteries" includes all cells and batteries, that contain Lithium in any form.

Legal basis for the transport of Lithium-batteries

Overview: regulations for UN 3090 / UN 3480

Europe

							
Classification	9, II	9, II	9, II	9, II			
Special regulations	188 230 310 348	188 230 310 636	188 230 310 957	A88 A99 A154 A164			
LQ- / EQ-transport	0 / E0	0 / E0	0 / E0	- / E0			
				UN 3090		UN 3480	
				PAX	CAO	PAX	CAO
Packaging regulation	P903	P903 P903a P903b	P903	PI 968		PI 965 Part I Part II	
Amount per package				2,5 kg G	35 kg G	5 kg G	35 kg G
Limiting amount		333 kg					

Legal basis for the transport of Lithium-batteries

Overview: special regulations (SP)



- SP 188** Transport of small cells / batteries under simplified conditions (max. 20 Wh for cells)
- SP 230** Testing and design requirements for cells / batteries
- SP 310** Transport of prototypes and small production runs (≤ 100 pieces)
- SP 348** From 31.12.11 marking with Watt-hour
- SP 636** Used cells / batteries with a gross weight of max. 500 g
- SP 957** Transition period for cells / batteries with a production date before 01.01.2003



- A 48** Packaging without UN-specification (only UN3091 / UN 3481)
- A 88** Transport of prototypes and small production runs
- A 99** Exception for transport of packages with a gross mass > 35 kg (only for UN 3090 / UN 3480)
- A 154** Transport of prototypes and small production runs; prohibition of transport of „defect“ cells / batteries
- A 164** General requirements for the transport of electrical batteries, cordless devices and vehicles

Legal basis for the transport of Lithium-batteries

Overview: packaging instructions for Li-ion Batteries



P 903

- Packaging group II
- Conditions for batteries in and with equipment
- Conditions for batteries > 12kg



Europe

P 903a

- Used batteries with a gross mass > 500g:
- Packaging group II
 - Conditions for packages ≤ 30kg

P 903b

- Used batteries with a gross mass ≤ 500g, only for disposal and for collection with other battery types:
- 1H2, 4H2 on packaging group II
 - 1A2, 4A on packaging group II with add. Req.
 - Conditions for packages ≤ 30kg



PI 965

General Reg: Test and design requirements according SP 230 UN Rec.

Section I: Fully regulated Li-Ion Batteries

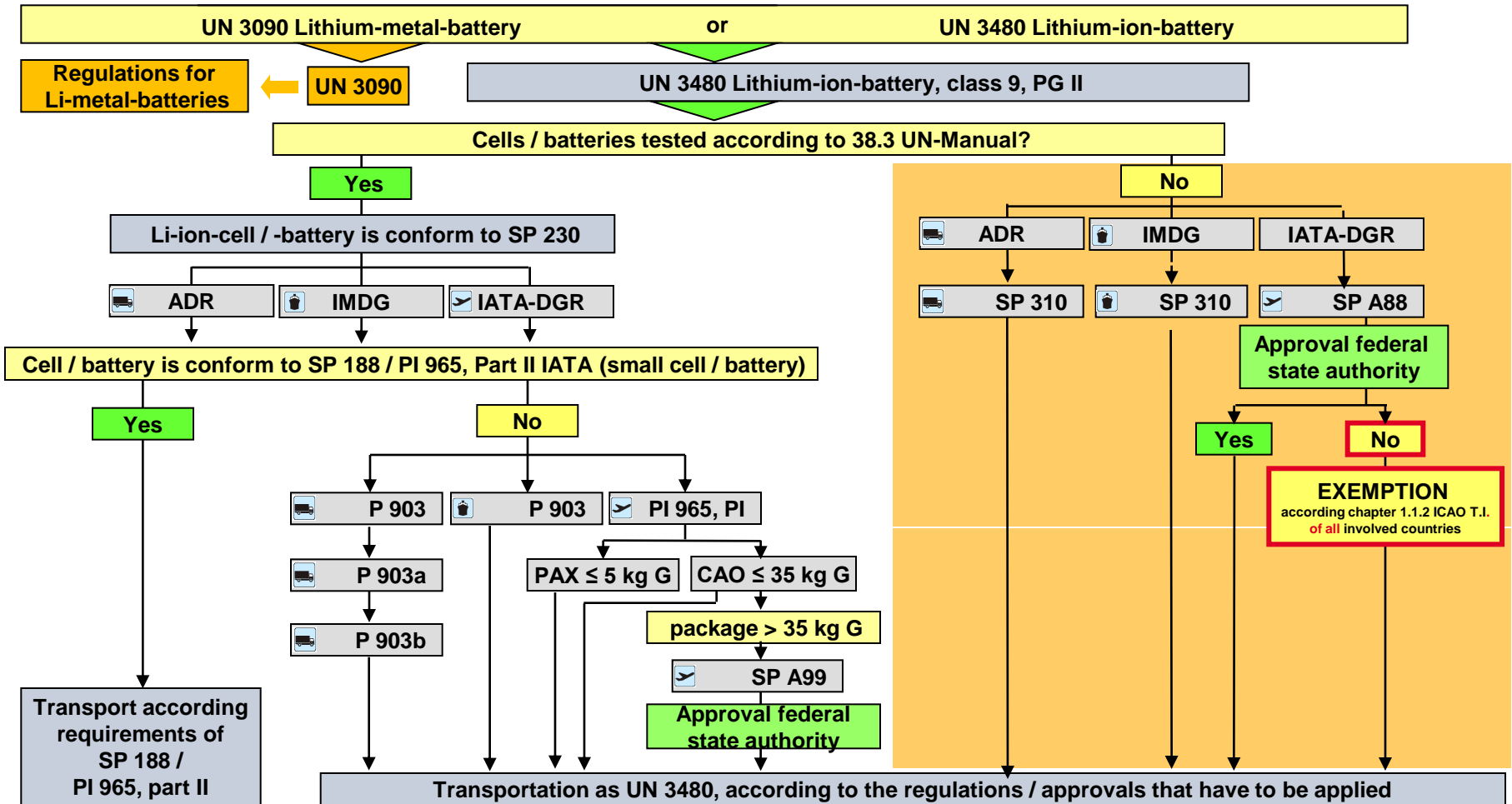
- Packaging group II
- Conditions for batteries > 12kg
- Max. Quantity per package: PAX 5 kg; CAO 35 kg

