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Lithium Batteries – Managing Transportation Compliance Obligations

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Preliminary Information

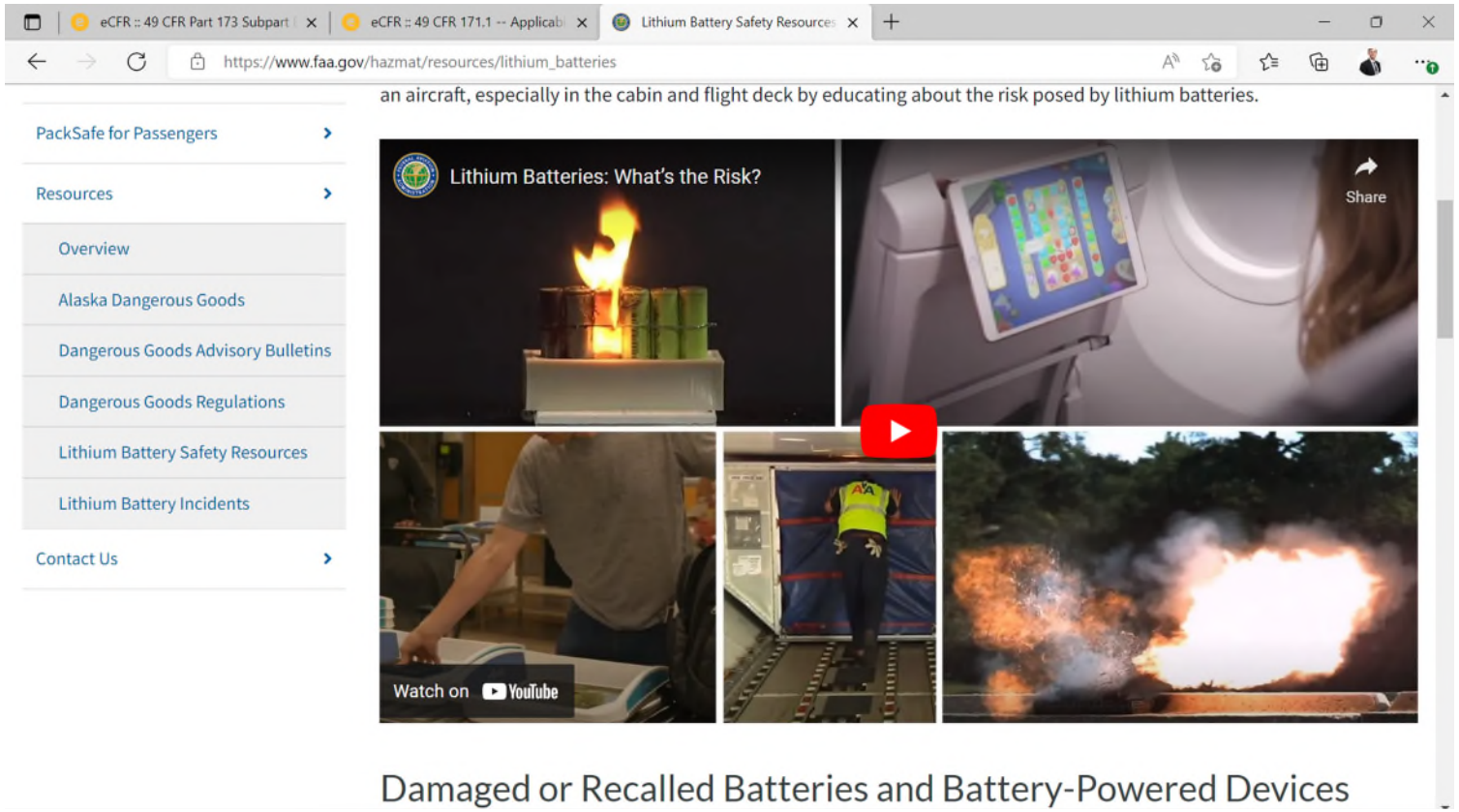
- Who we are and why this topic now?
- Objective – facilitate understanding of basic legal framework and fundamental requirements for shipping lithium batteries
- Disclaimers…

Agenda

- Introduction
- Key Definitions
- Regulatory Framework
- Testing
- Shipping Requirements
  - Opportunities for Relief
- Upcoming Changes
- Summary
- Resources

