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1. Introduction

Transport of lithium ion batteries is in the scope of Dangerous Goods Transport Regulations. Therefore many specific requirements have to be respected for their transport.
The following recommendations have been created to provide initial practical guidance to the regulations of the transport of lithium ion batteries.

It refers to the commercial transport by

- Road / Rail (ADR/RID)
- Seafreight (IMDG)
- Airfreight (IATA)

Lithium ion batteries are classified as follows:

- UN3480 Lithium Ion batteries
- UN3481 Lithium Ion batteries contained in equipment
- UN3481 Lithium Ion batteries packed with equipment

Especially the watt-hour rating and other conditions classify which dangerous goods regulations must be taken into account for the transport of lithium ion batteries. Please refer to the product data sheet.

For all shipments, it is required that all personnel involved in the preparation and transport of lithium ion cells or batteries receive adequate instruction on these requirements or Dangerous Goods training.

In individual cases, a dangerous goods expert should be consulted. Local authorities are responsible for the interpretation and implementation of the relevant regulations. They can make decisions differing from this guidelines. Therefore, no liability can be assumed for the content and the completeness of this document.

2. Provisions for Lithium Batteries carried by Passengers on Aircrafts

Certain restrictions apply to the carriage of lithium metal and lithium ion batteries even when carried by passengers as baggage. Only batteries that have successfully passed the Tests outlined in Part III, Sub Section 38.3 of the UN Manual of tests and criteria may be carried.

IATA Table 2.3.A Provisions for Dangerous Goods Carried by Passengers or Crew (Subsection 2.3):

	The approval of the operator is required	Permitted in or as checked baggage	Permitted in or as carry-on baggage	The pilot-in-command must be informed of the location
Lithium Batteries: Portable electronic devices containing lithium metal or lithium ion cells or batteries, including medical devices such as portable oxygen concentrators (POC) and consumer electronics such as cameras, mobile phones, laptops and tablets, when carried by passengers or crew for personal use (see 2.3.5.9). For lithium metal batteries the lithium metal content must not exceed 2 g and for lithium ion batteries the Watt-hour rating must not exceed 100 Wh. Devices in checked baggage must be completely switched off and must be protected from damage.	NO	YES	YES	NO
Lithium batteries, spare/loose with a Watt-hour rating exceeding 100 Wh but not exceeding 160 Wh for consumer electronic devices and Portable Medical Electronic Devices (PMED) or with a lithium content of 2 g but not exceeding 8 g for PMED only. Maximum of two spare batteries may be carried in carry-on baggage only. These batteries must be individually protected to prevent short circuits.	YES	NO	YES	NO
Lithium battery-powered electronic devices. Lithium ion batteries for portable (including medical) electronic devices, a Wh rating exceeding 100 Wh but not exceeding 160 Wh. For portable medical electronic devices only, lithium metal batteries with a lithium content exceeding 2 g but not exceeding 8 g. Devices in checked baggage must be completely switched off and must be protected from damage. Devices in checked baggage must be completely switched off and must be protected from damage.	YES	YES	YES	NO

3. Transport regulations for Dangerous Goods

Please refer to the listed regulations for further and detailed information:

ADR: European Agreement concerning the International Carriage of Dangerous Goods by Road,

49 CFR: Code of Federal Regulations, DOT, PHMSA is responsible for regulating movement of hazardous materials by all modes of transportation within the US.

IATA DGR: International Air Transport Association, Dangerous Goods Regulations,

ICAO: International Civil Aviation Organization, Technical Instructions for the Safe Transport of Dangerous Goods by Air,

IMDG Code: International Maritime Dangerous Goods Code,

RID: International Statutory Order on the Conveyance of Dangerous Goods by Rail,

UN: United Nations Recommendations on the Transport of Dangerous Goods

4. UN Transportation Testing (UN DOT 38.3) for Lithium Batteries

Nearly all lithium batteries are required to pass section 38.3 of the UN Manual of Tests and Criteria (UN Transportation Testing) with the following procedure:

T1 – Altitude Simulation (Primary and Secondary Cells and Batteries)
T2 – Thermal Test (Primary and Secondary Cells and Batteries)
T3 – Vibration (Primary and Secondary Cells and Batteries)
T4 – Shock (Primary and Secondary Cells and Batteries)
T5 – External Short Circuit (Primary and Secondary Cells and Batteries)
T6 – Impact (Primary and Secondary Cells)
T7 – Overcharge (Secondary Batteries)
T8 – Forced Discharge (Primary and Secondary Cells)

5. Shipping Guidelines

5.1. Shipment of Lithium Ion Batteries ≤ 100 Wh by Truck / Rail (ADR/RID), Sea Freight (IMDG)

A passed transportation test according section 38.3 of the UN Manual of Tests and Criteria is required!

<table>
<tr><th></th><th colspan="3">Truck / Rail (ADR/RID), Sea Freight (IMDG)</th></tr>
<tr><td></td><td colspan="3">For lithium ion cell the Watt-hour rating is not more than 20 Wh.
For lithium ion battery the Watt-hour rating is not more than 100 Wh.
Lithium ion batteries subject to this provision shall be marked with the Watt-hour rating on the outside case, except those manufactured before 1 January 2009</td></tr>
<tr><td>Packing Instructions</td><td colspan="3">ADR/RID SP188, IMDG SP188</td></tr>
<tr><td>Transportation Mode</td><td>Batteries
(without equipment)
  </td><td>Batteries packed with equipment
  </td><td>Batteries contained in equipment
  </td></tr>
<tr><td>Max. Quantity</td><td colspan="3">none</td></tr>
<tr><td>Weight Limit</td><td>30 kg gross weight per packaging</td><td colspan="2">none</td></tr>
<tr><td>Packaging</td><td colspan="2">Batteries must be placed in inner packagings that completely enclose the battery, batteries must be protected so as to prevent short circuits.

Strong outer packaging, e.g. fibreboard box (drop test passed: content shall not be damaged or shifted).</td><td>Strong outer packaging

Protection against unintentional activation

Short circuit protection</td></tr>
<tr><td>Marking</td><td colspan="2">Minimum dimensions: 120 x 110 mm
  </td><td>Except for packages containing button cell batteries installed in equipment (including circuit boards), or no more than four cells installed in equipment or no more than two batteries installed in equipment, each package shall be marked with the following:

Minimum dimensions: 120 x 110 mm
  </td></tr>
<tr><td>Sea Freight Container-Marking</td><td colspan="3">none</td></tr>
<tr><td>Transport Document</td><td colspan="3">none</td></tr>
<tr><td>Miscellaneous</td><td colspan="3">Work instruction of involved staff</td></tr>
</table>

5.1.1. Example: Packaging containing batteries ≤ 100 Wh, SP188

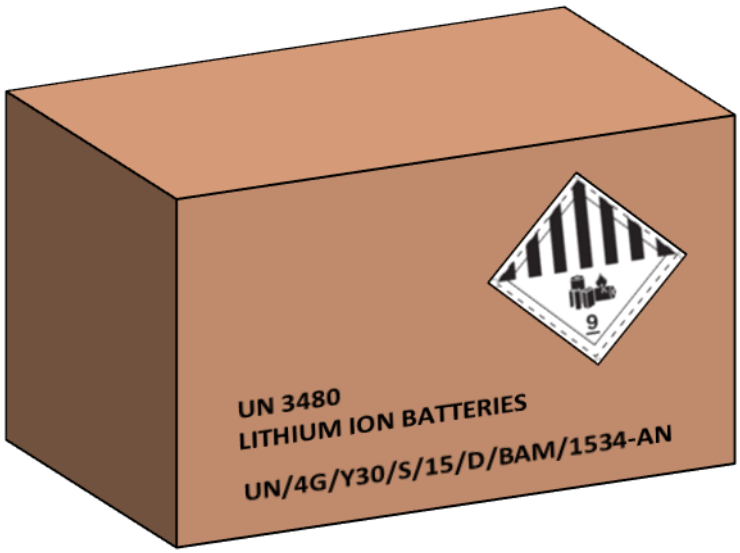
Max. content: 30 Kg G (G = gross weight) per packaging

5.2. Shipment of Lithium Ion Batteries > 100 Wh by Truck / Rail (ADR/RID), Sea Freight (IMDG)

A passed transportation test according section 38.3 of the UN Manual of Tests and Criteria is required!

