303(r), 332, and §§ 1.1 and 1.425 of the Commission's rules, 47 CFR 1.1, 1.425, the windows for challengers and respondents to collect information in connection with the MF–II challenge process *are extended*, to the extent described herein.

15. *It is further ordered* that, pursuant to § 1.427(b) of the Commission's rules, 47 CFR 1.427(b), this Order *shall be effective* upon its publication in the **Federal Register**.

16. *It is further ordered* that the Commission's Consumer and Governmental Affairs Bureau, Reference Information Center, *shall send* a copy of this Order, including the Final Regulatory Flexibility Certification, to the Chief Counsel for Advocacy of the SBA.

Federal Communications Commission.

Marlene Dortch,

Secretary.

[FR Doc. 2019–03635 Filed 3–5–19; 8:45 am]

BILLING CODE 6712–01–P

DEPARTMENT OF TRANSPORTATION

Pipeline and Hazardous Materials Safety Administration

49 CFR Parts 172 and 173

[Docket No. PHMSA–2016–0014 (HM–224I)]

RIN 2137–AF20

Hazardous Materials: Enhanced Safety Provisions for Lithium Batteries Transported by Aircraft (FAA Reauthorization Act of 2018)

AGENCY: Pipeline and Hazardous Materials Safety Administration (PHMSA), DOT.

ACTION: Interim final rule (IFR).

SUMMARY: PHMSA issues this interim final rule (IFR) to revise the Hazardous Materials Regulations for lithium cells and batteries transported by aircraft. This IFR prohibits the transport of lithium ion cells and batteries as cargo on passenger aircraft; requires lithium ion cells and batteries to be shipped at not more than a 30 percent state of charge aboard cargo-only aircraft when not packed with or contained in equipment; and limits the use of alternative provisions for small lithium cell or battery shipments to one package per consignment. This IFR does not restrict passengers or crew members from bringing personal items or electronic devices containing lithium cells or batteries aboard aircraft, or restrict cargo-only aircraft from transporting lithium ion cells or batteries at a state of charge exceeding 30 percent when packed with or contained in equipment or devices.

DATES:

Effective date: This interim final rule is effective on March 6, 2019.

Comment date: Comments must be received by May 6, 2019.

ADDRESSES: You may submit comments identified by Docket Number [PHMSA–2016–0014 (HM–224I)] by any of the following methods:

- *Federal eRulemaking Portal:* Go to *http://www.regulations.gov*. Follow the online instructions for submitting comments.
- *Fax:* 1–202–493–2251.
- *Mail:* Docket Operations, U.S. Department of Transportation, West Building, Ground Floor, Room W12–140, Routing Symbol M–30, 1200 New Jersey Avenue SE, Washington, DC 20590.
- *Hand Delivery:* To Docket Operations, Room W12–140 on the ground floor of the West Building, 1200 New Jersey Avenue SE, Washington, DC 20590, between 9 a.m. and 5 p.m., Monday through Friday, except Federal Holidays.

Instructions: All submissions must include the agency name and docket number for this rulemaking at the beginning of the comment. Note that all comments received will be posted without change to the docket management system, including any personal information provided.

Docket: For access to the dockets to read background documents or comments received, go to *http://www.regulations.gov* or DOT's Docket Operations Office (see **ADDRESSES**).

Privacy Act: In accordance with 5 U.S.C. 553(c), DOT solicits comments from the public to better inform its rulemaking process. DOT posts these comments, without edit, including any personal information the commenter provides, to *www.regulations.gov*, as described in the system of records notice (DOT/ALL–14 FDMS), which can be reviewed at *www.dot.gov/privacy*.

FOR FURTHER INFORMATION CONTACT: Shelby Geller, (202) 366–8553, Standards and Rulemaking Division, Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, 1200 New Jersey Avenue SE, Washington, DC 20590–0001.

SUPPLEMENTARY INFORMATION:

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I. Executive Summary

The safe transport of lithium batteries by air has been an ongoing concern due to the unique challenges they pose to safety in the air transportation environment. Unlike other hazardous materials, lithium batteries contain both a chemical and an electrical hazard. This combination of hazards, when involved in a fire encompassing significant quantities of lithium batteries, may exceed the fire suppression capability of the aircraft and lead to a catastrophic loss of the aircraft.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) issues this interim final rule (IFR) to amend the Hazardous Materials Regulations (HMR; 49 CFR parts 171–180) to (1) prohibit the transport of lithium ion cells and batteries as cargo on passenger aircraft; (2) require all lithium ion cells and batteries to be shipped at not more than a 30 percent state of charge on cargo-only aircraft; and (3) limit the use of alternative provisions for small lithium cell or battery to one package per consignment. These amendments will predominately affect air carriers (both passenger and cargo-only) and shippers offering lithium ion cells and batteries for transport as cargo by aircraft. The amendments will not restrict passengers or crew members from bringing personal items or electronic devices containing lithium cells or batteries aboard aircraft, or restrict the air transport of lithium ion cells or batteries when packed with or

contained in equipment. To accommodate persons in areas potentially not serviced daily by cargo aircraft, PHMSA, through the requirement in the FAA Reauthorization Act of 2018, is providing a limited exception, with the approval of the Associate Administrator, for not more than two replacement lithium cells or batteries specifically used for medical devices to be transported by passenger aircraft. Furthermore, these batteries may be excepted from the state of charge requirements, when meeting certain provisions. See ''Section V.D. Limited Exceptions to Restrictions on Air Transportation of Medical Device Cells or Batteries'' for further discussion.

This IFR is necessary to address an immediate safety hazard, meet a statutory deadline, and harmonize the HMR with emergency amendments to the 2015–2016 edition of the International Civil Aviation Organization's Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Technical Instructions). The serious public safety hazards associated with lithium battery transportation and the statutory deadline in the FAA Reauthorization Act of 2018 necessitate the immediate adoption of these standards in accordance with sections 553(b)(3)(B) and 553(d)(3) of the Administrative Procedure Act (APA). While PHMSA values public participation in the rulemaking process, the current risk of a lithium battery incident and statutory deadline imposed by Congress makes it impractical and contrary to public interest to delay the effect of this rulemaking until after a notice and comment period. However, with the publication of this IFR, PHMSA encourages persons to participate in this rulemaking by submitting comments containing relevant information, data, or views. PHMSA will consider all comments received on or before the IFR closing comment date, consider late-filed comments to the extent practicable, and make any necessary amendments as appropriate.

In developing this IFR, PHMSA considered the findings of lithium battery research conducted by the Federal Aviation Administration's William J. Hughes Technical Center (FAA Technical Center), the National Transportation Safety Board (NTSB), and several other well-respected academic sources on lithium batteries and their hazards. The FAA Technical Center's research found that lithium batteries subject to certain conditions could result in adverse events, such as smoke and fire, that could impair the safe operation of the aircraft. Specifically, they found that in a lithium battery fire, flammable gases could collect, ignite, and ultimately exceed the capabilities of an aircraft's fire suppression system. The ICAO also recognized these dangers and enacted international regulations, which went into effect on April 1, 2016. The potential for a catastrophic loss of an aircraft, the need for harmonization of the HMR with emergency amendments to the ICAO Technical Instructions, and the statutory deadline in the FAA Reauthorization Act of 2018 provide compelling justification to immediately adopt these changes into the HMR without prior notice and comment.

A Regulatory Impact Analysis (RIA) is included in the docket for this rulemaking and supports the amendments made in this IFR. PHMSA examined the benefits and costs of these rulemaking provisions using the post-ICAO baseline [1] as shown in the analysis below. Table 1 shows the costs by affected section and rulemaking provision over a 10-year period, discounted at a 7 percent rate:

TABLE 1—SUMMARY OF BENEFITS AND COSTS FOR LITHIUM BATTERY PROVISIONS—POST ICAO

Provision	Benefits	Unquantified costs	10-Year quantified cost (7%)
State of Charge	• Limits the volume of flammable gases emitted by lithium ion cells propagated in a thermal runaway. • Results in a less energetic thermal runaway event if one should occur. • Reduces the likelihood of thermal propagation from cell to cell. • Harmonization facilitates international trade by minimizing the burden of complying with multiple or inconsistent safety requirements (although currently domestic shippers and carriers have the option to voluntarily comply with ICAO requirements). Consistency between regulations reduces compliance costs and helps to avoid costly frustrations of international shipments.	• Potential changes in manufacturing procedures to ensure compliance with state of charge provision. • Reevaluation of management practices and potentially instituting changes to avoid or lessen supply chain impacts such as reduced shelf life of batteries and battery quality issues. • Additional time for end users needed to charge the batteries from 30 percent state of charge or less instead of the typical levels of 40 percent or 50 percent at which manufacturers currently set the state of charge.	$2,304,551 These estimates include only the cost for entities to apply for permission to ship batteries at higher charge levels.

[1] The post-ICAO baseline is the international operating environment present after April 1, 2016; this would (1) restrict lithium ion batteries to a 30 percent state of charge for international air shipments, (2) restrict the number of Section II packages to one per consignment on international air shipments, and (3) prohibit the shipping of lithium ion batteries as cargo on international passenger flights. This environment also includes a level of voluntary domestic compliance with the above provisions in the United States.

TABLE 1—SUMMARY OF BENEFITS AND COSTS FOR LITHIUM BATTERY PROVISIONS—POST ICAO—Continued

Provision	Benefits	Unquantified costs	10-Year quantified cost (7%)
Consignment Limit	• Reduces the risk of fire from shipping large quantities of excepted batteries that were previously being consolidated in overpacks, pallets, in single-unit load devices and single aircraft cargo compartments.. • Reduces the propensity for large numbers of batteries or packages shipped in accordance with regulatory exceptions.. • Harmonization facilitates international trade by minimizing the burden of complying with multiple or inconsistent safety requirements (although currently domestic shippers and carriers have the option to voluntarily comply with ICAO requirements). Consistency between regulations reduces compliance costs and helps to avoid costly frustrations of international shipments..	• Costs due to modal shift that might occur from air transport to ground or marine transport due to higher shipping costs by air. The end receivers may be inconvenienced by longer shipping times that imply less prompt access to goods purchased..	$44,328,936 Costs include additional hazard communication and employee training.
Lithium Battery Prohibition as Cargo on Passenger Aircraft.	• Safety benefits expected to be low or none given evidence of pre-IFR compliance.. • Eliminates the risk of an incident induced by lithium ion batteries shipped as cargo in a passenger aircraft.. • Eliminates the risk of a fire exacerbated by the presence of lithium ion batteries involving the cargo hold of a passenger aircraft.. • Harmonization facilitates international trade by minimizing the burden of complying with multiple or inconsistent safety requirements (although currently domestic shippers and carriers have the option to voluntarily comply with ICAO requirements). Consistency between regulations reduces compliance costs and helps to avoid costly frustrations of international shipments.	• Potential additional costs to air carriers transporting cargo shipments of lithium ion batteries on cargo planes instead of passenger aircraft. They vary for each air carrier based on the size of the airline and the areas they service, the availability of cargo-only aircraft fleet, the capacity usage and cargo volume availability of cargo aircraft fleet, and the volume of lithium ion batteries they were transporting by passenger airplanes.. • Cost due to modal shift that might occur as higher costs to ship by air may induce shippers to send by ground and marine transportation. The end receivers may be inconvenienced by longer shipping times that imply less prompt access to goods purchased. This can have potential impacts on rural and remote communities not serviced daily by cargo aircraft or only serviced by passenger aircraft. For customers needing lithium batteries used in devices, other than medical devices, the delays in the delivery of the required batteries could result in a range of consequences depending on their intended need..	Impact expected low given evidence of pre-IFR compliance.
Total	.....	.....	10-Year: $46,633,487 Annualized: $6,639,559

Based on the analysis described in the RIA, at the mean, PHMSA estimates the present value costs about $46.6 million over 10 years and about $6.6 million annualized (at a 7 percent discount rate).

While PHMSA examined the benefits and the costs of the provisions of this rulemaking using the post-ICAO baseline as the basis for the analysis, we acknowledge that using the pre-ICAO baseline [2] would produce different cost and benefit figures. That said, given the significant data uncertainties regarding pre-ICAO baseline and operational practices, PHMSA was unable to completely quantify the pre-ICAO baseline. PHMSA has provided a discussion of these qualitative benefits and costs. For more detail on cost and benefits of the pre-ICAO baseline, see ''Section 11 Alternative Baseline Analysis'' of the RIA included in the docket for this rulemaking. PHMSA requests public comment on the RIA as it applies to the benefits and costs under both baselines.

[2] The pre-ICAO baseline is the international operating environment present before April 1, 2016 with: (1) No limitations of state of charge, (2) No limitation on the number of Section II packages offered in a single consignment, and (3) No prohibition of shipping Lithium ion batteries as cargo on passenger carrying aircraft.

II. Current Lithium Battery Transportation Requirements

Lithium cells and batteries fall into one of two basic categories: lithium metal, including lithium alloy (also known as primary lithium batteries), and lithium ion, including lithium ion polymer (also known as secondary lithium batteries). As the name indicates, lithium metal cells and batteries contain a small amount of metallic lithium or a lithium alloy. Lithium metal batteries are mostly non-rechargeable and are often used in medical devices, computer memory, and as replaceable batteries (AA and AAA size) suitable for electronic devices. The lithium content in these cells and

batteries ranges from a fraction of a gram to a few grams and typical geometries include coin cells, cylindrical, and rectangular. Conversely, lithium ion cells and batteries contain a lithium compound (*e.g.,* lithium cobalt dioxide, lithium iron phosphate). Lithium ion batteries are generally rechargeable and are most often found in portable computers, mobile phones, and power tools. Common configurations are cylindrical and rectangular. For the purposes of the HMR, the size of lithium ion cells and batteries is measured in Watt-hours (Wh).

Lithium cells and batteries are capable of efficiently storing large amounts of energy and have a higher specific energy (capacity) and energy density relative to other battery chemistries, such as alkaline, nickel metal hydride (NiMH), and nickel cadmium (NiCd). However, when subjected to mechanical abuse, internal or external short circuit, overcharge, or excessive heat, a lithium cell or battery is susceptible to thermal runaway, which is a chain reaction leading to self-heating and release of stored energy.[3] [4] A lithium ion cell sufficiently heated can induce a thermal runaway event. Cells in thermal runaway can release excessive heat (up to 1400 °F (760 °C)), as well as flammable and toxic gases, and the heat from a single cell in thermal runaway can spread to adjacent cells in a battery or package.[5] [6] This cascading effect, or spreading, (hereafter referred to as propagation) increases the potential ignition of adjacent combustible materials. In addition, the pressure inside a cell can increase, causing the cell to rupture and resulting in a projectile hazard and the release of flammable gases. Vented gases from only a small number of cells, if ignited, can result in a pressure pulse that can compromise the fire suppression capability of an aircraft cargo compartment.[7] Based on FAA Technical Center data, the volume of flammable cell gas ignited to produce a 1.2 psi pressure rise corresponded to only 6.4 cells at 100 percent state of charge or 20 cells at 50 percent state of charge. Cargo compartments are only designed to withstand an approximate 1-psi pressure differential.

Triggering events to a thermal event include external short circuits, mechanical damage, exposure to heat, and manufacturing defects that result in an internal short circuit. While the likelihood of a thermal event occurring on an aircraft is low, the consequences of an event are high. The inability of the aircraft fire suppression systems to address lithium cell or battery fires poses an unacceptable safety risk, even if the likelihood of an event is low.