Introduction (1)

- **What is so special about lithium batteries?**
  - **Chemical (flammable, corrosive) & electrical hazards**
  - **High energy density…**



Introduction (2)

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Introduction – Why so Important? (1)

- Delivery truck destroyed
  - Cargo included 4 large lithium-ion batteries packaged in fiberboard box
- LAX ramp fire involving lithium batteries
  - Pallet of 120,000 lithium batteries was dropped on its side
  - The pallet erupted in flames 3 hours and 40 minutes later
- E-BikeKit Fire
  - Shipment of lithium-ion batteries designed to power bicycles converted to electric motor drive
- Air Shipment
  - Lithium-ion polymer battery fell out and struck the floor, catching fire
- Cell Phone Batteries
  - 3 skids of boxes found to contain used cell phone batteries

Introduction – Why so Important? (2)

- **FAA** – proposes $1.1 million civil penalty: multiple air shipments of lithium-ion batteries with testing, packaging, training issues
- **FAA** – $126,000 civil penalty: 220 lithium-ion cell phone batteries offered for air shipment – not packaged, marked, or labeled properly
- **PHMSA** – $131,456 civil penalty: lithium batteries offered for shipment without shipping papers, markings, or labels
- **FAA** – $168,000 civil penalty: 180 lithium-ion batteries offered to FedEx for shipment by air, improperly packaged in a plastic bag
- **FAA** proposed a civil penalty of $63,000 against CTC Battery
  - Offered four 12.8V rechargeable lithium-ion phosphate batteries to UPS for air transportation
  - No shipping papers and no emergency response information

Key Definitions (1)

- **Cell** – single, encased electrochemical unit
- **Battery** – multiple electrically connected cells (or single cell such as AA, C, or coin cell)
- **Amp(ere)** – unit of electrical current
  - Battery capacity (Ah) – Amp-hours
- **Volt** – unit of electrical potential difference (force to send electrons through circuit to establish current)
- **Watt** – measure of power (Watt = Volt*Amp)
  - Watt Hour (Wh) rating
- **Lithium content** = 0.3*Ah (e.g., 2Ah*0.3= 0.6 grams)

Key Definitions (2)

- **Lithium-ion** – lithium compound; typically rechargeable; Wh; laptop, phone, tools, cars
- **Lithium metal** – metallic lithium or alloy; typically not rechargeable; grams; watch, thermometer
- **Packed with** – package contains equipment + cells/batteries not installed
- **Contained in** – package contains cells/batteries installed in equipment
- **DOT** – U.S. Department of Transportation
  - PHMSA - Pipeline and Hazardous Materials Safety Administration PHMSA
  - FAA – Federal Aviation Administration
  - HMR – Hazardous Materials Regulations
- **USPS** – United States Postal Service

Regulatory Framework (1)

- **Model Regulations** – UN Recommendations on the Transport of Dangerous Goods – Model Regulations ("Orange Book")
- DOT **HMR** – 49 CFR 100 - 180
- IMO **IMDG Code** – International Maritime Dangerous Goods Code
- **ICAO TI** – ICAO Technical Instruction for Safe Transport of Dangerous Goods by Air
  - **IATA DGR** – IATA Dangerous Goods Regulations
- **ADR** – The European Agreement Concerning the International Carriage of Dangerous Goods by Road

Regulatory Framework (2)

- DOT HMR - https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I
- UN Model Regulations, UN Manual of Tests and Criteria, ADR - https://unece.org/transport/dangerous-goods
- ICAO Technical Instructions for Safe Transport by Air - https://www.icao.int/safety/DangerousGoods/Pages/Doc9284-Technical-Instructions.aspx
- IATA Dangerous Goods Regulations - https://www.iata.org/en/publications/dgr/
- IMDG Code - https://www.imo.org/en/publications/Pages/IMDG%20Code.aspx

Regulatory Framework (3)