	Truck / Rail (ADR/RID), Sea Freight (IMDG)		
	For lithium ion cell the Watt-hour rating is more than 20 Wh. **For lithium ion battery the Watt-hour rating is more than 100 Wh.**		
Packing Instructions	ADR/RID P903 IMDG P903		
Transportation Mode	Batteries (without equipment) 	Batteries packed with equipment 	Batteries contained in equipment 
Max. Quantity	none		
Weight Limit	ADR 1.1.3.6: max. 333 kg / per transport unit (truck incl. trailer) If exceeding weight limit, additional requirements to the carrier required		
Packaging	Batteries must be placed in inner packagings that completely enclose the battery, batteries must be protected to prevent short circuits. Batteries must be secured against movement within the outer packaging. UN approved packaging (Packing Group II: e.g. UN/4G/Y30/...)		strong outer packaging protection against unintentional activation short circuit protection
	In addition for cells or batteries with a gross mass of 12 kg or more employing a strong, impact resistant outer casing, and assemblies of such cells or batteries: (a)Strong outer packagings; (b)Protective enclosures (e.g. in fully enclosed or wooden slattedcrates); or (c)Pallets or other handling devices. Cells or batteries shall be secured to prevent inadvertent movement, and the terminals shall not support the weight of other superimposed elements.		
Marking	Label (10x10 cm)  ADR: UN 3480 IMDG: UN 3480 LITHIUM ION BATTERIES	Label (10x10 cm)  ADR: UN 3481 IMDG: UN 3481 LITHIUM ION BATTERIES PACKED WITH EQUIPMENT	Label (10x10 cm)  ADR: UN 3481 IMDG: UN 3481 LITHIUM ION BATTERIES CONTAINED IN EQUIPMENT
Sea Freight Container-Marking	CONTAINER-PLACARDS (min. 25x25 cm) 		
Transport Document	UN 3480, LITHIUM ION BATTERIES, 9, (E) Number of packages and packaging type (e.g. 1 Fibreboard box) Battery weight (e.g. xx kg), Transport category 2 Shipper & consignee's address Sea freight (IMDG): (language English) IMO-DANGEROUS GOODS DECLARATION (SOLAS 74, KAP. VII, REG 5, MARPOL 73/79, ANNEX III REG. 4 OF IMDG-CODE)	UN 3481, LITHIUM ION BATTERIES PACKED WITH EQUIPMENT, 9, (E) Number of packages and packaging type (e.g. 1 Fibreboard box) Battery weight (e.g. xx kg) Transport category 2 Shipper & consignee's address Sea freight (IMDG): (language English) IMO-DANGEROUS GOODS DECLARATION (SOLAS 74, KAP. VII, REG 5, MARPOL 73/79, ANNEX III REG. 4 OF IMDG-CODE)	UN 3481, LITHIUM ION BATTERIES CONTAINED IN EQUIPMENT, 9, (E) Number of packages and packaging type (e.g. 1 Fibreboard box) Battery weight (e.g. xx kg) Transport category 2 Shipper & consignee's address Sea freight (IMDG): (language English) IMO-DANGEROUS GOODS DECLARATION (SOLAS 74, KAP. VII, REG 5, MARPOL 73/79, ANNEX III REG. 4 OF IMDG-CODE)
Miscellaneous	Work instruction of involved staff		

5.2.1. Example: Packaging containing batteries > 100 Wh, UN3480, P903



Max. content: as per UN packaging (e.g. Y30 = 30 Kg G)