The HMR include separate entries for lithium metal batteries (UN3090), lithium metal batteries packed with equipment (UN3091), lithium metal batteries contained in equipment (UN3091), lithium ion batteries (UN3480), lithium ion batteries packed with equipment (UN3481), and lithium ion batteries contained in equipment (UN3481). Both the HMR and the 2015–2016 ICAO Technical Instructions already prohibit the transport of lithium metal batteries (UN3090) as cargo on passenger aircraft.[8] [9]

The requirements for the transport of lithium batteries are based on risk and are designed to work together to create layers of safety, accounting for battery chemistry (lithium metal and lithium ion), battery size, and package quantity. Lithium batteries are subject to design type testing, various hazard communication, and packaging requirements. Design testing serves to ensure that batteries are able to withstand certain transport and abuse conditions without hazardous consequences.[10] However, the tests are not meant to ensure that lithium batteries are safe in all conditions, such as extreme heat or damage. Lithium cells and batteries may still be subject to mishandling in transport that can result in severe mechanical damage or short circuits.[11] This hazard drives the need for protection against damage and short circuits, as well as the use of strong outer packaging. Hazard communication (*i.e.,* package marks, labels, and shipping documents) serves to alert transport workers throughout the supply chain of the presence of lithium cells or batteries, the need to handle them properly, and the measures to take in the event of an emergency. Hazmat employees must be trained in accordance with the HMR, ensuring that personnel responsible for preparing for transport and transporting do so in compliance with the HMR and maintain safety throughout the supply chain.

In § 173.185, PHMSA sets forth general requirements for lithium cells and batteries, such as United Nations (UN) design testing requirements, packaging requirements, and provisions for small cells and batteries.[12] Unless otherwise specified in § 173.185, the hazard communication and training requirements are located in part 172 of the HMR.

Section 173.185(c) of the HMR describes provisions for the carriage of up to 8 small lithium cells or 2 small lithium batteries per package with alternative hazard communication that replaces the Class 9 label with a lithium battery mark that communicates the presence of lithium batteries and indicates (1) that the package is to be handled with care, (2) that a flammable hazard exists if the package is damaged, and (3) that special procedures must be followed in such event that the package is damaged (*i.e.,* inspection and repacking (if necessary), as well as a telephone number for additional information). Further, when used, an air waybill must indicate compliance with the provisions of § 173.185(c) or the applicable ICAO packing instruction.[13] Consignments of lithium batteries that comply with these provisions are provided alternatives from the standard hazard communication and relief from the acceptance checks that air carriers use to recognize and accept or reject hazardous materials as appropriate.

[3] Bandhauer, Todd M., Garimella, Srinivas, and Fuller, Thomas F., *A Critical Review of Thermal Issues in Lithium-ion Batteries,* The Journal of the Electrochemical Society, Vol. 158 R–21–R25, January 2011.

[4] Mikolajczak, Celina, P.E., Kahn, Michael, Ph.D., White, Kevin, Ph.D., and Long, Richard T., P.E., *Fire Protection Research Foundation Report: Lithium-Ion Batteries Hazard and Use Assessment,* Exponents Failure Analysis Associates, Inc., July 2011.

[5] Webster, H., *Fire Protection for the Shipment of Lithium Batteries in Aircraft Cargo Compartments,* FAA Technical Center, DOT/FAA/AR–10/31, November 2010. *http://www.fire.tc.faa.gov/pdf/10-31.pdf*

[6] Panagiotou, Joseph, Materials Laboratory Study Report, National Transportation Safety Board, Office of Research and Engineering, Materials Laboratory Division, Report No. 12–019, March 2012.

[7] Webster, Harry, Summer, Steven M., Maloney, Thomas, Dadia, Dhaval, Rehn, Steven J., Karp, Matthew, ''Summary of FAA Studies Related to the Hazards Produced by Lithium Cells in Thermal Runaway in Aircraft Cargo Compartments, FAA Report DOT/FAA/TC–16/37, June 2016, *available at https://www.fire.tc.faa.gov/pdf/TC-16-37.pdf.*

[8] Hazardous Materials: Prohibition on the Transportation of Primary Lithium Batteries and Cells Aboard Passenger Aircraft; Interim Final Rule; [69 FR 75208] December 15, 2004.

[9] Dangerous Goods Panel Working Group on Lithium Batteries; April 7–11, 2014; DGP–WG/LB/2–WP/8.

[10] The tests and procedures are described in the United Nations Manual of Tests and Criteria, Part III, Subsection 38.3.

[11] A lithium battery incident at LAX in 1999 was the result of severe mishandling of lithium metal batteries. Hazardous Materials Factual Report, DCA–99–MZ–005. Retrieved from *http://dms.ntsb.gov/public/13000-13499/13470/559466.pdf.*

[12] Small cells and batteries for the purposes of this rulemaking are a lithium metal cell containing not more than 1 gram of lithium metal, a lithium metal battery containing not more than 2 grams of lithium metal, a lithium ion cell not more than 20 Wh, and a lithium ion battery not more than 100 Wh (See § 173.185(c) and Section II of Packing Instructions 965 and 968 in the ICAO Technical Instructions).

[13] See 49 CFR 173.185(c)(4).

Currently, § 173.185(c) does not place a limit on the number of packages containing such lithium batteries permitted in overpacks,[14] pallets, single unit load devices, or single aircraft cargo compartments. This condition allows large numbers of packages of small cells and batteries to be placed near each other without standard declaration to the air carrier or pilot in command.

III. Need for the Rule

Lithium batteries are increasingly prevalent in today's consumer market due to their ability to store substantially more energy than other batteries of the same size and weight. This trend toward lithium ion battery technology has continued over the last decade as illustrated by an increase in lithium ion cell production from approximately 3 billion cells in 2007 to over 7 billion lithium ion cells produced in 2017. PHMSA identified a total of 39 incidents in air cargo transportation between 2010 and 2016 with 13 of these incidents involving lithium batteries and smoke, fire, extreme heat, or explosion that would have been affected by this rulemaking. Many of these incidents were identified at an air cargo sort facility either before or after a flight. In at least one instance, packages of lithium ion cells were found smoldering in an aircraft unit load device during unloading. This indicates that the initial thermal runaway likely occurred while the shipment was on the aircraft. PHMSA also notes three aircraft accidents in 2007, 2010, and 2011 where lithium ion batteries transported as cargo were suspected as either the cause or a factor that increased the severity of the fire. Collectively these accidents resulted in the complete loss of all three aircraft and four lives. These accidents highlight the potential for lithium batteries to contribute to an incident resulting in loss of life and/or loss of aircraft.

Testing conducted by the FAA Technical Center to assess the flammability characteristics of lithium ion rechargeable cells and the potential hazard associated with shipping them on transport aircraft confirmed that fires involving lithium batteries sometimes include a mechanical energy release that can create projectile hazards; thermal runaway from a single cell that can spread to adjacent cells and packages; and the venting of flammable gases that can occur even when the fire is suppressed. Cell failure resulting in a mechanical energy release was observed during testing and was more energetic at 100 percent state of charge relative to cells tested a lower state of charge. However, a state of charge at less than 100 percent still has the potential to result in a mechanical energy release. For example, the FAA testing conducted in 2010 using lithium ion 18650 LiCoO2 cells at a 50 percent state of charge resulted in all 100 cells experiencing thermal runaway.[15] Testing conducted by the NTSB confirmed the potential for fire and projectile hazards and further concluded that aircraft unit load device design can impact the time it takes to detect a fire originating from inside a cargo container.[16] Additionally, the FAA testing determined that Halon 1301, the fire-suppressant agent used in Class C cargo compartments, could suppress the electrolyte and burning packaging fires, but it had no effect on stopping the propagation of thermal runaway from cell to cell. See 14 CFR 25.857 for aircraft cargo compartment classification, including Class C. Halon 1301 was also shown to be ineffective in suppressing an explosion of the flammable gases vented from lithium ion cells during thermal runaway.

A. FAA Technical Center Testing

The FAA Technical Center issued a series of test reports in 2004, 2006, 2010, and 2014 that characterized the hazards posed by lithium cells and batteries transported as cargo on aircraft and the effectiveness of aircraft fire suppression agents, packagings, and packaging configurations. Specifically, the FAA Technical Center tested the ability of various fire extinguishing agents and fire resistant packagings to control fires involving lithium batteries. This testing revealed that: (1) The ignition of the unburned flammable gases associated with a lithium cell or battery fire could lead to a catastrophic loss of the aircraft; (2) the current design of the Halon 1301 fire suppression system[17] in a Class C cargo compartment in passenger aircraft is incapable of preventing such an explosion; and (3) the ignition of a mixture of flammable gases could produce an over pressure, which would dislodge pressure relief panels, allow leakage of Halon from the associated cargo compartment, and compromise the ability of fire suppression systems to function as intended. As a result, the smoke and fire can spread to adjacent compartments and potentially compromise the entire aircraft. Moreover, the FAA testing concluded neither oxygen starvation through depressurization in the case of cargo aircraft nor common shipping containers (*e.g.,* unit load devices) is effective in containing or suppressing a lithium cell or battery fire.

When controlling lithium battery fires, aircraft fire extinguishing agents must both extinguish the electrolyte fire and cool remaining cells to stop the propagation of thermal runaway. Gaseous agents (such as Halon) are somewhat effective against lithium ion battery fires; however, while Halon is effective in extinguishing the electrolyte fire and nearby combustible materials such as packaging, it has no effect in stopping the propagation of thermal runaway from cell to cell. Conventional fiberboard packagings initially protect cells and batteries but eventually ignite and add to the fire load. Special packagings originally designed for chemical oxygen generators are effective in containing a fire from burning lithium ion cells but allow smoke and fumes to escape the package. Currently available fire containment covers (FCC) and fire resistant containers (FRC) that suppress fires by means of oxygen starvation are not effective in controlling lithium ion cell or battery fires. The fire load for each test consisted of 5,000 lithium ion 18650 LiCoO2 cells, with the balance of the interior volume containing the standard fire test load of cardboard boxes filled with shredded paper. The state of charge was measured to be around 40 percent. The FCCs tested were unable to contain a fire involving lithium ion batteries and flames escaped from under the cover, while tests on the FRCs resulted in explosions that were caused by the ignition of accumulated flammable gases vented from burning cells and/or batteries.[18]

The 2004 tests concluded that the presence of a consignment of lithium metal batteries can significantly increase the severity of an in-flight cargo compartment fire and that Halon 1301 is ineffective in such occurrences.[19]

[14] See 49 CFR 171.8. An overpack means an enclosure that is used by a single consignor to provide protection or convenience in handling of a package or to consolidate two or more packages. *Overpack* does not include a transport vehicle, freight container, or aircraft unit load device. Examples of overpacks are one or more packages:

(1) Placed or stacked onto a load board such as a pallet and secured by strapping, shrink wrapping, stretch wrapping, or other suitable means; or

(2) Placed in a protective outer packaging such as a box or crate.

[15] Webster, H. See footnote 5.

[16] Panagiotou, Joseph. See footnote 6.

[17] Halon systems work by flooding the cargo compartment with Halon gas. The concentration of Halon in the local atmosphere interferes with the burning reaction and suppresses the flame. Halon is stored in pressurized containers and distributed via a series of pipes and fire suppression nozzles.

[18] Webster et al. See footnote 7.

[19] Webster, Harry, *Flammability Assessment of Bulk-Packed, Nonrechargeable Lithium Batteries in*

Furthermore, the report stated that the ignition of a lithium metal battery releases burning electrolytes and a molten lithium spray capable of perforating the aircraft cargo compartment liners, while also generating a pressure pulse that can dislodge the cargo compartment pressure relief panels. The dislodged pressure relief panels allow the Halon 1301 fire suppressant to leak out, reducing its effectiveness and permitting the fire to spread beyond the cargo compartment. These test results identified that the Halon fire suppression system required on passenger aircraft could not effectively suppress a fire involving lithium metal batteries, but they were inconclusive with respect to lithium ion batteries. Based on the 2004 FAA Technical Center test results, PHMSA published an IFR in December 2004 [69 FR 75208] prohibiting the transport of lithium metal batteries as cargo on passenger aircraft and indicated plans for the continued assessment of the hazards associated with lithium ion batteries in transportation. ICAO later aligned with the HMR.

The 2006 tests concluded that the Halon fire suppression system is effective in suppressing a fire arising from lithium ion batteries. Cells continued to vent due to the air temperature but did not ignite in the presence of Halon.[20]

The 2010 tests investigated the ability of various packages and shipping configurations to contain the effects of lithium battery fires and prevent the propagation of thermal runaway.[21] The baseline for these tests was a common shipping configuration for lithium ion cells consisting of a fiberboard box containing 100 cells with fiberboard separators. A single cell was removed from the package and replaced with a cartridge heater to initiate thermal runaway. The cartridge heater was activated at time zero, and its temperature reached 1000 °F (538 °C) at the 9-minute mark and peaked at 1250 °F (677 °C) at approximately 19 minutes, at which point the power to the cartridge heater was shut off. The fiberboard box began to smoke 8 minutes into the test and then caught fire at the 11-minute mark. As cells went into thermal runaway, strong torch flames erupted from the box as electrolytes were vented and ignited by the burning fiberboard. The fire continued to burn vigorously for 45 minutes until all of the cells were consumed. Data was collected until all thermocouples returned to near ambient temperature. In a subsequent test, the fiberboard separators were replaced with a fiberglass material used as a flame barrier in aircraft thermal acoustic insulation that was cut to the same dimensions as the fiberboard separators. The fiberglass separators were not successful in controlling the propagation of thermal runaway. In additional tests, the fiberboard dividers were replaced with those coated with intumescent paint or aluminum foil. This modification only delayed adjacent batteries from being driven into thermal runaway and did not prevent its propagation. Finally, the FAA Technical Center evaluated the ability of an overpack originally designed for the transport of chemical oxygen generators to protect against a lithium ion battery fire initiated from a single cell. This package consists of a fiberboard container with a foil and/or ceramic insulator that meets the requirements of HMR provisions found in appendix D to part 178—*Thermal Resistance Test* and appendix E to part 178—*Flame Penetration Resistance Test.* A fiberboard package with 100 cells and fiberboard separators was placed into the overpack. Thermal runaway was initiated and allowed to propagate until all cells were consumed. The overpack successfully contained the fire but allowed smoke and fumes to escape due to increased pressure. The chemical oxygen generator overpack standard did not account for the accumulation of vented flammable gases and was therefore not effective in containing lithium ion battery fires.

In 2013, the FAA Technical Center conducted a series of tests to examine the effectiveness of fire extinguishing agents for suppressing lithium metal and lithium ion battery fires and preventing thermal runaway propagation (DOT/FAA/TC–13/53). These tests used five 2600mAh lithium ion 18650 LiCoO2cells charged to 50 percent capacity. Aqueous agents were the most effective at preventing thermal runaway propagation.[22] The FAA Technical Center further tested the effectiveness of passive protection of lithium battery shipments and published a report in February 2016. For these tests, a packet of water placed above the cells in a package containing 16 lithium ion 18650 LiCoO2 cells (at 50 percent state of charge) was the most effective method of stopping thermal runaway propagation, aside from a lowered state of charge.[23] Early tests with small numbers of cells predicted that the Halon 1301 extinguishing agent would suppress the open flames but not prevent the propagation of thermal runaway from cell to cell. Further tests confirmed that, in some instances, the Halon fire suppression system was unable to mitigate a fire involving lithium ion batteries effectively. These tests were conducted with fiberboard boxes containing 100 lithium ion 18650 LiCoO2 cells. A single cell was removed and replaced with a cartridge heater to simulate a cell in thermal runaway. The test chamber was flooded with a 6 percent Halon 1301 concentration at the first indication of open flames. The agent extinguished the open flame and prevented open flames for the duration of the test. Thermal runaway continued to propagate throughout the box until all cells were consumed. Tests on FCCs and FRCs that suppress fires by means of oxygen starvation showed that these fire suppression methods are not effective in controlling lithium ion cell or battery fires. The fire load for these tests consisted of 5,000 lithium ion 18650 LiCoO2 cells, with the balance of the interior volume containing the standard fire test load of cardboard boxes filled with shredded paper. The state of charge was measured to be around 40 percent. Since Halon has no cooling effect, the temperatures found in a suppressed cargo fire were high enough that cells continued to vent, creating an ignition source for the accumulated gas. The buildup and subsequent ignition of these gases ruptured the container. The container and its contents were destroyed by the ensuing fire.[24]

Transport Category Aircraft, DOT/FAA/AR–04/26, June 2004.