- ***49 CFR 171.1(d) Functions not subject to the requirements of the HMR.***

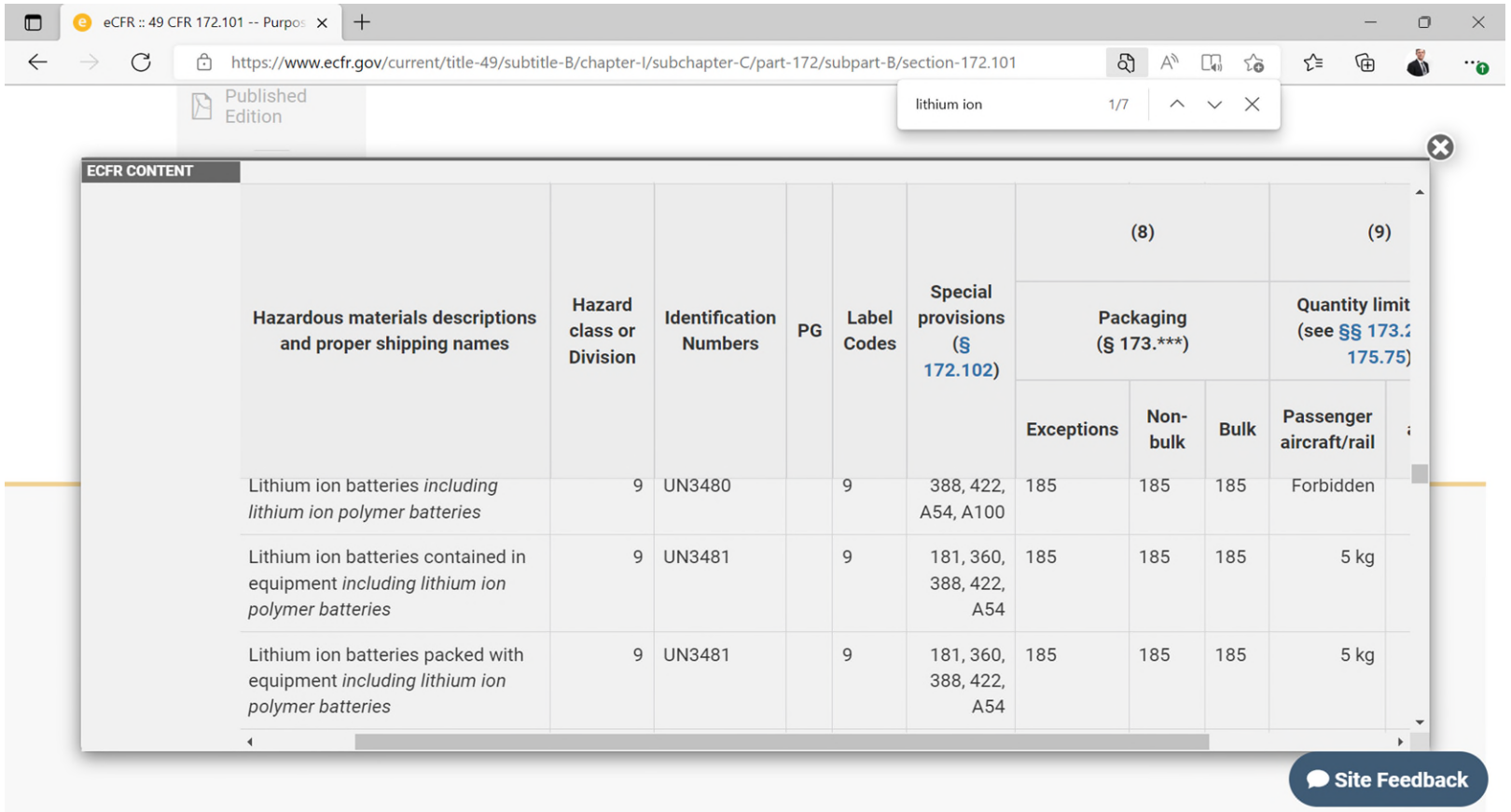
…

(6) Transportation of a hazardous material by an individual for non-commercial purposes in a private motor vehicle, including a leased or rented motor vehicle.

(7) Any matter subject to the postal laws and regulations of the United States.