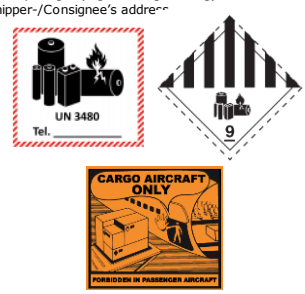
5.2.2. Example: Packaging containing batteries > 100 Wh, UN3480, P903, overpack used

Max. content: 333 Kg G / shipment (Truck), if exceeding, additional requirements to the carrier will be needed

5.3. Shipment of Lithium Ion Batteries ≤ 100 Wh by Air Freight (IATA)

A passed transportation test according section 38.3 of the UN Manual of Tests and Criteria is required!

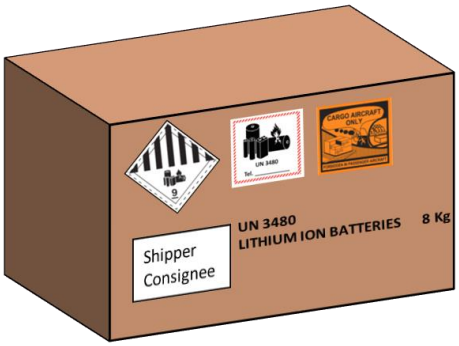
For IATA **PI965** SEC IB and II only**:** Lithium ion cells and batteries must be offered for transport at a state of charge (SoC) not exceeding 30% of their rated design capacity!

	Airfreight (IATA)			
	For lithium ion cell the Watt-hour rating is not more than 20 Wh. **For lithium ion battery the Watt-hour rating is not more than 100 Wh.** **Lithium ion batteries subject to this provision shall be marked with the Watt-hour rating on the outside case, except those manufactured before 1 January 2009**			
Packing Instructions	**IATA PI965 Section IB**	**IATA PI965 Section II**	**IATA PI966 Section II**	**IATA PI967 Section II**
Transportation Mode	Batteries (without equipment) 		Batteries packed with equipment 	Batteries contained in equipment 
Max. Quantity	none (more than 8 cells or 2 batteries per packaging)	2 batteries per package, 1 package per consignment 1 package per overpack	number required for equipment plus 2 spare	none
Weight Limit PAX	prohibited	prohibited	5 kg net battery weight per packaging	
Weight Limit CAO	10 kg net per packaging	N/A		
Packaging	Batteries must be placed in inner packaging that completely encloses the battery Batteries must be protected to prevent short circuits Batteries must be secured against movement within the outer packaging 1.2m drop test			Batteries must be secured against movement within the outer packaging. Equipment containing batteries must be secured and packed to prevent unintended operation during transport Strong outer packaging (cardboard box)
Marking	UN 3480, Lithium ion batteries, battery weight (e.g net weight xx kg) Shipper-/Consignee's addre 			Up to 2 batteries per package: no battery handling label required More than 2 batteries per package: battery handling label required 
Transport Document	Shipper's Declaration for Dangerous Goods: UN 3480 Lithium ion batteries, 9, //_____Fibreboard box(es) x_____kg // 965 // IB, see Example 1, delete the "PASSENGER AND CARGO AIRCRAFT" box	N/A	N/A	N/A
Information on Air Waybill	In the "Handling Information" box: "Dangerous Goods as per Shipper's Declaration CAO"	In the "Nature and Quantity of Goods" box: "Lithium ion batteries in compliance with section II of PI 965 CAO"	In the "Nature and Quantity of Goods" box: „Lithium ion batteries in compliance with section II of PI 966"	Only if more than 2 batteries per package, in the "Nature and Quantity of Goods" box: „Lithium ion batteries in compliance with section II of PI 967"
Miscellaneous	Official IATA-Training by authorized trainer required If not available, please contact IATA authorized expert	Adequate instruction commensurate with responsibilities Batteries <2.7 Wh can be shipped according to PI 965 Section II Max. net quantity per package 2.5 kg		
	Special Provisions: A88, A99, A154, A164, A181, A182, A183, A185, A201, A206, A331			