[20] Webster, H., *Flammability Assessment of Bulk-Packed, Rechargeable Lithium-Ion Cells in Transport Category Aircraft,* FAA Report DOT/FAA/AR–06/38, September 2006.

[21] Webster, H. See footnote 5.

[22] Maloney, T., *Extinguishment of Lithium-Ion and Lithium-Metal Battery Fires,* DOT/FAA/TC–13/53, January 2014.

[23] Maloney, T., and Dadia, D., *Passive Protection of Lithium Battery Shipments,* DOT/FAA/TC–15/38, February 2016.

[24] Webster et al. See footnote 7.

In July 2015, in response to the FAA Technical Center testing, two major aircraft manufacturers issued notices to aircraft operators warning of these hazards and supporting a prohibition on the carriage of high-density packages of lithium ion batteries on passenger aircraft until safer methods of transport were implemented.[25] [26] [27] Additionally, the aircraft manufacturers recommended that operators who choose to carry lithium batteries as cargo on cargo aircraft conduct a safety risk assessment that considers specific criteria listed in the July 2015 notices. While the likelihood of a cargo fire involving lithium batteries is low, the potential for catastrophic consequences including loss of life and loss of aircraft results in an unacceptable safety risk under the existing regulations.

B. ICAO Activities

The ICAO Technical Instructions set minimum standards for the international air transport of hazardous materials—including lithium batteries. PHMSA periodically amends the HMR to adopt revisions to the ICAO Technical Instructions. The harmonization between the HMR and the ICAO Technical Instructions creates consistency in hazardous materials transportation standards both internationally and domestically. The amendments in this IFR will aid in maintaining this alignment by adopting requirements consistent with the 2015–2016 ICAO Technical Instructions.

Based largely on the FAA Technical Center testing, which identified hazard factors leading to the potential compromise of the cargo compartment fire protection capabilities due to a loss of Halon containment and significant damage to the aircraft, ICAO conducted several Multidisciplinary Lithium Battery Transport Coordination Meetings consisting of a group of experts from hazardous materials, air operations, airworthiness, battery manufacturing, and package manufacturing disciplines. This multidisciplinary group met three times between 2014 and 2015 and developed a series of recommendations and high-level performance standards intended to mitigate the hazard of transporting lithium ion batteries by air to an acceptable level.[28] Several of these recommendations were directed to the attention of the ICAO Dangerous Goods Panel (DGP), including the development of performance standards to be met at the cell, battery, or package level; the implementation of interim measures, such as reducing the state of charge for lithium ion batteries; and the recommendation to no longer use the current provisions for small batteries for large consignments.

The FAA Technical Center's research was presented to the DGP over the last five years and specifically at each of the previous three meetings (ICAO DGP: Working Group 14, Working Group 2015, and DGP/25). The research was subsequently given to the ICAO Flight Operations Panel (FLTOPSP) and the ICAO Airworthiness Panel (AIRP), which are staffed with global experts in each discipline as well as representatives from appropriate Non-Government Organizations (NGO). The DGP determined that the implementation of a 30 percent state of charge provision and the reduction in the number of small cells and batteries permitted in a consignment and overpack were required to reduce the risk being introduced into the aviation system. In addition, the DGP determined that offering small cell and battery consignments separately to the air carrier will allow for better awareness of each shipment, enabling operators to have a more informed approach to safety risk management and ultimately a more robust safety management system. As a result, operators can apply more targeted controls to mitigate risks introduced into their system by shipments of lithium batteries. Mitigation strategies will be based on the characteristics of the operator's system and may include, but are not limited to, limiting quantities and using certain protective equipment when transporting these consignments. The major airframe manufacturers recommended that operators perform a safety risk assessment to establish whether they can manage the risks associated with the transport of lithium batteries. We expect that operators would incorporate information on lithium battery shipments to develop risk mitigation strategies as part of their safety management activities. Mitigations will vary but could include evaluating the specific fire protection features of the aircraft; how and where shipments are loaded including proximity of lithium batteries to each other and other hazardous materials, such as flammable liquids; and additional acceptance and handling procedures. This IFR will apply these important safety provisions to the small cell and battery consignments consistent with international requirements.

The FLTOPSP stressed the need for air carriers to conduct appropriate safety risk management activities to ensure that lithium cells and batteries can be carried safely.[29] The AIRP determined that the continued transportation of lithium ion batteries on passenger aircraft presents ''an unacceptable risk to aircraft'' under current conditions, and that ''lithium batteries and cells should not be transported in aircraft engaged in commercial air transport operations as cargo unless acceptable means to mitigate the risk can be established.'' The panel further emphasized the following:

> A growing body of test data has identified that existing cargo compartment fire protection systems certified to EASA CS 25.857 and U.S. CFR part 25.857 (CS/CFR part 25) regulations are unable to suppress or extinguish a fire involving significant quantities of lithium batteries, resulting in reduced time available for safe flight and landing of an aircraft to a diversion aerodrome.[30]

ICAO recognized the safety hazard associated with the offering and acceptance of lithium batteries as cargo and addressed it by taking action to implement addenda to the current ICAO Technical Instructions based on input and expertise from the AIRP, FLTOPSP, DGP, Air Navigation Commission, and the FAA Technical Center research. Based on this information, the ICAO Council authorized the issuance of an addendum—an ICAO tool used for a high consequence event resulting in, or creating a direct risk of, loss of life or serious injury to a person or damage to the aircraft—to address the immediate safety risk. The FAA subsequently issued Safety Alert for Operators (SAFO) 16001: *Risks of Fire or Explosion when Transporting Lithium Ion Batteries or Lithium Metal Batteries as Cargo on Passenger and Cargo*

[25] Boeing Multi Operator Message MOM–MOM–15–0469–01B, Information—Transporting Lithium Batteries, July 17, 2015. See *http://www2.anac.gov.br/transparencia/audiencia/2015/aud19/anexoVI.pdf*.

[26] Airbus In-Service Information Transport of Dangerous Goods, Lithium Batteries, reference: 00.00.00182, July 24, 2015. See *http://www2.anac.gov.br/transparencia/audiencia/2015/aud19/anexoV.pdf*.

[27] A single quantifiable measurement for high density is not possible because of the variable effects battery chemistry, cargo compartment characteristics, and loading configurations. As such, high-density quantities of lithium batteries could be any number of batteries or cells having the potential to overwhelm cargo compartment fire protection features.

[28] A report of each ICAO Multidisciplinary Lithium Battery Transport Coordination Meeting is available through the following URL: *http://www.icao.int/safety/DangerousGoods/Pages/Multidisciplinary.aspx*.

[29] Flight Operations Panel (FLTOPSP); Second Meeting; October 12–16, 2015; FLTOPSP/2–WP/31.

[30] Airworthiness Panel (AIRP); Third Meeting; December 7–11, 2015; AIRP/3–WP/21.

Aircraft on January 19, 2016, advising operators of the safety hazard associated with lithium batteries in cargo. SAFO 16001 specifically recommends performing a safety risk assessment and implementing risk mitigation strategies.[31]

Public Meeting

In consideration of the recommendations put forward by the multidisciplinary group, and in preparation for the ICAO DGP/25 meeting, DOT (with representatives from PHMSA, FAA, and OST) hosted a public meeting on September 18, 2015, to obtain feedback on how to better enhance the safe transport of lithium batteries by air.[32] DOT specifically requested public input on mitigation strategies, information, and data. The meeting included a discussion on pertinent safety recommendations from the multidisciplinary group and possible amendments to the ICAO Technical Instructions. DOT noted both in the meeting notice and during the public meeting that we may consider adopting new standards or revised ICAO Technical Instructions in a future rulemaking action. Additionally, on October 8, 2015, FAA hosted a public meeting to discuss the agenda for ICAO DGP/25, including those proposals related to lithium batteries.

ICAO agreed to a series of measures to address the previously and newly identified hazards, such as prohibiting the transport of lithium ion batteries as cargo on passenger aircraft and requiring all lithium ion cells and batteries transported on cargo-only aircraft to be shipped at a reduced state of charge of not more than 30 percent until such time that detailed performance standards could be developed and implemented. An approval provision would allow competent authorities to authorize transport of lithium ion batteries on cargo-only aircraft at a higher state of charge provided an equivalent level of safety can be established. ICAO also agreed to greatly reduce the application of long-standing provisions for the transport of small batteries (commonly referred to in the ICAO Technical Instructions as Section II batteries). Per this amendment, the Section II provisions apply only to a single small package offered and accepted for transport, thus eliminating the ability to ship multiple packages in a single consignment without standard hazard communication. ICAO agreed that these provisions should be incorporated in the current 2015–2016 edition of the ICAO Technical Instructions by way of addenda as they address immediate hazards to air transport safety.

Specifically, ICAO agreed to the following measures effective April 1, 2016:[33] [34]

1. Prohibit the transport of lithium ion batteries (not packed with or contained in equipment) as cargo on passenger aircraft;

2. Require all lithium ion batteries (not packed with or contained in equipment) to be shipped at not more than a 30 percent state of charge on cargo-only aircraft;

3. Restrict the use of Section II[35] (both lithium ion and lithium metal) cell and battery shipments to one package per consignment or overpack.

ICAO agreed that prohibiting the transport of lithium ion batteries as cargo on passenger aircraft addresses a pressing safety issue and further determined that a reduced state of charge, combined with restricting Section II batteries to one package per consignment or overpack, is significantly safer than the current transport requirements. ICAO also agreed to include in the 2017–2018 ICAO Technical Instructions a provision highlighting the need for air carriers who wish to transport hazardous materials to include a safety risk assessment process for the transport of hazardous materials before choosing to do so. The provision will further state that safety risk assessments should include appropriate information to result in the implementation of safety measures that ensure the safe transport of hazardous materials, including lithium cells and batteries, as cargo.

C. Risk Potential

The respective FAA Technical Center and NTSB testing demonstrate that current packages, hazmat handling requirements, shipping configurations, and cargo compartment fire protection systems do not provide adequate protection and may be unable to effectively mitigate a fire involving lithium ion batteries. The results further demonstrate that a relatively small fire of only 450 °F (232 °C) is sufficient to heat lithium ion cells to thermal runaway and that the heat from a single cell in thermal runaway, which can reach 1100 °F (593 °C), is capable of igniting adjacent packaging materials.

Furthermore, while the Halon 1301 fire suppression system in Class C cargo compartments has been shown to effectively suppress the open fire associated with the burning electrolyte and greatly reduce the potential ignition of adjacent flammable materials, it is not effective in cooling any cells already engaged in thermal runaway. Thermal runaway will continue to propagate until all the cells in the consignment have been consumed. Aircraft cargo containers delay the detection of smoke and fire originating from container contents, thereby decreasing the time interval between when smoke and fire become detectable and taking immediate action to suppress a fire and protect the aircraft.[36] Flammable gases produced during a thermal runaway event may continue to develop and collect in a confined space, and the ignition of these gases is sufficient to rupture packages and dislodge pressure relief panels that could result in loss of Halon containment, significant damage to the aircraft, and danger to both the traveling public and flight crews.

This information was presented to the Multidisciplinary Meeting on Lithium Batteries that recommended mitigating measures be taken to reduce the risk of a fire involving significant quantities of lithium cells and batteries (UN3090 and UN3480) that may exceed the fire suppression capability of the aircraft and could lead to a catastrophic loss of the aircraft. Various other groups including the International Coordination Council for Aerospace Industry Association (ICCAIA), major airframe manufacturers, the International Federation of Airline Pilots Association (IFALPA), AIRP, and FLTOPSP endorsed the recommendations from the Multidisciplinary Meeting on Lithium Batteries and separately provided additional recommendations. The ICAO Council approved the adoption of additional requirements to mitigate risks posed by lithium batteries as cargo on cargo-only aircraft. This decision was based upon the input and expertise from

[31] The FAA Safety Alert for Operators (SAFO) 16001 is available through the following URL: *http://www.faa.gov/other_visit/aviation_industry/airline_operators/airline_safety/safo/all_safos/media/2016/safo16001.pdf.*

[32] The public meeting notice and the comments received are available on the public docket DOT–OST–2015–0169 available through *www.regulations.gov.*

[33] Addendum 3 to the 2015–2016 edition of the ICAO Technical Instructions, issued January 15, 2016. *http://www.icao.int/safety/DangerousGoods/AddendumCorrigendum%20to%20the%20Technical%20Instructions/Doc%209284-2015-2016.ADD-3.pdf.*

[34] Addendum 4 to the 2015–2016 edition of the ICAO Technical Instructions, issued February 23, 2016. *http://www.icao.int/safety/DangerousGoods/AddendumCorrigendum%20to%20the%20Technical%20Instructions/Doc%209284-2015-2016.ADD-4.en.pdf.*

[35] The term ''Section II'' is not used in the HMR but identical provisions for small cells and batteries are included. (See 49 CFR 173.185(c)).

[36] Panagiotou, J. See footnote 6.

the AIRP, FLTOPSP, DGP, Air Navigation Commission, and the FAA Technical Center research. The prohibition of the transport of lithium ion batteries (UN3480) as cargo on passenger aircraft was made in response to tests that demonstrate that fire involving lithium ion batteries may exceed the capability of aircraft cargo fire protection systems. The additional requirements to mitigate risks posed by lithium batteries, which will continue to be permitted for transport on cargo aircraft, include transporting all lithium ion batteries at a state of charge not exceeding 30 percent of their rated capacity and limiting the number of packages of small lithium ion or lithium metal batteries. While the likelihood of a fire involving a shipment of lithium batteries in air transport is low, the consequences of such an incident would be catastrophic. With the potential for an uncontrolled fire involving a relatively small quantity of lithium batteries to lead to a catastrophic failure of the airframe, the inability of the package or the aircraft fire suppression system to control such a fire presents an unacceptable safety risk. PHMSA acknowledges that there are advancements in packaging design and packaging configurations, including fill materials and fire suppression agents, which are promising and may eventually provide safe and reliable ways to continue to transport lithium batteries on board passenger aircraft. However, PHMSA identified a total of 39 incidents in air cargo transportation between 2010 and 2016, with 13 of these incidents involving lithium batteries and smoke, fire, extreme heat, or explosion, that would have been affected by this IFR. These types of incidents are indicative of the types of events that are possible if lithium ion batteries continue to be transported on passenger aircraft. Below are summaries of three U.S. and international events that highlight the potential for lithium batteries to contribute to an incident resulting is loss of life and/or loss of aircraft.

- *February 7, 2006:* Incident at the Philadelphia International Airport in which a fire suspected to have been caused by lithium ion batteries destroyed a cargo aircraft and much of its cargo.
- *September 3, 2010:* Dubai, United Arab Emirates, a 747–400 cargo aircraft (U.S. flag) crashed while attempting to land at the Dubai International Airport after a fire was discovered. Both pilots were killed, and the aircraft and its cargo, which included a significant quantity of lithium ion batteries, were destroyed.
- *July 28, 2011:* The Republic of Korea, a 747–400 cargo aircraft crashed into international waters. The two pilots aboard the flight were killed. The Korea Aviation and Railway Accident Investigation Board determined that the cause of this accident was a fire that developed on or near two pallets containing hazardous materials packages, including hybrid-electric vehicle lithium ion batteries and flammable liquids.

Please see the Appendix A of the RIA for this rulemaking, a copy of which has been placed in the docket, for more detail on PHMSA Incident Reports involving lithium batteries.

Although the aforementioned measures provide significant improvements to safety, they do not eliminate all risks and should be coupled with other mitigation strategies as part of a layered approach to safety. In this IFR, PHMSA is adopting the changes approved by ICAO that were informed by aviation safety experts and are already implemented in international air transportation.