Section II: Excepted Li-Ion Batteries

- Special conditions for cells ≤ 20 Wh / batteries ≤ 100 Wh

Legal basis for the transport of Lithium-batteries

Decision matrix on the application for UN 3090 / UN 3480



Test series acc. to subsection 38.3 UN-manual of Tests and Criteria

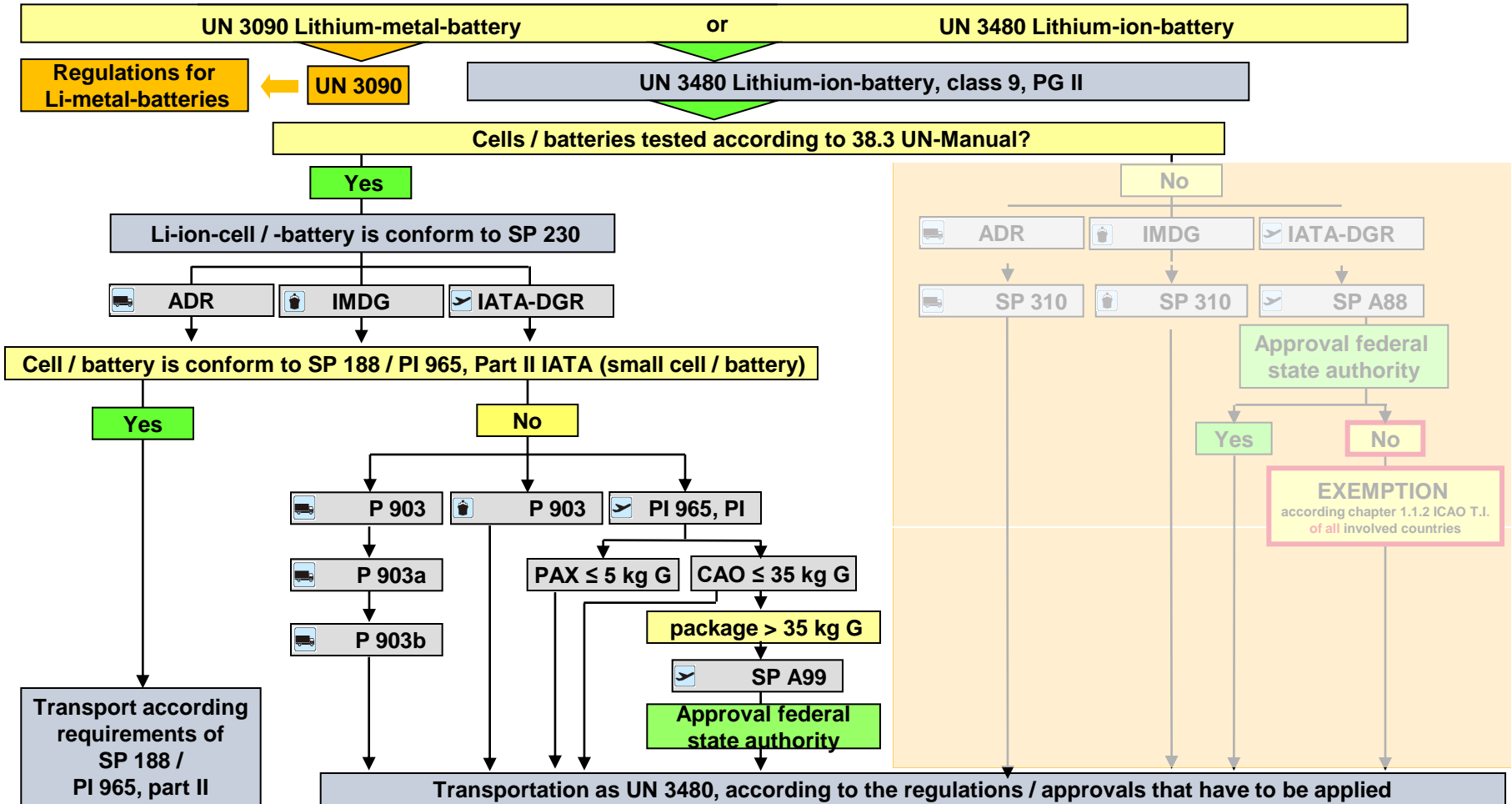
Test	Li-cell	Li-battery	Testing criteria
1. Altitude simulation (11.6 kPa at 20 °C ± 5°C)	X	X	<ul style="list-style-type: none"> ➔ No mass loss ➔ No leakage ➔ No venting ➔ No disassembly ➔ No breakage ➔ No fire ➔ OCV after test not smaller than 90% compared to beginning of test
2. Thermal test (75 °C / -40°C)	X	X	
3. Vibration (1 – 8g)	X	X	
4. Shock (150g / 50 g, 18 times)	X	X	
5. External short circuit	X	X	
6. Impact (9.1 kg from 0.62m)	X	Not required	<ul style="list-style-type: none"> ➔ No disassembly ➔ No fire within 7 days after end of test
7. Overcharge	Not required	X	
8. Forced discharge	X	Not required	