5.3.1. Example: Packaging containing batteries ≤ 100 Wh, PI 965, SEC II

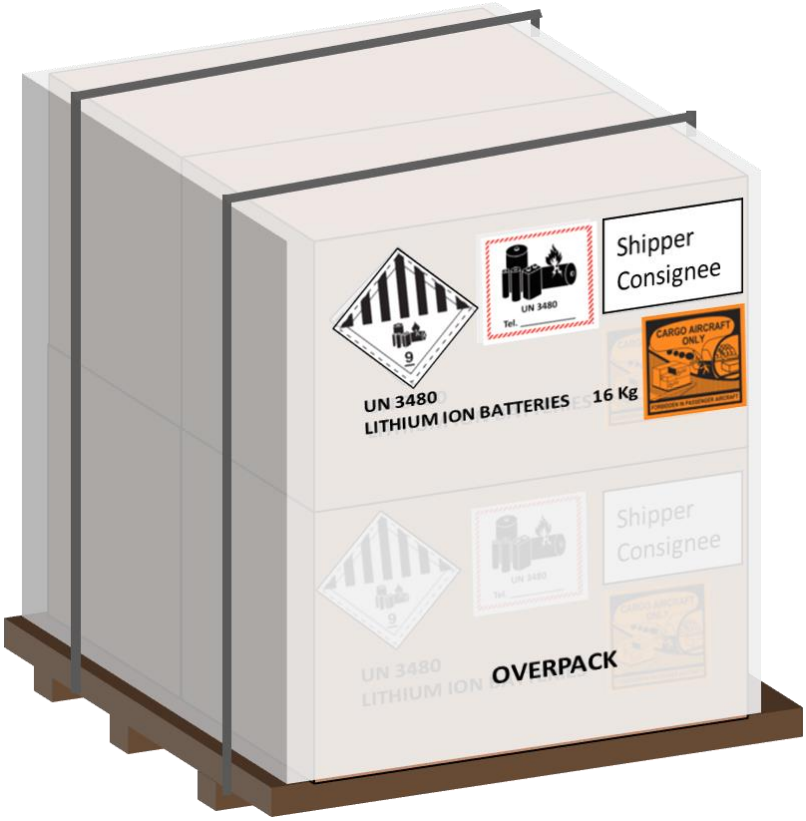
Max. content: 2 batteries per packaging

5.3.2. Example: Packaging containing batteries ≤ 100 Wh, PI 965, SEC IB



Max. content: 10 Kg net per packaging

5.3.3. Example: Packaging containing batteries ≤ 100 Wh, PI 965, SEC IB, overpack used



Max. content: none per overpack (from 01. Jan. 2016 min. size of "OVERPACK" 12mm)

5.4. Shipment of Lithium Ion Batteries > 100 Wh by Air Freight (IATA)

A passed transportation test according section 38.3 of the UN Manual of Tests and Criteria is required!