Shipping Requirements – Overview (1)

- **Look up proper shipping name/description in 49 CFR 172.101 (DOT Hazmat Table) or Dangerous Goods List:**



Hazardous materials descriptions and proper shipping names	Hazard class or Division	Identification Numbers	PG	Label Codes	Special provisions (§ 172.102)	(8) Packaging (§ 173.***)			(9) Quantity limit (see §§ 173.2 175.75)
						Exceptions	Non-bulk	Bulk	Passenger aircraft/rail
Lithium ion batteries *including lithium ion polymer batteries*	9	UN3480		9	388, 422, A54, A100	185	185	185	Forbidden
Lithium ion batteries contained in equipment *including lithium ion polymer batteries*	9	UN3481		9	181, 360, 388, 422, A54	185	185	185	5 kg
Lithium ion batteries packed with equipment *including lithium ion polymer batteries*	9	UN3481		9	181, 360, 388, 422, A54	185	185	185	5 kg

Shipping Requirements – Overview (2)

- UN ID, Proper Shipping Names:
  - UN3480 – Lithium-ion batteries
  - UN3481 – Lithium-ion batteries packed with or contained in equipment
  - UN3090 – Lithium metal batteries
  - UN3091 – Lithium metal batteries packed with or contained in equipment
  - UN3171 – Battery powered vehicles
  - UN3536 – Cargo transport units
- From DOT Hazmat Table (49 CFR 172.101)
  - Go to 49 CFR 173.185 [173.220 for UN3171 or n/a for UN3536]
  - Review Special Provisions

Shipping Requirements – Overview (3)

- **Key Questions**
  - Have all cells and batteries passed UN 38.3 testing?
  - Type and size of cells/batteries?
  - # of cells/batteries per package?
  - Mode of transport?

Testing (1)

- ***UN Manual of Tests and Criteria*** **(**https://unece.org/about-manual-tests-and-criteria**)**
  - 49 CFR 171.7 (incorporated by reference)
- UN 38.3 Testing:
  - Require tests:
    - All cells T.1 – T.6, T.8
    - All non-rechargeable batteries T.1 – T.5
    - All rechargeable batteries T.1 – T.5, T.7
  - T.1 – altitude simulation
  - T.2 – thermal test
  - T.3 – vibration
  - T.4 – shock
  - T.5 – external short circuit
  - T.6 – Impact/Crush
  - T.7 – Overcharge
  - T.8 – Forced discharge

Testing (2)

- Test Summary [49 CFR 173.185(a)(2), (3)]
  - Lithium cell/battery manufacturers
    - Must create record of satisfactory completion of testing
      - Maintain for as long as design is offered for transportation + 1 year
      - Make available to government upon request
  - Lithium cell/battery **manufacturers** and subsequent **distributors**
    - Applies to lithium cells or batteries manufactured from 1/1/2008 forward
    - "Make available" a test summary
      - To individual or entity in supply chain upon request
      - Can be achieved by placing information on website

Testing (3)

- Test Summary – required elements:
  - Name of cell, battery, or product manufacturer, as applicable
  - Contact information – address, telephone, e-mail, website
  - Test laboratory - address, telephone, e-mail, website
  - Unique test report ID number
  - Date of test report
  - Description of cell or battery, including:
    - Lithium ion or lithium metal cell or battery
    - Mass
    - Watt-hour rating or lithium content
    - Physical description of the cell/battery
    - Cell or battery model number or, if for product containing, product model number
  - List of Tests conducted, results
  - Reference to assembled battery testing requirements (if applicable)
  - Reference to revised edition of UN Manual of Tests and Criteria
  - Signature with name/title of signatory as indication of validity of information

Testing (4)

UN 38.3 Lithium Battery Test Summary

Cell, Battery or Product Model Number

Item Number:
Item Name:

Cell, battery, or product manufacturer's contact information

Name:			
Address:			
City:	State:	ZIP:	Country:
Telephone:	E-mail:	Website:	

Test Laboratory

Name:			
Address:			
City:	State:	ZIP:	Country:
Telephone:	E-mail:	Website:	

Cell or Battery Description

Cell or Battery:	Physical Description (dimensions, appearance):
Cell or Battery Type:	
Watt-hour rating or Lithium Content:	
Completed Cell or Battery Weight:	
Unique Test Report ID Number:	Date of test report:

List of Tests Completed

Yes	No		Pass	Fail	Additional Comments (or indicate compliance with other standards, e.g. Underwriters Laboratory)
		Test T.1: Altitude simulation			
		Test T.2: Thermal test			
		Test T.3: Vibration			*Reference to assembled battery testing requirements, if applicable (i.e., 38.3.3.1 (f) and 38.3.3.1(g)).*
		Test T.4: Shock			
		Test T.5: External short circuit			
		Test T.6: Impact/Crush			*Reference to the revised edition of the Manual of Tests and Criteria used and to amendments thereto, if any:*
		Test T.7: Overcharge			
		Test T.8: Forced discharge			

Signature with name and title of signatory as an indication of the validity of information provided: Date:

Shipping Requirements – Details

- All lithium cells/batteries*
  - Satisfy UN38.3 testing*
  - Incorporate a safety venting device or design to preclude violent rupture**
  - Equipped with means of preventing external short circuits**
  - Equipped with means of preventing dangerous reverse current flow (e.g., diodes or fuses) if cells are connected in parallel**

*Except low production runs/prototypes (see 49 CFR 173.185(d))

**Except for smaller cells or batteries (see 49 CFR 173.185(c))

=> Consider answers to Key Questions (slide 15)

Shipping Requirements – Fully Regulated, Stand-alone – UN3480 and UN3090 (1)

- **Packaging** – see 49 CFR 173.185(b); non-metallic inner that completely encloses; UN specification, PG II outer packaging
  - Lithium batteries ≥ 12 kg with strong impact-resistant outer casing; options in lieu of UN spec for outer (e.g., strong outer, crates, pallets)
- **Marking/labeling** – UN ID number, proper shipping name (172.301); Class 9 Lithium battery label (172.447); Cargo aircraft only (172.448) – if by air; consignor/consignee name and address (172.301); UN pckg marking
- **Shipping papers** – see 49 CFR 172.200 – 206, emergency response info & telephone number per 49 CFR 172, subpart G

Shipping Requirements – Fully Regulated, Stand-alone – UN3480 and UN3090 (2)

- **DOT HMR training** – per 49 CFR 172.704
- **Air restrictions** – not allowed as cargo on passenger aircraft
  - State of Charge ≤ 30% of rates capacity [special provision A100 for lithium-ion]
  - Packages net quantity ≤ 35 kg [unless obtain DOT approval/special permit]
  - May not be packed in same outer packaging with explosives, flammable gases, flammable liquids, flammable solids or oxidizers

Shipping Requirements – Fully Regulated, Stand-alone – UN3480 and UN3090 (3)

- Note - If in overpack, Class 9 Lithium Battery label, UN ID number, proper shipping name and Cargo Aircraft Only label must show (49 CFR 173.25)

Shipping Requirements – Fully Regulated Cells/Batteries Packed with or Contained in Equipment, UN3481, UN3091

- Packaging requirements…
  - **When packed with equipment:**
    - Cells/batteries must be in inner packagings that completely enclose and then in outer packaging – must meet PG II performance requirements
  - **When contained in equipment:**
    - Outer packaging, if used, need not be UN Specification packaging
    - Equipment must be secured to prevent damage caused by shifting within outer packaging
    - Must be packed to prevent accidental operation during transport
    - If includes spare cells or batteries, then must meet “packed with” requirements
- Other requirements – see slides 20-22 (Fully regulated cells/batteries)

Opportunities for Relief

- Smaller cells or batteries [49 CFR 173.185(c)]
  - Lithium-ion – cells ≤ 20Wh and batteries ≤ 100 Wh
    - For highway and rail only, threshold increase to 60 Wh (cells) and 300 Wh (batteries)
  - Lithium metal – cells ≤ 1 g and batteries ≤ 2 g
    - For highway and rail only, threshold increase to 5 g (cells) and 25 g (batteries)
- Other
  - Approvals/special permits
  - By regulation

Shipping Requirements – Smaller Cells and Batteries – UN3480 and UN3090 (1)

- **Packaging** – see 49 CFR 173.185(b); non-metallic inner that completely encloses; strong outer packaging capable of withstanding 1.2 m drop test in any orientation; completed package ≤ 30 kg
- **Marking/labeling** – Lithium battery mark with UN ID number and telephone number; Cargo Aircraft Only label; for highway or rail only "LITHIUM BATTERIES – FORBIDDEN FOR TRANSPORT ABOARD AIRCRAFT AND VESSEL" [background of contrasting color, min font size]
- **Shipping papers** – none required

Shipping Requirements – Smaller Cells and Batteries – UN3480 and UN3090 (2)