WITHOUT complete and successful tests a legal transport of batteries from mass production is not possible

Legal basis for the transport of Lithium-batteries

Decision matrix on the application for UN 3090 / UN 3480



Legal basis for the transport of Lithium-batteries

Special provision (SP) 230

SP 230 - general requirements



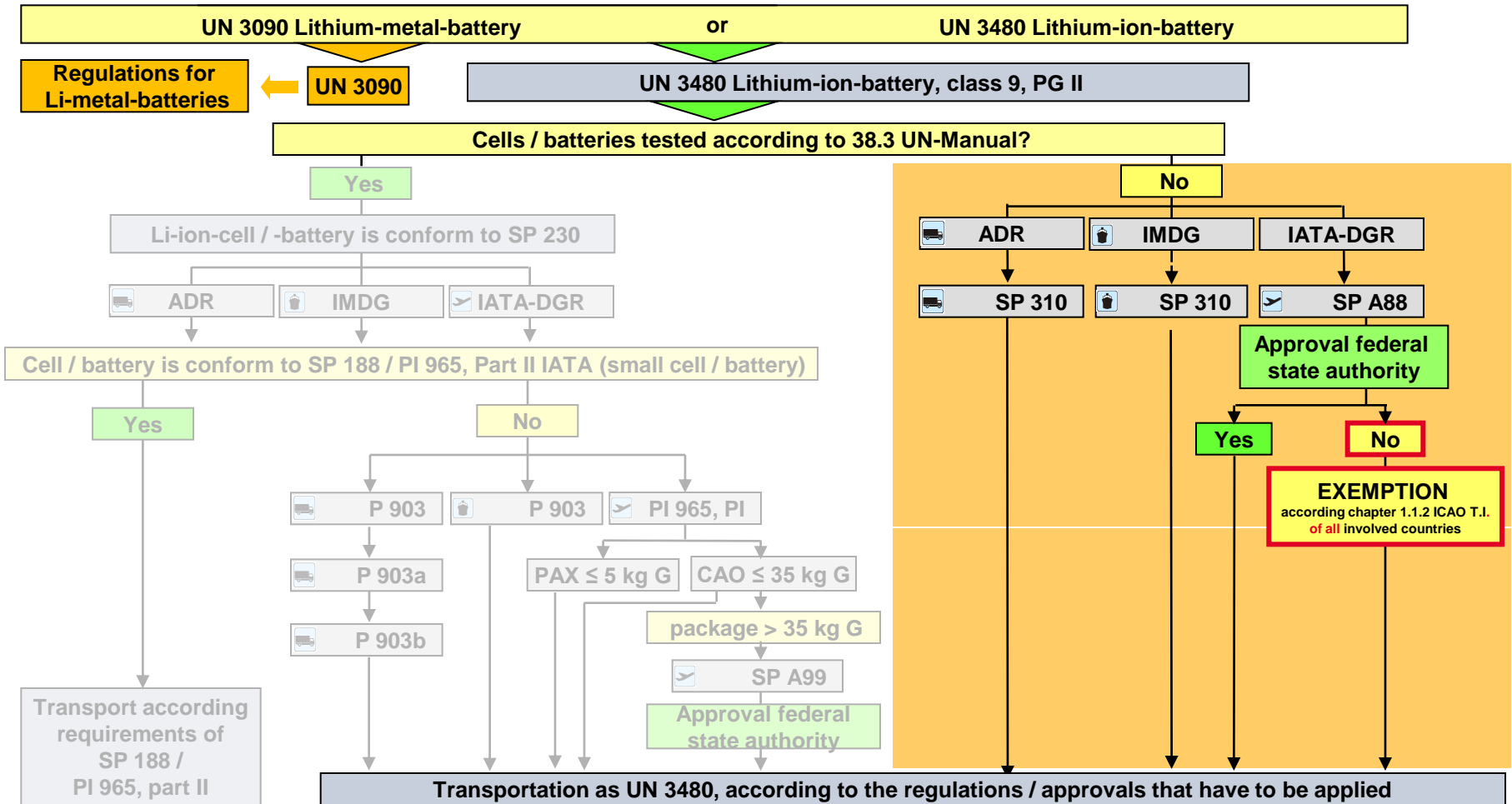
→ Term contains each kind of cell / battery that contains Lithium, including Lithium-polymer- or Lithium-ion-cells or batteries