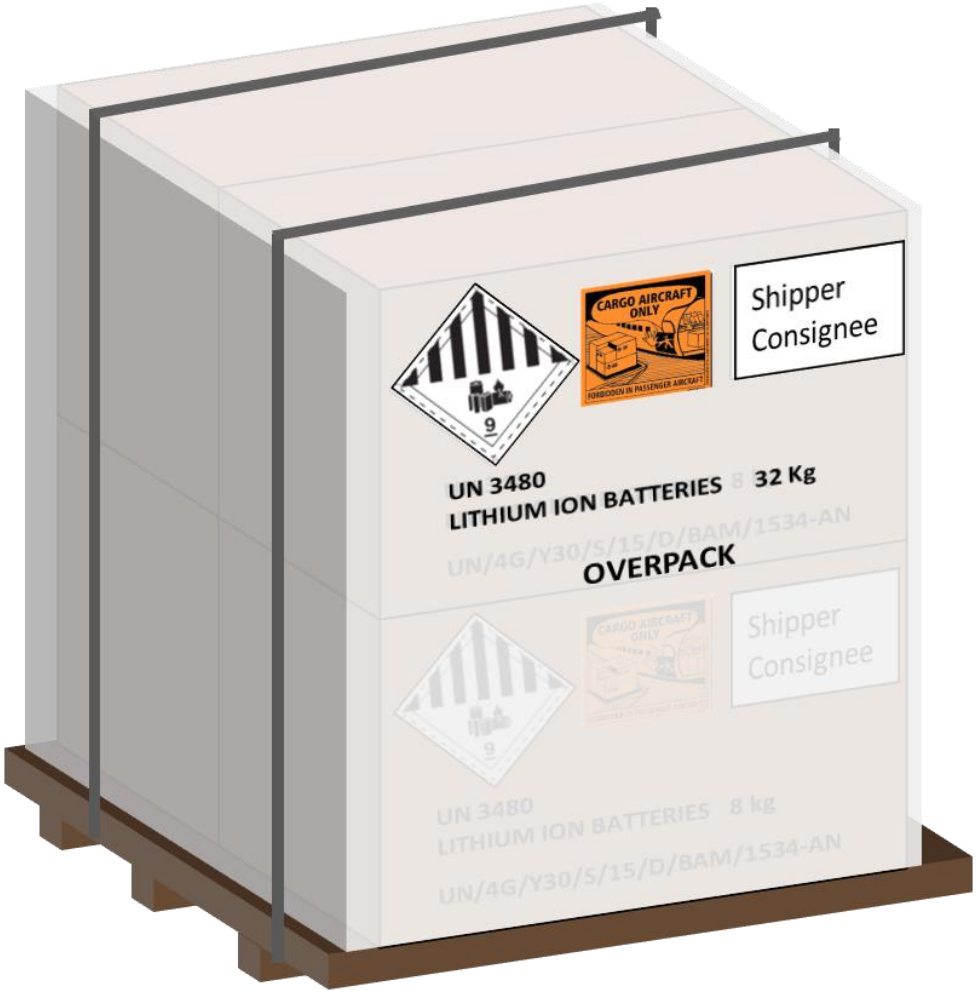
For IATA **PI965** SEC IA only**:** Lithium ion cells and batteries must be offered for transport at a state of charge (SoC) not exceeding 30% of their rated design capacity!

	Airfreight (IATA)		
	For lithium ion cell the Watt-hour rating is more than 20 Wh. **For lithium ion battery the Watt-hour rating is more than 100 Wh.**		
Packing Instructions	IATA PI965 Section IA	IATA PI966 Section I	IATA PI967 Section I IATA SP A48
Transportation Mode	Batteries (without equipment) 	Batteries packed with equipment 	Batteries contained in equipment 
Max. Quantity	none	number required for equipment plus 2 spare	none
Weight Limit PAX	prohibited	5 kg net battery weight per packaging	
Weight Limit CAO	35 kg net battery weight per packaging		
Packaging	Batteries must be placed in inner packaging that completely encloses the battery, batteries must be protected to prevent short circuits UN approved packaging (Packing Group II: e.g. UN 4G/Y30/...)	Batteries must be placed in inner packaging that completely enclose the battery, batteries must be protected so as to prevent short circuits UN approved packaging (Packing Group II: e.g. UN 4G/Y30/...)	Equipment containing batteries must be secured and packed to prevent unintended operation during transport Batteries must be protected to prevent short circuits due to contact to further conductible materials within the same packaging Strong outer packaging (e.g. cardboard box) UN approved packaging not required (SP A48)
Marking	UN 3480, Lithium ion batteries Net weight (NET QTY) Shipper-/Consignee's address  	UN 3481, Lithium ion batteries packed with equipment Net weight (NET QTY) Shipper-/Consignee's address 	UN 3481, Lithium ion batteries contained in equipment Net weight (NET QTY) Shipper-/Consignee's address 
Transport Document	Shipper's Declaration for Dangerous Goods: UN 3480 Lithium ion batteries, 9 // 965, delete the "PASSENGER AND CARGO AIRCRAFT" box	Shipper's Declaration for Dangerous Goods: UN 3481 Lithium ion batteries packed with equipment, 9 // 966	Shipper's Declaration for Dangerous Goods: UN 3481 Lithium ion batteries contained in equipment, 9 // 967
Information on Air Waybill	Dangerous Goods as per attached DGD - Cargo Aircraft only When a shipment contains both dangerous goods and non-dangerous goods, the number of packages containing dangerous goods shall be added in the "Handling Information" box		
Miscellaneous	Official IATA-Training by authorized trainer required. If not available, please contact IATA authorized expert		
	Special Provisions: A88, A99, A154, A164, A181, A182, A183, A185, A201, A206, A331		