As discussed in ''Section IV. Good Cause for Immediate Adoption,'' PHMSA has determined that proceeding with notice and comment to adopt additional safety measures for transport of lithium ion batteries is impracticable.

D. Alternative Transport Conditions

PHMSA considered an alternative in which the IFR would prescribe specific conditions authorizing the transport of lithium ion batteries at a charge greater than 30 percent on cargo-only aircraft or as cargo on passenger aircraft. The conditions would need to mitigate the safety risks posed by the batteries, which include fire, thermal runaway, and explosion from ignition of vented gases. The conditions considered included limits on the size and number of cells, a reduced state of charge, the number of packages, the packaging, additional fire suppression systems, and manufacturing controls on the cells themselves. PHMSA was unable to identify a general set of conditions in which it would be safe to transport any quantity or type of lithium ion cells as cargo on a passenger aircraft or at a charge greater than 30 percent on cargo-only aircraft.

However, PHMSA is authorizing, with the approval of the Associate Administrator, up to two lithium batteries used for medical devices to be transported on passenger aircraft, and as applicable, at a state of charge higher than 30 percent, when the intended destination of the batteries is not serviced daily by cargo aircraft. See ''Section V.D. Limited Exceptions to Restrictions on Air Transportation of Medical Device Cells or Batteries'' for further discussion. This provision addresses the legislation titled ''FAA Reauthorization Act of 2018'' signed on October 5, 2018, by the President, which instructs the Secretary to issue limited exceptions for lithium ion and metal cells or batteries used for a medical device to be transported on passenger aircraft. *See* Public Law 302–89. Additionally, the provision addresses comments submitted to Docket No. DOT–OST–2015–0169 announcing a public meeting to seek input on issues concerning lithium batteries that were to be discussed by the ICAO DGP, in which the Medical Device Battery Transport Council (MDBTC) noted concerns relevant to shipping medical devices and batteries by air (*e.g.,* delivery to remote locations and increased supply chain constraints). The MDBTC noted that prohibiting the transport of lithium ion batteries on passenger aircraft and the 30 percent state of charge restriction would negatively impact the transport of replacement lithium ion batteries for medical devices. The provision also addresses comments to the docket that identified a need to ship lithium ion cells and batteries to remote areas.

As previously discussed in ''Subsection A. FAA Technical Center Testing'' of this section, the ineffectiveness of fire suppression systems (Halon or oxygen starvation) to control propagation of thermal runaway from cell to cell or to control the production of large quantities of flammable gases drives the need for additional safety controls. The ICAO Council adopted a prohibition on the transport of lithium ion batteries as cargo on passenger aircraft due to the inability of aircraft fire suppression systems to mitigate a fire involving lithium ion batteries. Determination of the aircraft fire suppression system vulnerability was based on assessments and positions presented by a wide range of global experts in the field of aircraft design, certification, and operations. The additional requirements to mitigate risks posed by lithium batteries, which will continue to be permitted for transport on cargo aircraft, include transporting all lithium ion batteries at a state of charge not exceeding 30 percent of their rated capacity and limiting the number of packages of small lithium ion or lithium metal batteries.

Therefore, in this IFR, PHMSA is implementing the revisions approved by ICAO and informed aviation safety experts to address the risks created by the air transport of lithium batteries,

along with an exception for the limited transport of lithium cells or batteries specifically used for a medical device where the intended destination is not serviced daily by cargo aircraft, with the approval of the Associate Administrator.

IV. Good Cause for Immediate Adoption

The Administrative Procedure Act (APA), 5 U.S.C. 551 *et seq.,* generally requires public notice before promulgating regulations. See 5 U.S.C. 553(b). The APA provides an exception, however, when there is good cause to conclude that notice and public comment is impracticable, unnecessary, or contrary to the public interest. See 5 U.S.C. 553(b)(3)(B).

PHMSA finds that compliance with the notice-and-comment process for this rulemaking would be impracticable. Accordingly, PHMSA finds that there is good cause for this IFR to be exempt from the notice-and-comment process. Interested parties will still have an opportunity to submit comments in response to this IFR before a permanent final rule is issued.[37] PHMSA's finding of good cause is based on the impracticability of providing the public with notice-and-comment while attempting to comply with the 90-day statutory rulemaking mandate in the FAA Reauthorization Act of 2018, Public Law 115–254 (October 5, 2018, FAA Reauthorization Act of 2018).[38]

Section 333 of the FAA Reauthorization Act of 2018 requires the Secretary of Transportation to conform U.S. regulations on the air transportation of lithium cells and batteries to the 2015–2016 edition of the ICAO Technical Instructions, including the amendments that were made effective on April 1, 2016. The act was signed into law on October 5, 2018, and requires DOT to take this action within 90 days, which is January 3, 2019. This IFR adopts the 2015–2016 edition of the ICAO Technical Instructions and subsequent revised standards effective April 1, 2016, into the domestic HMR, as required. The IFR is necessary to allow PHMSA to come close to complying with the 90-day timeframe required by the FAA Reauthorization Act of 2018. The statutory mandated deadline does not provide PHMSA with sufficient time to prepare and publish a proposed regulation in the **Federal Register**, provide an opportunity to comment, and issue a final rule.

The purpose of Section 333 is to address the potential safety risk in transporting lithium batteries by air. Indeed, the caption of the provision is ''Safe Air Transportation of Lithium Cells and Batteries.'' Congress's choice to single out Section 333 for rapid implementation suggests that it perceived this safety risk to warrant accelerated intervention. The need to follow Congress's directive to address, within 90 days, a status quo that Congress itself regarded as demanding urgent remediation would make the notice-and-comment process ordinarily applicable under the APA ''contrary to the public interest'' in this instance. Congress's desire to eliminate, as speedily as possible, potential air transportation risks associated with lithium batteries among air operators which have not already voluntarily adopted ICAO's 2015–2016 lithium battery standards is supported by FAA Technical Center testing showing the potential for an uncontrolled fire involving a relatively small quantity of lithium batteries and the potential buildup of flammable gases in a suppressed lithium ion battery fire that could lead to a catastrophic failure of the airframe, as well as the large body of research conducted by DOT, NTSB, and other respected sources that demonstrates the potential safety risks of lithium batteries transported by air under the current regulations and the connection of the revised regulations to those hazards.

PHMSA finds that the use of notice and comment procedures before issuing this rulemaking is impracticable. This IFR is the only rulemaking option that will allow PHMSA to come close to meeting the statutory deadline in the FAA Reauthorization Act of 2018 while addressing the potential safety risk in transporting lithium batteries by air. Additionally, while the APA generally requires that publication of a substantive rulemaking be made at least 30 days before its effective date, the APA provides for dispensation of the 30-day effectiveness delay upon good cause similar to the notice and comment requirements. 5 U.S.C. 553(d). For the reasons discussed above, PHMSA finds good cause to dispense with the 30-day delay in effectiveness upon publication. Accordingly, this IFR is effective upon publication in the **Federal Register**.

V. Summary of Changes

To ensure the safe transport of lithium batteries by air and protect the traveling public, flight crews, and for harmonization with international regulations from ICAO, PHMSA amends the HMR to prohibit the transport of lithium ion cells and batteries (UN3480) as cargo on passenger aircraft; require all lithium ion cells and batteries (UN3480) to be shipped at not more than a 30 percent state of charge on cargo-only aircraft; and restrict small lithium cell or battery shipments to one package per consignment or overpack. Also, PHMSA is providing a limited exception, with the approval of the Associate Administrator, to the restrictions on the air transport of replacement medical device cells and batteries if the intended destination for the cells or batteries is not serviced daily by cargo aircraft. PHMSA would authorize the transport on passenger aircraft of not more than two lithium cells or batteries specifically used for a medical device and would waive the 30 percent state of charge limit for lithium ion cells and batteries, with an approval of the Associate Administrator. PHMSA further defines medical device for the purposes of the HMR as an instrument, apparatus, implement, machine, contrivance, implant, or in vitro reagent, including any component, part, or accessory thereof, which is intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, of a person. See ''Subsection D. Limited Exceptions to Restrictions on Air Transportation of Medical Device Cells or Batteries'' of this section for further discussion.

A. Passenger Aircraft Prohibition

PHMSA is prohibiting the transport of lithium ion batteries (UN3480) as cargo on passenger aircraft because of their unique challenges associated with thermal runaway: Pressure pulses, venting of flammable gas, and resistance to extinguishment. The FAA Technical Center investigated the ability of various fire suppression measures—fire suppression agents, depressurization, FCC, and FRC—to control lithium ion battery fires. The results concluded that gaseous fire suppression agents were effective in extinguishing the electrolyte fire but had no effect in stopping the propagation of thermal runaway from cell to cell. Therefore, a lithium ion battery fire can still compromise the aircraft critical systems even in the presence of Halon, which is the current

[37] DOT has sought public input on multiple occasions prior to this rulemaking. DOT held a public meeting on September 18, 2015, to discuss the ICAO Technical Instructions lithium battery amendments and to obtain input on mitigation strategies, information, and data on how to better ensure the safe transportation of lithium batteries by air. *See* Notice of Lithium Battery Safety Public Meeting and Request for Information, 80 FR 52368 (August 28, 2015). Additionally, FAA hosted a public meeting on October 8, 2015, to discuss the agenda for ICAO's lithium battery proposed amendments.

[38] PHMSA's compliance with the statutory deadline was negatively impacted by a lapse in funding from December 22, 2018 through January 25, 2019, that affected PHMSA, FAA, and other government agencies.

means of suppression in passenger aircraft cargo compartments. A lithium ion battery fire was marginally controlled through oxygen starvation, which is the primary means of controlling fires in Class E cargo compartments.[39] The FCCs were unable to contain flames and flammable gases from escaping, and tests involving FRCs resulted in explosions. The FRCs permitted flammable gases generated from cells in thermal runaway to accumulate in a confined area within the FRC before being ignited by burning packages, or a spark from a burning cell, and exploding. An analysis of the batteries consumed in the FRC fire test indicated that only a small fraction of the 5,000 cells went into thermal runaway, vented, and caused the explosion.

As discussed in this IFR, the FAA Technical Center tested the ability of several common shipping containers to contain the effects of a thermal runaway originating from a single lithium cell. Currently authorized packages, package configurations, shipping containers, and consignment limits could neither contain a lithium battery fire nor prevent the propagation of fire from one package to another. FCCs and FRCs were unable to contain a fire involving lithium batteries. Overpack containers designed to transport chemical oxygen generators successfully contained the fire from lithium ion batteries but permitted smoke and vapors to escape. Neither were fire suppression systems, including the Halon that is currently used in cargo compartments, entirely effective against lithium battery fires. Of the package configurations that were tested, the only effective methods to stop propagation of thermal runaway were reducing the state of charge to 30 percent and adding a pack of water above the cells.[40] The inability of the package or the aircraft fire suppression system to control a fire involving lithium ion batteries presents an immediate safety hazard of which the actions in this IFR will address, while also harmonizing to the ICAO Technical Instructions.

This IFR is consistent with the July 2015 aircraft manufacturer notices to air carriers warning of these hazards and supporting a prohibition on the carriage of high-density packages of lithium ion batteries on passenger aircraft. Several large passenger air carriers responded to the notices by voluntarily instituting bans on the transport of lithium ion batteries.

Removal of Authorization for Lithium Ion Aircraft Batteries

As a consequence of the prohibition on the transport of lithium ion batteries (UN3480) as cargo on passenger aircraft, PHMSA is removing the authorization in § 172.102(c)(2) special provision A51 that permits the transport of lithium ion aircraft batteries on passenger aircraft. Special provision A51 was added to the HMR in the HM–215L final rule. 78 FR 987 (Jan. 7, 2013). This amendment, which became effective on January 1, 2013, harmonized the HMR with an authorization added to the 2013–2014 ICAO Technical Instructions that allowed a package containing a single lithium ion aircraft battery with a net mass not exceeding 35 kg on passenger aircraft. In 2013, shortly after the authorization in special provision A51 became effective, there were two incidents involving lithium ion batteries installed in Boeing Model 787–8 aircraft. The first incident on January 7, 2013, involved a Japan Airlines Boeing 787–8 that was parked at the gate at Logan International Airport in Boston, MA. Maintenance personnel observed smoke coming from the lid of the auxiliary power unit battery case, as well as a fire with two distinct flames at the electrical connector on the front of the case. No passengers or crewmembers were aboard the airplane at the time and none of the maintenance or cleaning personnel aboard the airplane was injured.[41] A second incident on January 16, 2013, on an All Nippon Airways flight required the flight to make an emergency landing. Four passengers out of the 173 occupants on board the aircraft suffered minor injuries during the evacuation. It appears that in both cases the heat from a single overheated cell propagated to adjacent cells resulting in a thermal runaway.[42] In response to these incidents, ICAO issued an addendum in February 2013 to disallow lithium ion batteries from being transported under special provision A51. Lithium ion batteries with a net weight of up to 35 kg may continue to be transported on cargo-only aircraft.[43]

B. State of Charge Requirement

PHMSA is requiring all lithium ion cells and batteries transported as UN3480 (not packed with or contained in equipment) on cargo-only aircraft be shipped at a state of charge of not more than 30 percent of their rated capacity. This requirement was determined based on FAA Technical Center test results demonstrating that the propagation of thermal runaway could be greatly reduced or eliminated at this level. The hazardous effects of thermal runaway were markedly less when the cells were at 30 percent state of charge or less relative to higher states of charge. The FAA tested lithium ion 18650 LiCoO2 cells at five charge states: 100% (two tests), 50%, 40%, 30%, and 20%.

The results can be summed up as follows:

- The 100% cell exploded in both tests, and rapid cooling was observed. Peak temperature: 1030 °F.
- The 50% test consumed all cells. Peak temperature: 1044 °F.
- At 40%, two cells were consumed, and the peak temperature 760 °F decreased after thermal runaway in Cell 2.
- At 30%, venting occurred in Cell 1 with no thermal runaway. Peak temperature: 560 °F.
- At 20%, venting occurred in Cell 1 with no thermal runaway. Peak temperature: 502 °F.

These results apply to lithium ion cells of this size and chemistry and thermal runaway effects may be different for different cell sizes and chemistries. However other studies involving different lithium ion cell chemistries show a similar trend of reduced hazardous effects at a reduced state of charge. The ICAO agreed that a 30 percent state of charge limit was appropriate based on the testing information available.

In implementing the ICAO Technical Instructions, PHMSA has fully transmitted the provisions into the HMR. Consistent with the ICAO Technical Instructions, PHMSA authorizes the transport of lithium ion cells or batteries on cargo-only aircraft at a higher state of charge subject to the approval of the Associate Administrator for Hazardous Materials Safety. Also, consistent with ICAO, PHMSA did not provide an authorization for transporting lithium ion batteries as

[39] Class E cargo compartments are common on the upper deck cargo compartments of freighter aircraft. Class E compartments have fire detection systems, the means to shut off ventilation flow, and the means to exclude hazardous quantities of smoke, flames, and noxious gases from the flight crew compartment. Class C cargo compartments also include an approved built-in fire extinguishing or suppression system controllable from the cockpit. See 14 CFR 25.857.

[40] Maloney, T., and Dadia, D. See footnote 23.

[41] Aircraft Incident Report; Auxiliary Power Unit Battery Fire; National Transportation Safety Board NTSB/AIR–14/01; Adopted November 21, 2014.

[42] Aircraft Serious Incident Investigation Report, Japan Transport Safety Board; AI25014–4; September 25, 2014.

[43] Addendum 1 to the 2013–2014 edition of the ICAO Technical Instructions, issued February 12, 2013. *http://www.icao.int/safety/DangerousGoods/Documents/Doc%209284-2013-2014Edition_Addendum-1.en.pdf.*

cargo on passenger aircraft. Accordingly, if there is a need to transport lithium ion batteries on a passenger aircraft, an applicant must apply for a special permit in accordance with the provisions of part 107, subpart B.