Transport of Lithium-cells / -batteries is permitted if:

- Cell / battery is consistent with a **kind / type** that has been tested according to **UN-manual „Tests and Criteria“**, part III subsection
- Cells / batteries are equipped with **protection devices against inner overpressure** **OR** against forced rupture under normal transport conditions
- Cell / battery is equipped with an active device to **prevent outer short circuits**
- Cells connected in parallel or batteries containing parallel connected cells are equipped with an **active device to prevent dangerous back currents** (e.g. diodes, fused...)

Legal basis for the transport of Lithium-batteries

Decision matrix on the application for UN 3090 / UN 3480



Transport of prototypes and pre-production samples

Special provision (SP) 310

SP 310 – ADR / IMDG-Code



Valid for:

- **UN 3090 / UN 3480 Lithium-cells and –batteries**
- **without testing** according to subsection 38.3 of the UN-manual
- **Series of production of max. 100 Lithium-cells and –batteries**
- **Pre-production prototypes of Lithium-cells and –batteries**
- **Transportation exclusively for the purpose of testing**

Requirements:

- **Outer package** + barrel made of metal, plastic or wallboard
+ box made of metal, plastic or wood
- **Outer package** corresponds to **packaging group I (X-coding)**
- **Each cell / battery packed individually in an inner packages** inside of the outer package
- Usage of **non-flammable, non-conductive padding material**

7. Transport of prototypes and pre-production samples

7.3 Air transport according to SP A88 – IATA DGR

Special Provision A88 – IATA-DGR



Valid for:

- ➔ **Prototypes / test model** of cells / batteries **without testing** according to subsection 38.3 of the UN-manual

Requirements:

- ➔ **Approval of the responsible authority** of the country of origin
- ➔ **Maximum 24 cells or 12 batteries per package**
- ➔ **Outer case** + barrel made of metal, plastic or wallboard
+ box made of metal, plastic or wallboard
- ➔ **Outer case** corresponds to **packaging group I (X-coded)**
- ➔ Each **cell / battery individually packed in an inner packages** within the outer case
- ➔ Usage of **non-flammable, non-conductive padding material**

Remark:

- ➔ **PAX 5 kg and CAO 35 kg limitation is still valid (Blue pages IATA)**

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Open questions

→ Regulations for used batteries for UN recommendations and for sea transport has to be defined.

Conditions for used batteries may differ:

- › Used batteries which have the same quality and safety as new batteries
- › Used batteries which are at their end-of-life without further defects
- › Used batteries which are defect.

Open questions

- Defect batteries have to be transported during their life time for recycling as well as for analysis of the defects :
- Development phase: Prototypes will be tested in order to ensure a safe product and may be defect after testing (Electrical, environmental and abuse testing, vehicle crash tests)
 - Series production: Series products may get defect due to e.g. accidents or at end-of-life

Open questions

- Regulations for defect batteries for UN recommendations and for all mode of transportation has to be defined (defect prototypes, defect series batteries)

- Criteria of “defect battery” has to be defined. Different cases exist, e.g.:
 - › Batteries which are defect but have no limitations for safe transport
 - › Batteries which are defect but have limitations for safe transport:
(Defective for safety reasons or damaged see IATA SP A154)

- Identification of tested batteries