5.4.1. Example: Packaging containing batteries > 100 Wh, PI 965, SEC IA

Max. content: 35 Kg net per packaging (CAO)

5.4.2. Example: Packaging containing batteries > 100 Wh, PI 965, SEC IA, overpack used



Weight limit CAO (cargo aircraft only): 35 kg net battery weight per packaging, none for overpack

5.5. Shipment of Lithium Ion Battery Prototypes

Transportation Mode	Prototypes Truck/Rail/Sea Freight	Prototypes Airfreight
	Prototypes: Batteries not tested according UN Test 38.3 **Only for transport of** **• small production series of max. 100 batteries (IATA: p.a.)** **• prototypes for testing reasons only**	
Packing Instructions	ADR/RID/IMDG Code: SP 310, P910	IATA SP A88, P910: Approval required from the Competent Authority of the state of origin Note: to/across/via USA additional approval required from US Authority (DOT)
Max. Quantity	n/a	as defined in approval
Weight Limit	n/a	as defined in approval
Packaging	UN approved packaging: e.g. fibreboard box (Packing Group II: e.g. UN 4G/Y30/...) • Each battery shall be individually packed in an inner packaging, e.g. in a plastic bag • Non-combustible, non-conductive thermal insulation material, e.g. Vermiculite • Must be secured against movement within the outer packaging	as defined in approval
Marking	ADR/RID: UN 3480 IMDG: UN 3480 LITHIUM ION BATTERIES (100 x 100 mm) 	as defined in approval
Transport Document	Shipper's & consignee's address UN 3480 LITHIUM ION BATTERIES, 9, (E) Number of packages and packaging type (e.g. 1 fibreboard box) Battery weight (e.g. xx kg) "CARRIAGE IN ACCORDANCE WITH SPECIAL PROVISION 310" IMDG Code: IMO-DANGEROUS GOODS DECLARATION (SOLAS 74, KAP. VII, REG 5, MARPOL 73/79, ANNEX III REG. 4 OF IMDG-CODE	as defined in approval
Miscellaneous	Work instruction of involved staff	as defined in approval