An approval is written consent, including a competent authority approval, from the Associate Administrator or other designated Department official, to perform a function that requires prior consent under the HMR. Approvals are an extension of the regulations and facilitate the continued safe transport of hazardous materials by providing specific regulatory relief on a case-by-case basis. Approvals are valid for both domestic and international transportation and are recognized as approval by a competent authority for the purposes of the ICAO Technical Instructions and other international hazardous materials regulations. When shipping internationally, approval is required from the country of origin and the country of the air carrier. Only a single approval is required for shipments originating in the United States transported by a domestic air carrier. PHMSA's approval application procedures are set forth in 49 CFR part 107, subpart H. PHMSA specifies an expiration date in each approval, which is typically 2 years from the date of issuance. It is important to note that PHMSA only grants approvals for activities allowed (if approved) under specific conditions identified in the HMR. Applications for approvals and supporting documentation may be submitted by mail, by facsimile, electronically via email, or through PHMSA's online system. Unless emergency processing is requested and granted, applications are usually processed in the order in which they are filed.

Lithium ion batteries contain both a chemical and an electrical hazard. It is the combination of these two hazards that creates a unique challenge to safety in the air transportation environment. As referenced in this section, numerous private and public sector studies have clearly demonstrated and validated through physical testing that reducing a cell or battery's state of charge measurably reduces this risk. A number of factors can lead to an incident in transport, including but not limited to thermal, mechanical, or electrical abuse; substandard cell design; and internal cell faults associated with cell manufacturing defects. Existing transport requirements reduce the likelihood of thermal runaway from damage and external short circuits. Internal short circuits can form during charge and discharge cycles, physical damage to the cell or battery or manufacturing defects. Thermal runaway events originating from internal cell faults appear to be rare, but do nevertheless occur. Regardless of the cause, the hazardous effects of a thermal runaway event are the same. Cell chemistry, state of charge, and heat transfer environment are some of the significant factors that influence the effects of failure.[44] Multiple independent studies have shown that, independent of the initiating factor, reducing the state of charge measurably reduces both the likelihood and consequence of an incident involving lithium ion batteries. Most significantly, lowering the state of charge reduces or eliminates the ability of a cell to experience thermal runaway and the potential for propagation. Reducing the state of charge for lithium ion cells and batteries offered for transport translates to a safer transport environment.

Specifically, reducing the state of charge of a lithium ion cell or battery:

- Decreases the likelihood of thermal runaway; [45]
- Decreases or eliminates the potential for thermal runaway to spread to adjacent cells or batteries; [46]
- Increases the cell's ability to tolerate a short circuit and significantly reduces the maximum temperature achieved at the point of shorting; [47]
- Reduces the quantities of gases released if thermal runaway occurs; [48] [49] [50] [51]
- Reduces the magnitude of the heating rate if thermal runaway occurs.[52] [53] [54] [55] [56]

Comprehensive laboratory testing from various sources, including the FAA, has shown that lithium ion batteries are thermally more stable and the hazardous effects of thermal runaway are less when the battery is at a reduced state of charge. Both Roth et al.[57] and Doughty and Roth [58] found that a higher state of charge in commercially-available lithium ion 18650 LiCoO2 cells resulted in lower onset temperature of self-generated heating and that the magnitude of a cell's response to internal short circuit is influenced by state of charge. Other studies, such as that done by Somandepalli et al.[59] have observed that the volume of gas vented from cells in thermal runway is less at lower states of charge. More importantly, a sufficiently reduced state of charge for the most commonly carried cells eliminates propagation of thermal runaway and the potential for a chain reaction in the event of a single cell failure.

In an aviation environment, the safety benefits associated with a reduced state of charge are more pronounced than for other modes due to the potential consequences of an in-flight event. As evidenced by testing conducted by the FAA Technical Center and supported by analyses performed by a major aircraft manufacturer, an incident involving even a relatively small number of lithium ion cells is sufficient to overwhelm existing aircraft safety systems and compromise the integrity of the aircraft. Taking this into account, manufacturers often preemptively ship lithium ion batteries at a reduced state of charge as a business practice.

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[44] Mikolajczak et al. See footnote 4.

[45] Doughty, Dan, and Roth, E. Peter, *A General Discussion of Li Ion Battery Safety,* The Electrochemical Society Interface, Vol. 21, No.2, Summer 2012.

[46] Doughty, Dan, and Roth, E. Peter. See footnote 45.

[47] Doughty, Dan, and Roth, E. Peter. See footnote 45.

[48] Doughty, Dan, and Roth, E. Peter. See footnote 45.

[49] Somandepalli, V., Marr, Kevin C., and Horn, Quinn C., *Quantification of Combustion Hazards of Thermal Runaway Failures in Lithium-Ion Batteries,* SAE International. J. Alt. Power, Vol. 3, No. 1, May 2014.

[50] Golubkov, Andrey W., Scheikl, Sebastian, Planteu, René, Voitic, Gernot, Wiltsche, Helmar, Stangl, Christoph, Fauler, Gisela, Thaler, Alexander, and Hacker, Viktor, *Thermal runaway of commercial 18650 Li-ion batteries with LFP and NCA cathodes—impact of state of charge and overcharge,* Royal Society of Chemistry Advances, Issue 70, June 2015.

[51] Roth, E. P., Crafts, CC, Doughty, D. H., and McBreen J., *Advanced Technology Development Program for Lithium-Ion Batteries: Thermal Abuse Performance of 18650 Li-Ion Cells,* Sandia Report: SAND2004–0584, March 2004.

[52] Doughty, Dan, and Roth, E. Peter. See footnote 45.

[53] Somandepalli et al. See footnote 49.

[54] Bandhauer et al. See footnote 3.

[55] Roth et al. See footnote 51.

[56] Golubkov et al. See footnote 52.

[57] Roth et al. See footnote 51.

[58] Doughty, Dan, and Roth, E. Peter. See footnote 45.

[59] Somandepalli et al. See footnote 49.

Existing aircraft protection systems simply cannot mitigate the accumulation and potential for ignition of flammable gases, which can completely overwhelm current aircraft safety systems and lead to loss of the aircraft's flight capabilities. Requiring cells and batteries to be transported at a sufficiently reduced state of charge would immediately and measurably reduce both the likelihood and consequences of an incident involving lithium ion cells or batteries in an aviation environment. As demonstrated by multiple studies and physical testing, the exothermic reaction experienced by a cell is highly dependent on the state of charge.[60] [61] For the most commonly carried cell, the lithium ion 18650 LiCoO2 cell, research and testing is particularly significant. The FAA Technical Center testing has specifically demonstrated that for these cells, a state of charge of 30 percent not only reduces the intensity of thermal runaway but also completely eliminates propagation of thermal runaway.[62] While no one safety measure known today is singularly effective in eliminating all hazards inherent in the transport of lithium ion batteries, this particular measure dramatically reduces the possibility of an unmanageable event that could lead to loss of the aircraft and the lives of those aboard. Further research and additional work is necessary to more comprehensively assess the most effective mechanisms to mitigate those hazards. While this work continues, it is in the best interest of the public that carriage of lithium ion cells or batteries as cargo on passenger aircraft be prohibited and that state of charge be reduced on lithium ion cells and batteries being carried as cargo on cargo-only aircraft.

C. Consignment and Overpack Restriction

PHMSA is restricting the use of alternative provisions for small lithium cells and batteries to one package per overpack or consignment to prevent the consolidation of large numbers of lithium cell and battery shipments in a single overpack or consignment under provisions designed for small quantities of batteries. Shippers can still offer lithium cells or batteries in an overpack or a consolidated consignment, but these must be identified to the air operator as hazardous materials. The identification of these consignments as hazardous materials will allow operators to consider safety risk assessments and implement mitigation strategies appropriate to the operator's specific capabilities, thus reducing the hazards posed by such consignments.

The hazardous materials regulatory system has for decades proven its effectiveness in mitigating risks associated with hazardous materials transportation. Shippers and operators understand this system and have included steps in their processes to ensure compliance. Current provisions for small batteries were developed based on the reduced risk posed by a limited number of small batteries in a single package. These provisions were developed before current research and testing that demonstrate the significant fire hazard posed by consolidations of such packages in an aviation environment. ICAO considered reducing or eliminating the provisions for Section II of the ICAO Technical Instructions because such consignments do not require shipping papers or notification to the pilot in command. Shipping papers provide air carriers with information (*i.e.,* quantity, type of package, package weight) that is essential to accurately identify packages of lithium batteries and to conduct effective safety assessments. ICAO ultimately agreed to limit provisions for Section II batteries by restricting to one the number of packages that can be offered as a single shipment or placed into a single overpack and noted that this action would ensure such consignments were subject to standard hazard communication, thereby improving awareness to the operator. ICAO considered recent actions by government regulators and the industry, and various recommendations from the Third International Multidisciplinary Lithium Battery Transport Coordination Meeting:

- A safety alert for operators issued by the FAA in 2010 (SAFO 10017) recommending that operators load bulk consignments of Section II batteries in Class C cargo compartments or locations where alternate fire suppression was available; [63]
- A multi-operator message issued by the Boeing Company in 2015 (MOM–MOM–15–0469–01B) advising operators who transport lithium batteries to conduct a safety risk assessment that takes into account, among other factors, the types and quantities of lithium batteries carried, the quantity per flight, their location within the cargo compartment, and their proximity to other dangerous goods;
- An in-service information article issued by Airbus Industries in 2015 (ISI 00.00.00182) advising operators who transport lithium batteries to conduct a safety assessment that considers, among other factors, information on the types of lithium batteries being shipped, as well as the quantity and density of the consignment. Airbus further recommended that all consignments of lithium batteries be identified and notified, and that policy to notify the flight crew of all lithium battery consignments is established; and
- Interim recommendations from the Third International Multidisciplinary Lithium Battery Transport Coordination Meeting (see paragraph 5.1.3 and appendix A to the report available at *http://www.icao.int/safety/DangerousGoods/Pages/Multidisciplinary.aspx*), including safety risk assessments by operators who wished to transport lithium batteries that would require consideration of information on the types and quantities of lithium batteries and cells being transported.

Alignment of the HMR with the revised Section II provisions in the ICAO Technical Instructions for small batteries directly addresses NTSB Recommendation A–07–109 that the Department ''eliminate regulatory exemptions for the packaging, marking, and labeling of cargo consignments of small secondary lithium batteries (no more than 8 grams equivalent lithium content) until the analysis of the failures and the implementation of risk-based requirements asked for in Safety Recommendation A–07–108 are completed.'' This recommendation was closed by NTSB when the DOT took an ''Acceptable Alternative Action'' by harmonizing the HMR with the 2013–2014 ICAO Technical Instructions, which included amended provisions for Section II batteries. The relevant amendments to the 2013–2014 ICAO Technical Instructions were adopted by ICAO on the basis that those amendments were considered to ensure that:

> [T]raining would now be required for many more shippers preparing lithium battery shipments; operators would now be required to perform acceptance checks on all large shipments of lithium batteries prior to loading and stowage aboard an aircraft; pilots would be notified of the presence, location and quantity of lithium batteries aboard the aircraft . . . and regulators would be

[60] Mikolajczak, C.J., and A. Wagner-Jaureff, *US FAA-Style Flammability Assessment of Lithium Ion Cells and Battery Packs in Aircraft Cargo Holds,* Exponent Failure Analysis Report, April 15, 2005 Retrieved from: *http://www.prba.org/wp-content/uploads/Exponent_PRBA_burn_box_report_final1.pdf.*

[61] Webster, H. See footnote 20.

[62] Maloney, T., and Dadia, D. See footnote 23.

[63] The FAA Safety Alert for Operators (SAFO) 10017 is available through the following URL: *http://www.faa.gov/news/press_releases/media/safo10017.pdf.*

provided a framework in which better training, oversight and enforcement could be applied.

However, implementation of the revised ICAO provisions in practice revealed a deficiency in that large numbers of Section II packages continued to enter the air transport stream in bulk (overpacked and/or palletized) configurations. Adopting the amendments in this IFR will bring the HMR into alignment with the ICAO Technical Instructions and address this deficiency.

D. Limited Exceptions to Restrictions on Air Transportation of Medical Device Cells or Batteries

To execute the mandate in Section 333 of the FAA Reauthorization Act of 2018, PHMSA is authorizing, with the approval of the Associate Administrator, the transport of not more than two lithium cells or batteries used for a medical device to be transported on passenger aircraft and an exception from the 30 percent state of charge limit under specified conditions. This provision applies when the intended destination of the batteries is not serviced daily by cargo aircraft and the batteries are required for medically necessary care. The medical device cells or batteries must be (1) individually packed in an inner packaging that completely encloses the cell or battery, (2) placed in a rigid outer packaging, and (3) protected to prevent short circuiting.[64] PHMSA is also adopting the definition of medical device as used in the FAA Reauthorization Act of 2018 as follows: ''A medical device means an instrument, apparatus, implement, machine, contrivance, implant, or in vitro reagent, including any component, part, or accessory thereof, which is intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, of a person.''

Several aspects necessary to implement the FAA Reauthorization Act of 2018 requirements, are not defined in the congressional mandate. In this IFR, PHMSA defines requirements based on previous interpretations, current regulatory requirements, and ease of implementation. PHMSA requests comments on these criteria, including potential impacts these criteria may have on stakeholders.

- The limitation to ''not more than two replacement lithium cells or batteries'' applies to the number of cells or batteries per package, as approved by the Associate Administrator.
- A destination is no longer considered to be ''serviced daily by a cargo aircraft'' when it is impracticable[65] to reach the intended destination by cargo aircraft and subsequent motor vehicle transportation. The person applying for the approval of the Associate Administrator must demonstrate that this provision applies. PHMSA has not provided a specific distance of when a location is no longer considered serviced daily by a cargo aircraft to allow for flexibility in evaluating each scenario on a case-by-case basis; however, PHMSA seeks comment on whether a distance should be considered.
- Batteries ''required for medically necessary care'' are batteries that are needed for a medical device that is used by the recipient for medical care.

PHMSA's standard operating procedures [for approvals and special permits] will be updated when reviewing applications for consignments of lithium cells or batteries for medical devices, as prescribed in Section 333 paragraph (b)(1) of the FAA Reauthorization Act of 2018. Specifically, PHMSA will either grant or deny an application for air transportation of lithium ion cells or batteries specifically used for medical devices, no later than 45 days after receipt of the application. A draft will be submitted to the FAA no later than 30 days after the date of application, and the FAA will conduct an on-site inspection no later than 20 days after receiving the draft from PHMSA. Section 333 paragraph (b)(1) applies to only lithium ion cells and batteries, but since paragraph (b)(2) applies to both lithium ion and metal batteries for medical devices, PHMSA understands the FAA Reauthorization Act of 2018 language in section 333 paragraph (b)(1) to also apply to lithium metal batteries for medical devices. PHMSA seeks comments on the application requirements or evaluation process, including any potential impacts on applicants or airlines, such as package design, distance between the intended destination and an airport not serviced daily by a cargo aircraft, communication requirements, and the FAA on-site inspection.

This limited exception also addresses comments submitted to Docket No. DOT–OST–2015–0169, which identified a need to transport lithium ion batteries to remote areas that are accessible by passenger aircraft only.

VI. Regulatory Analysis and Notices

A. Statutory/Legal Authority for This Rulemaking

This IFR is published under the authority of the Federal Hazardous Materials Transportation Law, 49 U.S.C. 5101 *et seq.* Section 5103(b) authorizes the Secretary of Transportation to prescribe regulations for the safe transportation, including security, of hazardous material in intrastate, interstate, and foreign commerce. This IFR revises regulations for the safe transport of lithium cells and batteries by air and the protection of aircraft operators and the flying public.

B. Executive Order 12866 and DOT Regulatory Policies and Procedures

Executive Order 12866 (''Regulatory Planning and Review'') requires agencies to regulate in the ''most cost-effective manner,'' to make a ''reasoned determination that the benefits of the intended regulation justify its costs,'' and to develop regulations that ''impose the least burden on society.''