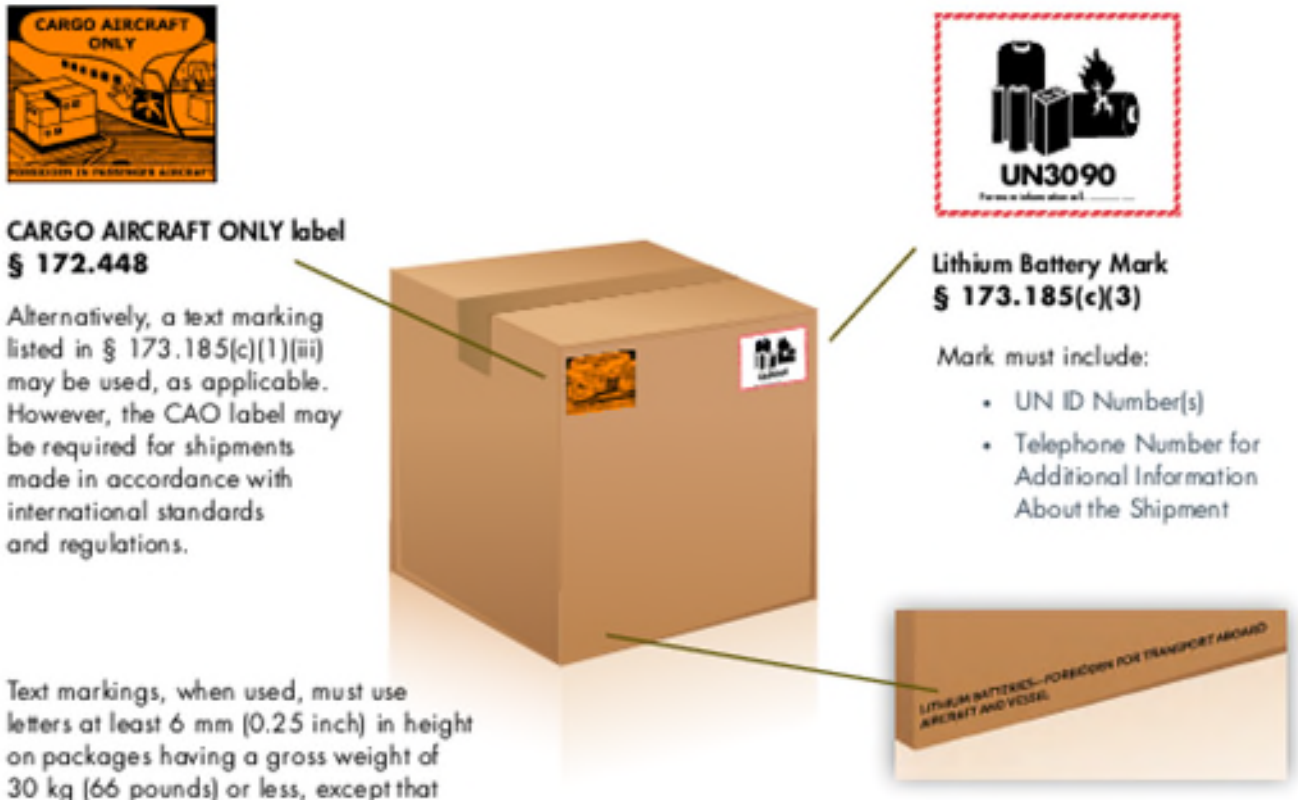
- **DOT HMR training** – none per 49 CFR 172.704, except for air shipments, must receive instructions on requirements corresponding to function
- **Air restrictions** – not allowed as cargo on passenger aircraft
  - State of Charge ≤ 30% of rates capacity [special provision A100 for lithium-ion]
  - See 49 CFR 173.185(c)(4) for quantity limits (Table 1); shipper may offer only 1 package per consignment; may not be packed in the same outer packaging with other hazardous materials; may not be packed in same overpack with packages containing explosives, flammable gases, flammable liquids, flammable solids or oxidizers; include reference on air waybill

Shipping Requirements – Smaller Cells and Batteries – UN3480 and UN3090 (3)