5.5.1. Example: Packaging containing Lithium Ion Battery Prototypes

5.6. Shipment of damaged or defective Lithium Ion Batteries

Transportation Mode	**Damaged or Defective Batteries**	
	Truck/Rail/Sea (not comply to UN Test 38.3 anymore)	**Air Transport of Damaged or Defective Batteries**
Packing Instructions	SP376 P908	Batteries, that have been identified as defective for safety reasons by the manufacturer, or that have been damaged, that have the potential of producing a dangerous evolution of heat, fire or short circuit, are forbidden for transport (e.g. those being returned to the manufacturer for safety reasons) (IATA A154).
Criteria for "Damaged or Defective"	"Non-critical" (no possible danger during transport) Batteries such that they do not conform to the tested type according to the applicable provisions of the UN Manual of Tests and Criteria, 38.3 This includes • Batteries identified as being defective for safety reasons; • Batteries that have leaked or vented; • Batteries that cannot be diagnosed prior to carriage; or • Batteries that have sustained physical or mechanical damage The following provisions (below) apply to batteries not 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. "Critical" (possible danger during transport) Batteries 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 Note: In order to assess the type of battery, its previous use and misuse shall be taken into account Transport only with approval from the Competent Authority (in Germany: Federal Institute for Materials Research and Testing (BAM)); detailed requirements as stated in the approval	n/a
Max. Quantity	n/a	
Weight Limit	n/a - A battery with a net mass of more than 30 kg shall be limited to one battery per outer packaging	
Packaging	• Each damaged or defective battery or equipment containing such batteries must be packed separately in leak proof inner packaging to prevent release of electrolyte • UN approved packaging required for all battery types (Packing Group II), e.g. fibreboard box • Must be secured against movement within the package • Sealed packagings shall be fitted with a venting device • Must be packed with non-combustible and non-conductive thermal insulation material, material class A1 or A2 (non-combustible, e.g. rockwool, glass wool, foamglass, Vermiculite) • Absorbing material to absorb leaking electrolyte from leaking batteries • Batteries shall be protected against short circuit "Critical batteries" : as per approval	n/a
Marking	UN 3480 DAMAGED/DEFECTIVE LITHIUM ION BATTERIES UN 3481 DAMAGED/DEFECTIVE LITHIUM ION BATTERIES CONTAINED IN EQUIPMENT  "Critical batteries" : as per approval	n/a
Transport Document	Shipper's & consignee's address UN 3480 LITHIUM ION BATTERIES, 9, (E) Number of packages and packaging type (e.g. 1 Aluminium box) Battery weight (e.g. xx kg)	n/a
Miscellaneous	Work instruction of involved staff	n/a

5.7. Shipment of Lithium Ion Batteries for Disposal or Recycling

Transportation Mode	**Batteries for Disposal & Recycling**	
	Truck/Rail/Sea **(not comply to UN Test 38.3 anymore)** **Waste batteries and batteries being shipped for recycling or disposal are prohibited from air transport unless approved by the appropriate national authority of the State of Origin and the State of the Operator.**	
	< 100 Wh (per battery)	**> 100 Wh (per battery)**
Packing Instructions	SP377 P909	
Max. Quantity	none	
Weight Limit	30 kg per packaging	none
Packaging	For batteries >100 Wh UN-approved packaging required (Packing Group II) For batteries ≤ 100 Wh and for batteries contained in equipment, UN-approved packaging is not required. Strong outer packagings constructed of suitable material, and of adequate strength and design in relation to the packaging capacity and its intended use. Batteries shall be packed to prevent short circuits and dangerous evolution of heat Protection against short-circuits and dangerous evolution of heat. This can be achieved by: • individual protection of the battery terminal • inner packaging to prevent contact between batteries • batteries with recessed terminals designed to protect against short-circuits or • the use of non-conductive and non-combustible cushioning material to fill empty space between the batteries in the package Batteries shall be secured within the outer packaging to prevent excessive movement during carriage (e.g. by using a non-conductive and noncombustible cushioning material or through the use of a tightly closed plastic bag)	
Marking	UN 3480 LITHIUM BATTERIES FOR DISPOSAL or LITHIUM BATTERIES FOR RECYCLING  	
Transport Document	Shipper's & consignee's address UN 3480, WASTE LITHIUM ION BATTERIES, 9, (E) Number of packages and packaging type (e.g. 1 Fibreboard box (4G)) Battery weight (e.g. xx kg)	
Miscellaneous	Work instruction of involved staff Damaged / defective batteries Batteries identified as being damaged or defective shall be carried in accordance with SP 376. Batteries for Disposal & Recycling Alternatively, lithium batteries for disposal and recycling can also be carried (like unused lithium batteries) under ADR SP 230 and SP 188, as appropriate, or – up to the intermediate processing facility – under ADR SP 636 b).	

6. Useful Websites

The following websites provide various sources of useful information:

http://www.unece.org
http://www.iata.org
http://www.icao.int
http://www.imo.org
http://www.gpo.gov/
http://phmsa.dot.gov/hazmat
https://www.lithium-batterie-service.de/en/