This IFR is considered a significant regulatory action under E.O. 12866 and the Regulatory Policies and Procedures of the Department of Transportation. 44 FR 11034. However, this IFR is not an economically significant regulatory action as defined by section 3(f)(1) under E.O. 12866, because it does not have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities. A Regulatory Impact Analysis (RIA) is available for review in the public docket for this rulemaking and summarized below. Please see the RIA for more details on the benefits and costs of the IFR.

As previously discussed, the safe transport of lithium batteries by air has been an ongoing concern for PHMSA, FAA, and DOT. Lithium batteries pose unique challenges to safety in a transportation environment because, unlike other hazardous materials, they contain both a chemical and an electrical hazard. This combination of hazards, when involved in a fire encompassing significant quantities of

[64] PHMSA notes methods to prevent short circuiting include, but are not limited to: Packaging each battery in fully enclosed inner packages made of non-conductive material, packaging batteries in a manner to prevent contact with other batteries, devices or conductive materials, and ensuring exposed terminals or connectors are protected with non-conductive caps, non-conductive tape, or by other appropriate means. See PHMSA Letter of Interpretation, Reference Number 16–0174; May 18, 2018.

[65] PHMSA has previously used the term ''impracticable'' in the HMR. See §§ 173.150(f) and 175.310(a).

lithium batteries, may exceed the fire suppression capability of the aircraft and lead to a catastrophic loss of the aircraft.

In response to both the hazards posed by the transport of lithium ion batteries by air, as evidenced by the FAA Technical Center testing results (see ''Section III.A. FAA Technical Center Testing''), and the recent developments in the international community, PHMSA is amending the HMR applicable to lithium cells and batteries not contained in or packed with equipment to:

(1) Prohibit the transport of lithium ion cells and batteries (not packed with or contained in equipment) as cargo on passenger aircraft;

(2) Require all lithium ion cells and batteries (not packed with or contained in equipment) to be shipped at not more than a 30 percent state of charge on cargo-only aircraft; and

(3) Restrict small lithium cell and battery shipments to one package per consignment or overpack.

Some costs and benefits are related to the total number of companies or employees affected. The IFR potentially impacts approximately 99 domestic passenger airlines, 468 shipping firms, and over 27,000 employees on average. PHMSA examined the benefits and the costs of the provisions of this rulemaking using the post-ICAO baseline [66] as the basis for the analysis as shown below. Table 2 summarizes the benefits and costs by rulemaking provision over a 10-year period and annualized, discounted at a 7 percent rate.

TABLE 2—SUMMARY OF BENEFITS AND COSTS FOR LITHIUM BATTERY PROVISIONS—POST ICAO

Provision	Benefits	Unquantified costs	10-Year quantified cost (7%)
State of Charge	• Limits the volume of flammable gases emitted by lithium ion cells propagated in a thermal runaway. • Results in a less energetic thermal runaway event if one should occur. • Reduces the likelihood of thermal propagation from cell to cell. • Harmonization facilitates international trade by minimizing the burden of complying with multiple or inconsistent safety requirements (although currently domestic shippers and carriers have the option to voluntarily comply with ICAO requirements). Consistency between regulations reduces compliance costs and helps to avoid costly frustrations of international shipments.	• Potential changes in manufacturing procedures to ensure compliance with state of charge provision. • Reevaluation of management practices and potentially instituting changes to avoid or lessen supply chain impacts such as reduced shelf life of batteries and battery quality issues. • Additional time for end users needed to charge the batteries from 30 percent state of charge or less instead of the typical levels of 40 or 50 percent at which manufacturers currently set the state of charge.	$2,304,551. These estimates include only the cost for entities to apply for permission to ship batteries at higher charge levels.
Consignment Limit	• Reduces the risk of fire from shipping large quantities of excepted batteries that were previously being consolidated in overpacks, pallets, in single-unit load devices and single aircraft cargo compartments. • Reduces the propensity for large numbers of batteries or packages shipped in accordance with regulatory exceptions. • Harmonization facilitates international trade by minimizing the burden of complying with multiple or inconsistent safety requirements (although currently domestic shippers and carriers have the option to voluntarily comply with ICAO requirements). Consistency between regulations reduces compliance costs and helps to avoid costly frustrations of international shipments.	• Costs due to modal shift that might occur from air transport to ground or marine transport due to higher shipping costs by air. The end receivers may be inconvenienced by longer shipping times that imply less prompt access to goods purchased.	$44,328,936. Costs include additional hazard communication and employee training.

[66] The post-ICAO baseline is the international operating environment present after April 1, 2016; this would (1) restrict lithium ion batteries to a 30 percent state of charge for international air shipments, (2) restrict the number of Section II packages to one per consignment on international air shipments, and (3) prohibit the shipping of lithium ion batteries as cargo on international passenger flights. This environment also includes a level of voluntary domestic compliance with the above provisions in the United States.

TABLE 2—SUMMARY OF BENEFITS AND COSTS FOR LITHIUM BATTERY PROVISIONS—POST ICAO—Continued

Provision	Benefits	Unquantified costs	10-Year quantified cost (7%)
Lithium Battery Prohibition as Cargo on Passenger Aircraft.	• Safety benefits expected to be low or none given evidence of pre-IFR compliance. • Eliminates the risk of an incident induced by lithium ion batteries shipped as cargo in a passenger aircraft. • Eliminates the risk of a fire exacerbated by the presence of lithium ion batteries involving the cargo hold of a passenger aircraft. • Harmonization facilitates international trade by minimizing the burden of complying with multiple or inconsistent safety requirements (although currently domestic shippers and carriers have the option to voluntarily comply with ICAO requirements). Consistency between regulations reduces compliance costs and helps to avoid costly frustrations of international shipments.	• Potential additional costs to air carriers transporting cargo shipments of the lithium ion batteries on cargo planes instead of passenger airplanes. They vary for each air carrier function of the size of the airline and the areas they service, the availability of cargo-only aircraft fleet, the capacity usage and cargo volume availability of their cargo aircraft fleet, the volume of lithium ion batteries they were transporting by passenger airplanes. • Cost due to modal shift that might occur as higher costs to ship by air may induce shippers to send by ground and marine transportation. The end receivers may be inconvenienced by longer shipping times that imply less prompt access to goods purchased. This can have potential impacts on rural and remote communities not serviced daily by cargo aircraft or only serviced by passenger aircraft. For customers needing lithium batteries used in devices other than medical devices, the delays in the delivery of the required batteries could result in a range of consequences depending on their intended need.	Impact expected low given evidence of pre-IFR compliance.
Total			10-Year: $46,633,487. Annualized: $6,639,559.

Based on the analysis described in this RIA, at the mean, PHMSA estimates the present value costs about $46.6 million over 10 years and about $6.6 million annualized (at a 7 percent discount rate).

While PHMSA examined the benefits and the costs of the provisions of this rulemaking using the post-ICAO baseline, we acknowledge that using the pre-ICAO baseline [67] would produce different cost and benefit figures. That said, given the significant data uncertainties regarding pre-ICAO baseline and operational practices, PHMSA was unable to completely quantify the pre-ICAO baseline. For more detail on cost and benefits of the pre-ICAO baseline see the ''Section 11 Alternative Baseline Analysis'' of the RIA included in the docket for this rulemaking.

PHMSA reviewed incidents involving lithium batteries shipped by air to determine how many reported incidents would be affected by the scope of this IFR. The following summary provides a breakdown of U.S. passenger and cargo-only aircraft incidents involving lithium batteries from 2010 to 2016 in which a Hazardous Materials Incident Report, DOT Form 5800.1, was submitted.

We filtered incidents for those involving lithium batteries and fire, extreme heat, or explosion. In addition, we filtered passenger aircraft incidents for those occurring in cargo as opposed to passenger baggage. We also filtered both passenger and cargo-only aircraft incidents for those involving lithium ion batteries as opposed to lithium metal batteries given applicability of the three provisions and the extent that information was available in the incident report. We further filtered incidents for undeclared shipments or those without labels and markings where possible.

U.S. Passenger Aircraft Lithium Battery Incidents: PHMSA identified a total of 21 lithium battery incidents in passenger air transportation relevant to the scope of this rulemaking. PHMSA started with a set of 36 lithium battery incidents in passenger air transportation and filtered out 15 of the incidents involving lithium ion batteries and fire, extreme heat, or explosion. PHMSA determined that the incidents resulting in fire involved lithium ion batteries transported in passenger baggage or were packed in equipment. While these incidents indicate the potential harm from the presence of a lithium ion battery fire, the scope of this rulemaking does not affect lithium ion batteries carried in airline passenger baggage or packed in equipment. There were no fatalities or hospitalizations associated with these incidents.

U.S. Cargo Aircraft Lithium Battery Incidents: PHMSA identified a total of 139 incidents in air cargo transportation. Thirteen of these incidents involved lithium batteries and fire, extreme heat or explosion that would be affected by the IFR. PHMSA cannot be certain of how many of the 13 lithium battery incidents in cargo transportation relate to the consignment limit provision. However, based on review of the narratives of the incidents, PHMSA believes that at least five of the incidents are related to the consignment limit provision.

Summary of Benefits

PHMSA expects the IFR will improve safety for flight crews, air cargo operators, and the public as a result of the state of charge requirement and the consignment and overpack restriction by reducing the possibility of fire on cargo-only aircraft. Additionally, the IFR will harmonize the prohibition of

[67] The pre-ICAO baseline is the international operating environment present before April 1, 2016 with: (1) No limitations of state of charge, (2) No limitation on the number of Section II packages offered in a single consignment, and (3) No prohibition of shipping Lithium ion batteries as cargo on passenger carrying aircraft.

lithium ion batteries as cargo on passenger aircraft and eliminate the possibility of a package of lithium ion batteries causing or contributing to a fire in the cargo hold of a passenger aircraft.

Passenger Aircraft Prohibition

The provision prohibiting lithium ion batteries as cargo on passenger aircraft will provide safety benefits to air operators and the public by virtually eliminating the possibility of (1) an incident induced by lithium ion batteries shipped as cargo in a passenger aircraft and (2) a fire exacerbated by the presence of lithium ion batteries in the cargo compartment of a passenger aircraft. In addition, this rulemaking will harmonize U.S. regulations with the ICAO Technical Instructions.

State of Charge Requirement

The provision limiting the state of charge will provide safety benefits to air cargo operators and the public by reducing the available energy and limiting the propagation of heat and fire in the event of thermal runaway in lithium ion cells and batteries. The FAA Technical Center report, *Hazards Produced by Lithium Batteries in Thermal Runaway in Aircraft Cargo Compartments,* found that the volume of gases emitted by lithium ion cells in thermal runaway is dependent on the state of charge of the cell and higher states of charge yield greater volumes of flammable gases. Further, reducing the state of charge of lithium ion 18650 LiCoO2 cells to not more than 30 percent resulted in a less energetic thermal runaway event and greatly reduced the likelihood of thermal propagation from cell to cell.[68] As such, the state of charge requirement in this rulemaking will serve to mitigate the likelihood of thermal propagation for lithium ion cells stored in cargo holds of cargo-only aircraft, particularly for lithium ion 18650 LiCoO2 cells, by preventing the propagation of thermal runaway.

Consignment and Overpack Restriction

The provision restricting the number of packages per consignment or overpack when transported in accordance with limited hazard communication will provide safety benefits to air cargo operators and the public by addressing the fire hazard associated with shipping large quantities of small lithium cells and batteries that were previously being consolidated in overpacks, pallets, in single unit load devices. The existing regulations permit large quantities of closely packed lithium ion batteries to be transported by aircraft without requiring the shipper to disclose information to the air operator or the pilot in command. The potential for a small number of lithium batteries in thermal runaway to vent flammable gas and propagate thermal runaway between cells in the same package and between adjacent packages and material caused the ICAO to review the effectiveness of the existing safety standards. ICAO adopted a consignment restriction to preclude abuse of the relief provided for small quantities of small lithium cells and batteries.

Based on the estimated mean 10-year undiscounted cost of $65.84 million and the estimated economic consequences of $34.9 million for a cargo-only flight incident, the rulemaking would need to prevent 1.9 incidents over the next 10 years for the benefits to exceed the quantified costs, or approximately one every 5 years. The rulemaking would need to prevent a larger number of incidents to exceed the rulemaking's cost when non-quantified costs are considered. There have been two fatalities in the U.S. safety record,[69] which covers the period related to accidents involving lithium ion batteries shipped by air.

C. Executive Order

This rulemaking is considered an Executive Order 13771 regulatory action. Details on the estimated costs of this rulemaking can be found in the rulemaking's economic analysis.

D. Executive Order 13132

This IFR has been analyzed in accordance with the principles and criteria contained in Executive Order 13132 (''Federalism'') and the President's memorandum (''Preemption'') published in the **Federal Register** on May 22, 2009 [74 FR 24693]. This IFR will preempt State, local, and Indian tribe requirements but does not propose any regulation that has substantial direct effects on the States, the relationship between the national government and the States, or the distribution of power and responsibilities among the various levels of government. Therefore, the consultation and funding requirements of Executive Order 13132 do not apply. If adopted, this IFR will preempt any State, local, or tribal requirements concerning these subjects unless the non-Federal requirements are ''substantively the same'' as the Federal requirements. In addition, this IFR does not have sufficient federalism impacts to warrant the preparation of a federalism assessment.

E. Executive Order 13175

This IFR has been analyzed in accordance with the principles and criteria contained in Executive Order 13175 (''Consultation and Coordination with Indian Tribal Governments''). Because this rulemaking does not significantly or uniquely affect the communities of Tribal governments and does not impose substantial direct compliance costs, the funding and consultation requirements of Executive Order 13175 do not apply.

F. Regulatory Flexibility Act, Executive Order 13272, and DOT Regulatory Policies and Procedures

Section 603 of the Regulatory Flexibility Act (RFA) requires an agency to prepare an initial regulatory flexibility analysis describing impacts on small entities whenever an agency is required by 5 U.S.C. 553 to publish a general notice of proposed rulemaking for any proposed rulemaking. Similarly, section 604 of the RFA requires an agency to prepare a final regulatory flexibility analysis when an agency issues a final rule under 5 U.S.C. 553 after being required to publish a general notice of proposed rulemaking. Because of the contributing factors and the need to address the identified safety risk, PHMSA has found that there is good cause to forgo notice and comment pursuant to the exceptions in 5 U.S.C. 553(b)(B)(3). Accordingly, PHMSA has not analyzed the effects of this action under 5 U.S.C. 603 and 604.

G. Paperwork Reduction Act

PHMSA currently has approved information collections under Office of Management and Budget (OMB) Control Numbers 2137–0034, ''Hazardous Materials Shipping Papers and Emergency Response Information'' and 2137–0557, ''Approvals for Hazardous Materials.'' A review of the baseline and change of paperwork and recordkeeping burden related to this IFR would bring small lithium batteries into fully regulated status, thus requiring shipping papers. PHMSA estimates that there will be an additional 28,242 shipments annually that will require a shipping paper. PHMSA estimates that each shipping paper takes one minute and thirty seconds to complete (28,242 shipments × 1 minute 30 seconds), which results in approximately 741 burden hours. PHMSA does not

[68] Webster et al. See footnote 7.

[69] For the purposes of this analysis, the scope of the U.S. safety record includes incidents reported to PHMSA over a 10-year period using a DOT Form 5800.1. Furthermore, PHMSA is unable to conduct a root cause analysis on many lithium battery incidents due to the destruction of evidence in fire.

estimate any increase in out-of-pocket costs. These shipments will also require a notification to the pilot in command (NOPIC) taking 1 minute per shipment (28,242 shipments × 1 minute), which results in an increase of approximately 471 burden hours. PHMSA does not estimate any increase in out-of-pocket costs. In total for this information collection, PHMSA estimates an approximate increase of 56,484 annual number of responses (28,242 shipping paper responses + 28,242 NOPIC responses) and approximate increase of 1,212 burden hours (741 shipping paper burden hours + 471 NOPIC burden hours).