- Table 1, 49 CFR 173.185(c)(4)(i) – air shipment limits

Contents	Lithium metal cells and/or batteries with a lithium content not more than 0.3 g	Lithium metal cells with a lithium content more than 0.3 g but not more than 1 g	Lithium metal batteries with a lithium content more than 0.3 g but not more than 2 g	Lithium-ion cells and/or batteries with a watt-hour rating not more than 2.7 Wh	Lithium-ion cells with a watt-hour rating more than 2.7 Wh but not more than 20 Wh	Lithium-ion batteries with a watt-hour rating more than 2.7 Wh but not more than 100 Wh
Maximum number of cells/batteries per package	No limit	8 cells	2 batteries	No limit	8 cells	2 batteries
Maximum net quantity (mass) per package	2.5 kg	n/a	n/a	2.5 kg	n/a	n/a

Shipping Requirements – Smaller Cells and Batteries – UN3480 and UN3090 (4)



- **Packaging** – see 49 CFR 173.185(b); non-metallic inner that completely encloses; strong outer packaging capable of withstanding 1.2 m drop test in any orientation; completed package ≤ 30 kg

Shipping Requirements – Smaller Cells/ Batteries Packed with or Contained in Equipment– UN3481, UN3091 (1)

- **See prior slides (25-29) but…**
  - If lithium cells or batteries are packed with or contained in equipment in quantities in outer package ≤ 5 kg net weight then no “CARGO AIRCRAFT ONLY” label
  - When lithium cells or batteries are packed with or contained in equipment, 30 kg gross weight limit for package not applicable
  - Excepted from 1.2 m drop test if lithium cells/batteries are contained in equipment

Shipping Requirements – Smaller Cells/ Batteries Packed with or Contained in Equipment– UN3481, UN3091 (2)

- **No lithium battery mark required if:**
  - Package contains button cell batteries installed in equipment (incl. circuit boards); or
  - ≤ 4 lithium cells or 2 lithium batteries contained in equipment AND ≤ 2 packages in the consignment
- **Air restrictions:**
  - For lithium batteries packed with or contained in equipment, # of batteries limited to minimum # to power equipment + 2 spare sets AND total mass of lithium cells/batteries in package ≤ 5 kg

Shipping Requirements – Special Cases

- **Lithium cells or batteries shipped for disposal or recycling [49 CFR 173.185(d)]**
  - Including those contained in equipment
  - If transport by motor vehicle to permitted storage facility, disposal site or for recycling:
    - Not subject to UN38.3 testing and record keeping of 173.185(a)
    - Not subject to UN performance packaging requirements if in strong outer packaging
  - If smaller size and meet 173.185(c)(1)-(3) requirements [size, pckg, hazcom] then not subject to other shipping paper, marking, labeling, placarding, emergency response, training obligations of 49 CFR 172, subparts C-H
- **Medical Device batteries [49 CFR 173.185(g)]**

Shipping Requirements – Cargo Transport Unit – UN3536

- Lithium batteries must have passed UN38.3 and contain necessary systems to prevent overcharge and discharge between batteries
- Lithium batteries must be securely attached in unit to prevent short circuits, accidental operation, and movement; no other hazmats unless necessary for safe and proper operation of CTU
- Three options as shown above for displaying UN ID number
- CTU must be placarded on two opposing sides with Class 9 Placard
- Transportation by air is forbidden absent special permit/approval
- See 49 CFR 172.102, Special Provision 389

Shipping Requirements – Battery-Powered Vehicle – UN3171

- **Scope**
  - Electrically powered trucks, cars, scooters, bicycles, aircraft, lawn tractors, boats, wheelchairs and other mobility aids, self-propelled farming, and construction equipment
- **See 49 CFR 173.220 for details…**
  - Not subject to any other requirements of the DOT HMR for transportation by motor vehicle or railcar if satisfy 173.220
- **49 CFR 176.905, 906 for vessel shipments**
  - Not subject to any other requirements of HMR if satisfy 173.220, 176.905, 176.906
- **49 CFR 173.220 and 173.27 for air shipments**
  - Not subject to marking, labeling, placarding, and emergency response info