PHMSA also estimates that an additional 468 approval requests will result from the new requirements in this IFR. PHMSA estimates that it takes 40 hours to complete the paperwork portion of an approval request, resulting in 18,720 additional burden hours (468 approval requests × 40 hours per request). PHMSA does not estimate any increase in out-of-pocket costs.

A summary of the information collection changes can be found below:

OMB Control Number 2137–0034

Annual Increase in Number of Respondents: 0.

Annual Increase in Annual Number of Responses: 56,484.

Annual Increase in Annual Burden Hours: 1,212.

Annual Increase in Annual Burden Costs: $0.

OMB Control Number: 2137–0557

Annual Increase in Number of Respondents: 468.

Annual Increase in Annual Number of Responses: 468.

Annual Increase in Annual Burden Hours: 18,720.

Annual Increase in Annual Burden Costs: $0.

Under the Paperwork Reduction Act of 1995, Public Law 104–13, no person is required to respond to an information collection unless it has been approved by OMB and displays a valid OMB control number. Section 1320.8(d) of title 5 of the CFR requires that PHMSA provide interested members of the public and affected agencies an opportunity to comment on information and recordkeeping requests. Please direct your requests for a copy of the information collection to Steven Andrews or Shelby Geller, U.S. Department of Transportation, Pipeline & Hazardous Materials Safety Administration (PHMSA), East Building, Office of Hazardous Materials Standards, 1200 New Jersey Avenue Southeast, Washington DC 20590, Telephone (202) 366–8553.

H. Regulation Identifier Number (RIN)

A regulation identifier number (RIN) is assigned to each regulatory action listed in the Unified Agenda of Federal Regulations. The Regulatory Information Service Center publishes the Unified Agenda in April and October of each year. The RIN contained in the heading of this document can be used to cross-reference this action with the Unified Agenda.

I. Unfunded Mandates Reform Act

This IFR does not impose unfunded mandates under the Unfunded Mandates Reform Act of 1995. It does not result in costs of $141.3 million or more to either State, local, or Tribal governments, in the aggregate, or to the private sector, and it is the least burdensome alternative that achieves the objective of the rulemaking.

J. Environmental Assessment

The National Environmental Policy Act of 1969, 42 U.S.C. 4321–4375 (NEPA) requires Federal agencies to consider the environmental impacts of proposed actions in their decision-making process. Where an agency does not anticipate significant environmental impacts, the Council on Environmental Quality (CEQ) regulations implementing NEPA require Federal agencies to conduct an environmental assessment to consider (1) the need for the action, (2) alternatives considered, (3) the human and environmental impacts of the action and alternatives, and (4) a list of the agencies and persons consulted. *See* 40 CFR 1508.9(b). This IFR would amend the Hazardous Materials Regulations (HMR; 49 CFR parts 171–180), with the following provisions to (1) prohibit the transport of lithium ion cells and batteries as cargo on passenger aircraft; (2) require all lithium ion cells and batteries to be shipped at not more than a 30 percent state of charge on cargo-only aircraft; and (3) restrict small lithium cell and battery shipments to one package per consignment or overpack.

1. Need for the Action

Lithium batteries pose unique challenges to safety when transported by air because, unlike other hazardous materials, they contain both a chemical and an electrical hazard. This combination of hazards, when involved in a fire encompassing significant quantities of lithium batteries, may exceed the fire suppression capability of an aircraft and lead to a catastrophic lithium battery event. Lithium batteries can overheat and ignite under certain conditions and, once ignited, can be especially difficult to extinguish. The presence of lithium batteries can also increase the severity of a fire originating from another source. In general, lithium batteries have a higher energy density (*i.e.,* high energy to size ratio) than other types of batteries and are susceptible to thermal runaway, which is a chain reaction leading to self-heating and uncontrolled release of the battery's stored energy. In addition, most lithium ion batteries manufactured today contain a flammable electrolyte.

Laboratory testing conducted at the FAA Technical Center has demonstrated that lithium batteries pose a greater risk in air transportation than other types of batteries (*e.g.,* alkaline, nickel-metal hydride, and nickel cadmium). This testing has also demonstrated that even a few lithium batteries can present a serious hazard. The current fire suppression systems installed on aircraft provide, at best, limited effectiveness in mitigating fires involving a consignment of lithium batteries, which confirms that lithium batteries pose unique transportation hazards of which the current requirements are not effective in mitigating.

Additionally, during the ICAO Dangerous Goods Panel Meeting (DGP–25; October 19–30, 2015), the DGP proposed two amendments to the ICAO Technical Instructions. These proposed amendments were based on recommendations developed at the Second and Third International Multidisciplinary Lithium Battery Transport Coordination Meetings, which took place in September 2014 and July 2015, respectively. By way of DGP–25, the DGP recommended that the ICAO Technical Instructions be amended to (1) require all lithium ion cells and batteries on cargo-only aircraft to be shipped at not more than a 30 percent state of charge and (2) restrict the number of packages that may be offered under current ICAO Technical Instructions provisions for small batteries (''Section II'' batteries) to not more than one package per consignment. The ICAO Council approved and published these amendments for incorporation into the 2015–2016 ICAO Technical Instructions in January 2016, with an effective date of April 1, 2016.

On February 22, 2016, in addition to the two safety enhancements discussed above, ICAO adopted an additional safety measure that prohibits, on an interim basis, all consignments of lithium ion batteries as cargo on passenger aircraft. This prohibition will

continue to be in force as separate work continues through ICAO on a new lithium battery packaging performance standard. This additional safety measure is also effective April 1, 2016.

Lastly, this rulemaking meets the congressional requirements in Section 333 of the FAA Reauthorization Act of 2018. The FAA Reauthorization Act of 2018 mandates that within 90 days of enactment, the Secretary shall issue regulations that adopt the requirements in the 2015–2016 ICAO Technical Instructions related to the air transportation of lithium cells and batteries, as well as the revised standards adopted by ICAO, which were effective on April 1, 2016, and any other provisions adopted by ICAO prior to the effective date of the FAA Reauthorization Act of 2018. The FAA Reauthorization Act of 2018 also directs the issuance of a limited exception to the restrictions on medical device lithium cells and batteries transported via aircraft, including an expedited review of applications for approvals and special permits related to the air transportation of lithium cells and batteries required for medically necessary care.

2. Alternatives Considered

In this rulemaking, PHMSA considered the following three alternatives:

Selected Alternative:

The Selected Alternative is the scenario, in which PHMSA adopts into the HMR the amendments presented in this rulemaking, including to:

- Prohibit the transport of lithium ion cells and batteries as cargo on passenger aircraft;
- Require all lithium ion cells and batteries to be shipped at not more than a 30 percent state of charge on cargo-only aircraft; and
- Restrict small lithium cell and battery shipments to one package per consignment or overpack.

PHMSA's selected alternative is the ''full harmonization'' approach since it aligns with ICAO actions and amendments to the ICAO Technical Instructions described in this rulemaking. Full harmonization under this rulemaking includes all three amendments above. In addition, this alternative meets the FAA Reauthorization Act of 2018 mandate to harmonize with the 2015–2016 ICAO Technical Instructions for air transportation of lithium cells and batteries and adopt any further revisions adopted prior to the effective date of the FAA Reauthorization Act of 2018 within 90 days of enactment (*See* Section 333). This alternative also meets the FAA Reauthorization Act of 2018 mandate to issue a limited exception for lithium cells and batteries transported via aircraft for medically necessary care.

Alternative 1: No Action Alternative:

The No Action Alternative is the scenario in which PHMSA does not adopt any of the provisions that comprise the IFR. This alternative represents a baseline scenario in that it portrays the way the world would look absent of PHMSA action. The current regulatory standards would remain in effect. This alternative does not meet the FAA Reauthorization Act of 2018 congressional mandate to harmonize with the 2015–2016 ICAO Technical Instructions for air transportation of lithium cells and batteries, harmonize with any further revisions including those effective on April 1, 2016, and to add a limited exception and expedited review of special permit and approval applications for air transportation of lithium cells and batteries for medical device.

Alternative 2: Partial Harmonization Alternative:

Under the Partial Harmonization Alternative, PHMSA would:

- Partially adopt the planned regulation. In particular, this alternative would involve adoption of the prohibition provision described in this rulemaking as well as the 30 percent state of charge provision (see ''Section V. Summary of Changes'' for further detail on these provisions). While there may be some combination of factors that effectively mitigate the hazards posed by the transportation of lithium ion batteries on passenger aircraft, the variable effects of battery chemistry, cargo compartment characteristics including fire suppression capabilities, and loading configuration clearly demonstrates that there is no single factor that would preclude the possibility of a thermal runaway event for all types of lithium ion batteries. Therefore, since the information to date does not provide for a level of surety that the risk can be fully mitigated, a prohibition on the transport of lithium ion batteries as cargo on passenger aircraft is most suitable option. With respect to the prohibition provision, PHMSA expects that the prohibition on transporting lithium ion batteries on domestic passenger aircraft would result in minimal cost impacts on shippers of lithium ion batteries and air carriers. This is because most U.S. passenger air carriers have already voluntarily stopped carrying this cargo on their passenger aircraft.
- Adopt the 30 percent state of charge requirement. PHMSA maintains that the technical basis for this provision is widely agreed-upon; numerous laboratory tests support that thermal runaway is related to the battery's state of charge.
- Not adopt the provision to restrict excepted battery shipments to one package per consignment or overpack.
- As this alternative only partially addresses the transportation of lithium cells and batteries adopted by ICAO prior to the effective date of the FAA Reauthorization Act of 2018, this alternative would not meet congressional mandate in its entirety.

3. Environmental Impacts

Preferred Alternative:

In selecting the provisions as described in this IFR, PHMSA concluded that human safety and environmental risks would be reduced and an increase in protections to human health and environmental resources. As discussed in detail in ''Section III. Need for the Rule,'' FAA research has shown that air transportation of lithium ion batteries poses a human safety risk. This IFR includes the specific measures to reduce environmental and human safety risks to air cargo operators and the public. Specifically, the consignment and overpack restriction will lower the risk of inadvertent bulk loading batteries in a cargo compartment of a cargo-only aircraft without full hazard communication, and the state of charge provision will decrease both the likelihood and consequence of an incident involving lithium ion batteries. Additionally, the prohibition of lithium ion batteries as cargo on passenger aircraft will generate human safety benefits to air operators and public by eliminating the possibility of (1) an incident induced by lithium ion batteries and (2) a fire exacerbated by the presence of lithium ion batteries involving the cargo hold of a passenger aircraft.

Potential environmental impacts of each amendment in the IFR are discussed below:

(1) Prohibit the transport of lithium ion cells and batteries as cargo on passenger aircraft.

Prohibiting lithium ion batteries as cargo on passenger aircraft will generate human safety benefits to air operators and the public by virtually eliminating the possibility of (1) an incident induced by lithium ion batteries shipped as cargo in a passenger aircraft and (2) a fire exacerbated by the presence of lithium ion batteries involving the cargo compartment of a passenger aircraft.

Incident-related contaminated debris entering the air, water (possible when aircraft make transoceanic flights or a

cargo's manifest involves a segment of transportation aboard an ocean vessel), and soil media would be avoided or mitigated and thus benefit the natural environment under this provision. Additionally, fewer and mitigated incidents involving lithium batteries will result in less contaminated debris to be landfilled. PHMSA expects that the prohibition on transporting lithium ion batteries on domestic passenger aircraft will have an incremental benefit to human safety and the environment over the current state since most U.S. passenger air carriers have already voluntarily stopped carrying this cargo on their passenger aircraft.

PHMSA acknowledges that the medical device exception poses an increase in safety risk and environmental risk due to the dangers posed by lithium ion cells and batteries. The FAA Reauthorization Act of 2018 requires the implementation of a medical device exception but did not fully specify how the exception applies. By providing this exception, PHMSA has considered the needs of individuals who require the replacement of lithium ion cells or batteries for medically necessary purposes as required by the FAA Reauthorization Act of 2018.

PHMSA further concludes that this amendment, which will increase standardization and consistency of regulations, will result in greater protection of human health and the environment. Consistency between U.S. and international transportation requirements enhances the safety and environmental protection of international hazardous materials transportation through:

- Better understanding of the regulations;
- An increased level of industry awareness and hence, compliance;
- The smooth flow of hazardous materials from their points of origin to their points of destination; and
- Consistent emergency response in the event of a hazardous materials incident.

Protections for human safety and environmental protection will also be enhanced through more targeted and effective training. This amendment will eliminate inconsistent hazardous materials regulations, which hamper compliance training efforts. For ease of compliance with appropriate regulations, air carriers engaged in the transportation of hazardous materials generally elect to comply with the ICAO Technical Instructions, as appropriate. By maintaining consistency between these international regulations and the HMR, shippers and carriers are able to train their hazmat employees in a single set of requirements for classification, packaging, hazard communication, handling, stowage, etc., thereby minimizing the possibility of improperly preparing and transporting a consignment of hazardous materials because of differences between domestic and international regulations. Greenhouse gas emissions would remain the same under this amendment.

(2) Require all lithium ion cells and batteries to be shipped at not more than a 30 percent state of charge on cargo-only aircraft.

Requiring all lithium ion cells and batteries on cargo-only aircraft to be shipped at not more than a 30 percent state of charge will provide safety benefits to air cargo operators and the public by reducing the available energy and limiting the propagation of heat and fire in the event of thermal runaway in lithium ion cells and batteries. The FAA Technical Center report, *Summary of FAA Studies Related to the Hazards Produced by Lithium Cells in Thermal Runaway in Aircraft Cargo Compartments,* FAA Report DOT/FAA/TC–16/37, June 2016, found that ''the volume of gases emitted by lithium ion cells in thermal runaway is dependent on the state of charge of the cell. Higher states of charge yield greater volumes of flammable gases. Reducing the state of charge of lithium ion 18650 LiCoO2 cells to thirty percent or less resulted in a less energetic thermal runaway event and greatly reduced the likelihood of thermal propagation from cell to cell.'' As such, the state of charge requirement in this rulemaking will serve to mitigate the likelihood of thermal propagation for lithium ion cells stored in cargo holds of cargo-only aircraft, particularly for lithium ion 18650 LiCoO2 cells, by preventing propagation of thermal runaway.

In addition to human safety benefits, incident-related contaminated debris entering the air, water (possible when aircraft make transoceanic flights or a cargo's manifest involves a segment of transportation aboard an ocean vessel), and soil media would be avoided or mitigated and thus benefit the natural environment under this provision. Additionally, fewer and mitigated incidents involving lithium batteries will result in less contaminated debris to be landfilled.

PHMSA acknowledges that the medical device exception poses an increase in safety risk and environmental risk due to the dangers posed by lithium ion cells and batteries. The FAA Reauthorization Act of 2018 requires the implementation of a medical device exception but did not fully specify how the exception applies. By providing this exception, PHMSA has considered the needs of individuals who require the replacement of lithium ion cells or batteries for medically necessary purposes as required by the FAA Reauthorization Act of 2018.

PHMSA further concludes that the amendment, which will increase standardization and consistency of regulations, will also result in greater protection of human health and the environment. Consistency between U.S. and international transportation requirements enhances the safety and environmental protection of international hazardous materials transportation through:

- Better understanding of the regulations;
- An increased level of industry awareness and hence, compliance;
- The smooth flow of hazardous materials from their points of origin to their points of destination; and
- Consistent emergency response in the event of a hazardous materials incident.

Enhanced environmental protection will also be achieved through more targeted and effective training. This amendment will eliminate inconsistent hazardous materials regulations, which hamper compliance training efforts. For ease of compliance with appropriate regulations, air carriers engaged in the transportation of hazardous materials generally elect to comply with the ICAO Technical Instructions, as appropriate. By maintaining consistency between these international regulations and the HMR, shippers and carriers are able to train their hazmat employees in a single set of requirements for classification, packaging, hazard communication, handling, stowage, etc., thereby minimizing the possibility of improperly preparing and transporting a consignment of hazardous materials because of differences between domestic and international regulations. Greenhouse gas emissions would remain the same under this amendment.

(3) Restrict the number of packages that may be offered under current provisions for small cells and batteries to one package per consignment or overpack.

Restricting each consignment and overpack to one package will provide human safety benefits to air cargo operators and the public by addressing the fire hazards associated with shipping large quantities of small lithium cells and batteries, which were previously being consolidated in overpack pallets, in single unit load devices and in single aircraft cargo compartments. Under this provision, air cargo operators will be able to more

accurately control the number of batteries loaded on an aircraft and thus prevent fires that could result in injuries and loss of life. The number of consignments and paperwork for air operators and offerors will increase with only one package allowed per consignment. However, the additional amount of administrative work is expected to be small and would be offset by the much greater savings in avoided and mitigated incidents.

In addition to human safety benefits, incident-related contaminated debris entering the air, water (possible when aircraft make transoceanic flights or a cargo's manifest involves a segment of transportation aboard an ocean vessel), and soil media would be avoided or mitigated and thus benefit the natural environment under this provision. Additionally, fewer and mitigated incidents involving lithium batteries will result in less contaminated debris to be landfilled.

PHMSA further concludes that the amendment, which will increase standardization and consistency of regulations, will also result in greater protection of human health and the environment. Consistency between U.S. and international transportation requirements enhances the safety and environmental protection of international hazardous materials transportation through:

- Better understanding of the regulations;
- An increased level of industry awareness and hence, compliance;
- The smooth flow of hazardous materials from their points of origin to their points of destination; and
- Consistent emergency response in the event of a hazardous materials incident.

Enhanced environmental protection will also be achieved through more targeted and effective training. This amendment will eliminate inconsistent hazardous materials regulations, which hamper compliance training efforts. For ease of compliance with appropriate regulations, air carriers engaged in the transportation of hazardous materials generally elect to comply with the ICAO Technical Instructions, as appropriate. By maintaining consistency between these international regulations and the HMR, shippers and carriers are able to train their hazmat employees in a single set of requirements for classification, packaging, hazard communication, handling, stowage, etc., thereby minimizing the possibility of improperly preparing and transporting a consignment of hazardous materials because of differences between domestic and international regulations.

Greenhouse gas emissions would remain the same under this amendment.

Alternative 1: No Action Alternative:

Under the No Action Alternative, current regulations would remain in place, and PHMSA would not add new provisions to the HMR. Not adopting the environmental and safety requirements in the IFR under the No Action Alternative would result in a lost opportunity for reducing the number of and mitigating the damage from environmental and safety-related incidents.

Additionally, efficiencies gained through harmonization in updates to transport standards would not be realized. Foregone efficiencies in the No Action Alternative include freeing up limited resources to concentrate on air transport hazard communication issues of potentially much greater environmental impact. Greenhouse gas emissions would remain the same under the No Action Alternative.

Alternative 2: Partial Harmonization Alternative:

Under the Partial Harmonization Alternative, PHMSA would adopt the passenger aircraft prohibition provision, as well as the 30 percent state of charge provision into the HMR. The Partial Harmonization Alternative does not, however, include the consignment and overpack provision. Improvements in human safety and reduction in potential for environmental impacts from an incident under this alternative would therefore lie somewhere between the No Action Alternative and those in the IFR. Referring to the regulation portion of the probable environmental impacts section above, the same increases in human safety and reduction in potential for environment impacts from an incident would occur for human safety and the environment as those discussed under provisions (1) and (2). Similarly, as discussed under provisions (1) and (2), PHMSA acknowledges that there are some safety and environmental risks to allowing the transportation of lithium cells and batteries for the purposes of medically necessary care, with the approval of the Associate Administrator, on passenger aircraft and at a state of charge greater than 30 percent, but that those risks are outweighed by the benefits to those individuals needing the replacement lithium cells and batteries for their medical devices. Those human safety and environmental benefits discussed under provision (3) would not be expected to occur.

The main difference between the Partial Harmonization Alternative and the regulation's environmental benefits is that the regulation will allow for better control of fires and consequent deaths, injuries, and environmental contamination through smaller, more controlled consignments, whereas the Partial Harmonization Alternative will not offer these protections.

4. Agencies Consulted

PHMSA has coordinated with the FAA in the development of this rulemaking.

5. Finding of No Significant Impact

The requirements in this IFR reduce the likelihood of lithium batteries causing or contributing to accidents on a cargo-only aircraft and virtually eliminate the likelihood on passenger aircraft. This rulemaking would reduce the possibility of an incident on passenger aircraft by prohibiting the transportation of lithium ion batteries as cargo on passenger flights. Secondly, reducing the charge of lithium ion batteries has been shown to reduce the likelihood of thermal runaway, thereby reducing the likelihood of a lithium battery fire on aircraft. Finally, the restriction of a consignment or overpack to one package is intended to ensure that consignments that currently meet the letter of, but not the spirit of, the alternative hazard communication provisions are shipped and labeled as Class 9 hazardous material.

In response to the hazard posed by the transport of lithium ion batteries by air, and recent developments in the international community, these amendments are intended to promote environmental protection, safety, international harmonization, and clarity. These regulatory revisions will offer more efficient and effective ways of achieving PHMSA's goal of safe and secure transportation, protecting both people and the environment from hazardous materials in commerce.

The IFR provides more protection to human health and the environment than the ''No Action'' and ''Partial Harmonization'' Alternatives discussed above. The IFR thus comprises the most environmentally preferable alternative. The provisions of this IFR build on current regulatory requirements to enhance the transportation safety and security of consignments of hazardous materials transported by aircraft, thereby reducing the risks of an accidental or intentional release of hazardous materials and consequent environmental damage. PHMSA therefore believes that the net environmental impact will be slightly positive. PHMSA finds that there are no significant environmental impacts associated with this IFR.

K. Privacy Act

Anyone may search the electronic form of written communications and comments received into any of our dockets by the name of the individual submitting the document (or signing the document, if submitted on behalf of an association, business, labor union, etc.). The DOT posts these comments, without edit, including any personal information the commenter provides, to *www.regulations.gov*, as described in the system of records notice (DOT/ALL–14 FDMS), which can be reviewed at *www.dot.gov/privacy*.

L. Executive Order 13609 and International Trade Analysis

Under Executive Order 13609, agencies must consider whether the impacts associated with significant variations between domestic and international regulatory approaches are unnecessary or may impair the ability of American business to export and compete internationally. In meeting shared challenges involving health, safety, labor, security, environmental, and other issues, international regulatory cooperation can identify approaches that are at least as protective as those that are or would be adopted in the absence of such cooperation. International regulatory cooperation can also reduce, eliminate, or prevent unnecessary differences in regulatory requirements.

Similarly, the Trade Agreements Act of 1979 (Pub. L. 96–39), as amended by the Uruguay Round Agreements Act (Pub. L. 103–465), prohibits Federal agencies from establishing any standards or engaging in related activities that create unnecessary obstacles to the foreign commerce of the United States. For purposes of these requirements, Federal agencies may participate in the establishment of international standards, so long as the standards have a legitimate domestic objective, such as providing for safety, and do not operate to exclude imports that meet this objective. The statute also requires consideration of international standards and, where appropriate, that they be the basis for U.S. standards.

PHMSA participates in the establishment of international standards in order to protect the safety of the American public, and we have assessed the effects of the IFR to ensure that it does not cause unnecessary obstacles to foreign trade. In this case, the IFR will fully harmonize U.S. lithium battery provisions with the ICAO international standards. Further, the DOT engaged the public by highlighting the provisions of this IFR in a domestic public meeting prior to their adoption. DOT also requested comments from stakeholders on the effect of these provisions. Accordingly, this rulemaking is consistent with Executive Order 13609 and PHMSA's obligations under the Trade Agreement Act, as amended.

List of Subjects

49 CFR Part 172

Education, Hazardous materials transportation, Hazardous waste, Incorporation by reference, Labeling, Markings, Packaging and containers, Reporting and recordkeeping requirements.

49 CFR Part 173

Hazardous materials transportation, Incorporation by reference, Packaging and containers, Radioactive materials, Reporting and recordkeeping requirements, Uranium.

In consideration of the foregoing, PHMSA amends 49 CFR chapter I as follows:

PART 172—HAZARDOUS MATERIALS TABLE, SPECIAL PROVISIONS, HAZARDOUS MATERIALS COMMUNICATIONS, EMERGENCY RESPONSE INFORMATION, TRAINING REQUIREMENTS, AND SECURITY PLANS

■ 1. The authority citation for part 172 continues to read as follows:

Authority: 49 U.S.C. 5101–5128, 44701; 49 CFR 1.81, 1.97.

■ 2. In § 172.101, the Hazardous Materials Table is amended by revising the entry for ''Lithium ion batteries including lithium ion polymer batteries'' to read as follows:

§ 172.101 Purpose and use of the hazardous materials table.

* * * * *

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)			(9)		(10)	
							Packaging (§ 173.***)			Quantity limitations (see §§ 173.27 and 175.75)		Vessel stowage	
Symbols	Hazardous materials descriptions and proper shipping names	Hazard class or division	Identification No.	PG	Label codes	Special provisions (§ 172.102)	Exceptions	Non-bulk	Bulk	Passenger aircraft/ rail	Cargo aircraft only	Location	Other
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(8C)	(9A)	(9B)	(10A)	(10B)
	*		*	*		*		*		*	*		
.....	Lithium ion batteries *including lithium ion polymer batteries.*	9	UN3480	.....	9	422, A54, A100.	185	185 ...	185 ...	Forbidden	35 kg	A	
	*		*	*		*		*		*	*		

■ 3. In § 172.102, in paragraph (c)(2), revise special provision A51 and add special provision A100 in appropriate alphanumerical order to read as follows:

§ 172.102 Special Provisions.

* * * * *

(c) * * *

(2) * * *

A51 For aircraft batteries, irrespective of the quantity limitations specified in Column (9A) of the § 172.101 Table or § 175.75(c), wet cell batteries, UN2794 or UN2795, up to a limit of 100 kg net mass per package may be transported aboard passenger aircraft. Transport in accordance with this special provision must be noted on the shipping paper.

* * * * *

A100 Lithium ion cells and batteries must be offered for transport at a state of charge not exceeding 30 percent of their rated capacity. Lithium ion cells and batteries at a state of charge greater than 30 percent of their rated capacity

may only be transported under conditions approved by the Associate Administrator in accordance with the requirements in 49 CFR part 107, subpart H. Guidance and methodology for determining the rated capacity can be found in sub-section 38.3.2.3 of the UN Manual of Tests and Criteria (IBR, *see* § 171.7 of this subchapter).

* * * * *

PART 173—SHIPPERS—GENERAL REQUIREMENTS FOR SHIPMENTS AND PACKAGINGS

■ 4. The authority citation for part 173 continues to read as follows:

Authority: 49 U.S.C. 5101–5128, 44701; 49 CFR 1.81, 1.97.

■ 5. In § 173.185:
■ a. Revise the introductory text and paragraphs (c)(1)(iii) and (c)(4)(ii) through (vi);
■ b. Add paragraphs (c)(4)(vii) and (c)(5);
■ c. Redesignate paragraph (g) as paragraph (h); and
■ d. Add new paragraph (g).

The revisions and additions read as follows:

§ 173.185 Lithium cells and batteries.

As used in this section, c*onsignment* means one or more packages of hazardous materials accepted by an operator from one shipper at one time and at one address, receipted for in one lot and moving to one consignee at one destination address. *Equipment* means the device or apparatus for which the lithium cells or batteries will provide electrical power for its operation. *Lithium cell(s)* or *battery(ies)* includes both lithium metal and lithium ion chemistries. *Medical device* means an instrument, apparatus, implement, machine, contrivance, implant, or in vitro reagent, including any component, part, or accessory thereof, which is intended for use in the diagnosis of disease or other conditions, or in the cure, mitigation, treatment, or prevention of disease, of a person.

* * * * *

(c) * * *

(1) * * *

(iii) Except when lithium cells or batteries are packed with or contained in equipment in quantities not exceeding 5 kg net weight, the outer package that contains lithium cells or batteries must be appropriately marked: ''PRIMARY LITHIUM BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT'', ''LITHIUM METAL BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT'', ''LITHIUM ION BATTERIES—FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT'' or labeled with a ''CARGO AIRCRAFT ONLY'' label specified in § 172.448 of this subchapter.

* * * * *

(4) * * *

(ii) Not more than one package prepared in accordance with this paragraph (c)(4) may be placed into an overpack. When a package displays the ''CARGO AIRCRAFT ONLY'' label, the paragraph (c)(1)(iii) mark, or the paragraph (c)(3)(i) lithium battery mark and is placed in an overpack, the appropriate label or mark must either be clearly visible through the overpack, or the label or mark must also be affixed on the outside of the overpack, and the overpack must be marked with the word ''OVERPACK''.

(iii) A shipper is not permitted to offer for transport more than one package prepared in accordance with the provisions of this paragraph in any single consignment.

(iv) Each shipment with packages required to display the paragraph (c)(3)(i) lithium battery mark must include an indication on the air waybill of compliance with this paragraph (c)(4) (or the applicable ICAO Technical Instructions Packing Instruction), when an air waybill is used.

(v) Packages and overpacks of lithium batteries prepared in accordance with this paragraph (c)(4) must be offered to the operator separately from cargo which is not subject to the requirements of this subchapter and must not be loaded into a unit load device before being offered to the operator.

(vi) For lithium batteries packed with, or contained in, equipment, the number of batteries in each package is limited to the minimum number required to power the piece of equipment, plus two spares, and the total net quantity (mass) of the lithium cells or batteries in the completed package must not exceed 5 kg.

(vii) Each person who prepares a package for transport containing lithium cells or batteries, including cells or batteries packed with, or contained in, equipment in accordance with the conditions and limitations of this paragraph (c)(4), must receive instruction on these conditions and limitations, corresponding to their functions.

(5) For transportation by aircraft, a package that exceeds the number or quantity (mass) limits in the table shown in paragraph (c)(4)(i) of this section, the overpack limit described in paragraph (c)(4)(ii) of this section, or the consignment limit described in paragraph (c)(4)(iii) of this section is subject to all applicable requirements of this subchapter, except that a package containing no more than 2.5 kg lithium metal cells or batteries or 10 kg lithium ion cells or batteries is not subject to the UN performance packaging requirements in paragraph (b)(3)(ii) of this section when the package displays both the lithium battery mark in paragraph (c)(3)(i) and the Class 9 label. This paragraph does not apply to batteries or cells packed with or contained in equipment.

* * * * *

(g) *Limited exceptions to restrictions on air transportation of medical device batteries.* Irrespective of the quantity limitations described in column 9A of the § 172.101 Hazardous Materials Table of this subchapter, up to two replacement lithium cells or batteries specifically used for a medical device as defined in this section may be transported as cargo on a passenger aircraft. Packages containing these cells or batteries are not subject to the marking requirement in paragraph (c)(1)(iii) of this section or the ''CARGO AIRCRAFT ONLY'' label required by § 172.402(c) of this subchapter and may be transported as cargo on a passenger aircraft when approved by the Associate Administrator and provided the following conditions are met:

(1) The intended destination of the cells or batteries is not serviced daily by cargo aircraft if a cell or battery is required for medically necessary care; and

(2) Lithium ion cells or batteries for medical devices are excepted from the state of charge limitations in § 172.102, special provision A100, of this subchapter, provided each cell or battery is:

(i) Individually packed in an inner packaging that completely encloses the cell or battery;

(ii) Placed in a rigid outer packaging; and

(iii) Protected to prevent short circuits.

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Howard R. Elliott,

Administrator, Pipeline and Hazardous Materials Safety Administration.

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