USPS

- Publication 52
  - Provides information and guidance when mailing potentially hazardous, restricted, or perishable matter to domestic and international destinations
  - Standards are distinct from HMR and international hazmat regulations - https://pe.usps.com/text/pub52/welcome.htm
- USPS Packing Instruction 9D
  - Provides specific instructions for mailing limited quantities of lithium metal (non-rechargeable) cells and batteries and lithium-ion (rechargeable) cells and batteries
  - Packaging must meet all applicable requirements specified in 49 CFR 173.185
  - See Domestic Lithium Battery Mailability Exhibit - https://pe.usps.com/text/pub52/pub52apxc_032.htm
- PHMSA guidance on sending batteries by mail - https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/training/hazmat/56781/how-safely-send-batteries-and-battery-flyer-final-version_2.pdf

Upcoming Changes (1)

- UN Committee of Experts
  - 61st Session of the UN Sub-Committee of Experts on the Transport of Dangerous Goods (November 28 – December 6, 2022)
  - Various papers pertaining to lithium batteries being considered
  - New UN codes proposed for lithium batteries that are offered in transportation for purposes of disposal or recycling, or that are offered under damaged or defective provisions
  - Proposed revisions to size of marking – consistent with limited quantity and excepted quantity marks in the HMR
- DOT PHMSA
  - International Harmonization Final Rule, HM-215P

Upcoming Changes (2)

- UN Committee of Experts -
  - https://unece.org/info/events/unece-meetings-and-events/transport/dangerous%20goods

- DOT PHMSA -
  - https://www.phmsa.dot.gov/international-program/international-program-overview

Questions (1)

- **When is a special permit or approval required?**
  - Air shipment of low production run/prototype [49 CFR 173.185(e)(7)]
  - Air shipment of battery with mass > 35 kg [special provision A54]
  - Air shipment of battery ≥ 12 kg strong, impact-resistant outer casing packed in non-UN specification outer [49 CFR 173.185(b)(5)]
  - Air shipment of lithium-ion @ state of charge > 30%
  - Air shipment of batteries installed in cargo transport unit [special provision 389]
  - Deviate from regulatory requirements [49 CFR 173.185(h)]

- **Does cell or battery size matter?**
  - Yes, see 173.185(b), (c)

Questions (2)

- **What testing is required?**
  - See § 38.3 [UN Manual of Tests & Criteria – 49 CFR 173.185(a)(1)]
- **What is a battery test summary and who must provide it?**
  - To verify test history – See 49 CFR 173.185(a)(3)
  - Manufacturers and distributors of lithium cells or batteries
- **How can you ship batteries that have not completed UN testing?**
  - Exception for low production runs/prototypes – 49 CFR 173.185(e)
  - If air, then per DOT approval/special permit

Questions (3)

- **What marking, labeling, packaging, and documentation are necessary?**
  - Depends on answers to Key Questions
  - See PHMSA flowcharts - https://www.phmsa.dot.gov/training/hazmat/lithium-battery-guide-shippers
- **How do you ship damaged, defective, or recalled cells or batteries?**
  - See 49 CFR 173.185(f)
    - Individual, non-metallic inner packaging that completely encloses cell/battery
    - Surrounded by non-combustible, non-conductive, and absorbent cushioning material
    - Inner packaging individually placed in specified packaging
    - Mark outer package “Damaged/defective lithium-ion/metal battery”

Questions (4)

- **Is a lithium battery installed in a device treated differently?**
  - Yes, outer packaging not necessarily required & need not be UN specification packaging [see 49 CFR 173.185(b)(4)]
  - Additional relief if smaller cells/batteries

Summary

- Before you ship, know the answers to Key Questions
  - Have all cells and batteries passed UN 38.3 testing?
  - Type and size of cells/batteries?
  - # of cells/batteries per package?
  - Mode of transport?
- Regularly review, update, and document
  - SOPs
  - Test Summaries
  - Training
- Change management
  - Personnel
  - Regulations
  - Suppliers
  - Carriers

Resources

- Transporting Lithium Batteries | PHMSA (dot.gov)
  - https://www.phmsa.dot.gov/lithiumbatteries
- Lithium Battery Safety Resources | Federal Aviation Administration (faa.gov)
  - https://www.faa.gov/hazmat/resources/lithium_batteries
- IATA - Lithium Batteries
  - https://www.iata.org/en/programs/cargo/dgr/lithium-batteries/
- Dangerous Goods | UNECE
  - https://unece.org/transport/dangerous-goods

Thank You

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