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## **DEPARTMENT OF TRANSPORTATION**

### **Pipeline and Hazardous Materials Safety Administration**

#### **49 CFR Part 175**

[Docket No. PHMSA-2009-0126, Notice No. 15-3]

### **Hazardous Materials: Spare Fuel Cell Cartridges Containing Flammable Gas Transported by Aircraft in Passenger and Crew Member Checked Baggage**

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

**ACTION:** Notification of a More Definitive Statement.

**SUMMARY:** PHMSA issued a 2011 final rule in which we did not harmonize with international regulations regarding the carriage of spare fuel cell cartridges in passenger and crew member checked baggage. Lilliputian Systems, Inc. (Lilliputian) contested this final rule, first by filing an administrative appeal, then challenging the final rule in the United States Court of Appeals for the District of Columbia Circuit. On January 31, 2014, the Court remanded the rule and ordered PHMSA to provide further explanation for the prohibition on airline passengers and crew carrying flammable gas fuel cell cartridges in their checked baggage, including its response to Lilliputian's comments. 741 F.3d 1309, 1314 (D.C. Cir. 2014). As a result, we are issuing this document which provides a more thorough explanation and substantial evidence to support PHMSA's decision to prohibit the carriage of spare fuel cell cartridges in passenger and crew member checked baggage.

**DATES:** [Insert date of publication in the Federal Register].

**FOR FURTHER INFORMATION CONTACT:** Michael Stevens, Transportation Specialist (Regulations), Standards and Rulemaking Division, Office of Hazardous Materials Safety,

Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, 1200 New Jersey Avenue S.E., Washington, DC 20590, Telephone: (202) 366-8553 or, via email: [michael.stevens@dot.gov](mailto:michael.stevens@dot.gov) or Shawn Wolsey, Senior Attorney, Office of the Chief Counsel, Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation, 1200 New Jersey Avenue S.E., Washington, DC 20590, (202) 366-4400 or, via email: [shawn.wolsey@dot.gov](mailto:shawn.wolsey@dot.gov).

#### **SUPPLEMENTARY INFORMATION:**

##### Background

In 2009, the International Civil Aviation Organization (ICAO) voted and reissued its Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Technical Instructions), which lifted the previous restriction of spare fuel cell cartridges for all but Division 4.3 chemistries from passenger and crew member checked baggage. In response, on August 24, 2010, the Pipeline and Hazardous Materials Safety Administration (PHMSA) issued a notice of proposed rulemaking (NPRM) to harmonize U.S. Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) with updated international standards. These changes included updates to packaging, labeling, and testing requirements to increase harmony with the international rules and promote the flow of goods (75 FR 52070, HM-215K, 8/24/2010). PHMSA stated its goal was "... to harmonize without diminishing the level of safety currently provided by the HMR and without imposing undue burdens on the regulated public" and that we "...evaluate[d] each amendment on its own merit." [75 FR 52071]

Ultimately, PHMSA did not adopt every provision of every set of the international regulations. In the final rule published January 19, 2011 [76 FR 3308], PHMSA revised the 49 CFR 175.10 passenger exceptions to allow passengers and crew members to place certain spare fuel cell cartridges containing a flammable liquid (Class 3) or corrosive material (Class 8) in

checked baggage. PHMSA stated, “fuel cell cartridges themselves are subject to much more stringent construction, testing, and packaging requirements than for similar articles (e.g., aerosols).” However, PHMSA limited the scope of spare fuel cell cartridge chemistries allowed in checked baggage by excluding fuel cell cartridges containing Division 2.1 (flammable gas) and Division 4.3 (dangerous when wet) material. In the interest of safety, PHMSA elected to continue the longstanding limitations in the HMR for Division 2.1 (flammable gas) on passenger-carrying aircraft and thus maintained the existing prohibition on the transport of spare fuel cells containing Division 2.1 (flammable gas) in checked baggage. PHMSA and the Federal Aviation Administration (FAA) explained their expressed concern “due to the questionable integrity of [fuel cells] when packed in a passenger’s checked baggage” [76 FR 3337].

As a result of PHMSA’s rulemaking, Lilliputian filed an administrative appeal in accordance with 49 CFR 106.110. It requested PHMSA to revise 49 CFR 175.10(a)(19) to align with the ICAO Technical Instructions and allow spare fuel cell cartridges containing Division 2.1 (flammable gas) to be carried in checked baggage. PHMSA granted the administrative appeal by providing Lilliputian and the public additional opportunity for comment in a May 25, 2012 NPRM [77 FR 31274]. The subsequent final rule issued on January 7, 2013 [78 FR 1101] denied the placement of spare Division 2.1 fuel cell cartridges in checked baggage but continued to allow two spare Division 2.1 fuel cell cartridges in carry-on baggage.

Lilliputian filed a Petition for Review of the Final Order in the United States Court of Appeals for the District of Columbia Circuit on March 8, 2013. In a January 31, 2014, (731 F.3d 1309) decision, the Court remanded the rule and ordered PHMSA to “provide further explanation

for the prohibition on airline passengers and crew carrying flammable-gas fuel cell cartridges in their checked baggage, including its response to Lilliputian's comments.”<sup>1</sup>

#### Justification for Denial of the Administrative Appeal

When PHMSA decides whether to allow an item on a passenger-carrying aircraft, the Department only tolerates extraordinarily low levels of risk. For example, when failure of a component in an airplane could interfere with continued flight and safe landing, the risk of failure must be less than one billion to one.<sup>2</sup> This low level of tolerance for risk makes sense because, due to the high volume of air transport, even a very improbable event may eventually occur, and with catastrophic results. Additionally, PHMSA is required by 49 U.S.C. 5108(b) to pursue the “highest degree of safety in pipeline transportation and hazardous materials transportation.”<sup>3</sup> Under 49 U.S.C. 5103(b), PHMSA is authorized to issue regulations for the safe and secure transportation of hazardous materials in commerce, including transportation by air.

The risks presented by flammable gas on airplanes are clear. Flammable gases will burn if mixed with an appropriate amount of air, and an ignition source is present, and confined burning of a flammable gas can lead to detonation. As a result, PHMSA remains concerned with the hazards posed by flammable gases (such as the butane contained in some fuel cells) contributing to a fire in the cargo compartment of a passenger-carrying aircraft. This concern is particularly relevant to carriage in checked baggage, where damage to the fuel cell cartridge and the release of a flammable gas may occur if the baggage is mishandled.

PHMSA denied Lilliputian's appeal due to the uncertainty of the safety risks posed when combining 1) the uncertainty of how the baggage handling would affect the durability and

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<sup>1</sup> **741 F.3d 1314**

<sup>2</sup> [http://www.faa.gov/documentLibrary/media/Advisory\\_Circular/AC25.1309-1A.pdf](http://www.faa.gov/documentLibrary/media/Advisory_Circular/AC25.1309-1A.pdf)

<sup>3</sup> PHMSA's Administrator is charged with carrying out all duties and powers vested in the Secretary of Transportation under chapter 51 of Title 49 of the U.S. Code, which governs the transportation of hazardous materials. 49 U.S.C. 108(f)(1).

stability of these products, 2) the possible over-sight of hazmat communication and packaging requirements because the regulations do not apply to passengers, and 3) the limitations of aircraft's fire suppression systems. PHMSA was particularly concerned by the allowance for passengers to transport flammable-gas fuel cells because passengers "are not trained to recognize potential hazards" and "are unlikely to be aware of the safety implications" of improper packaging or handling. Considering those factors combined with the limitations of the aircraft's suppression system, (fire suppression systems "do not prevent fires" and are not "designed to completely extinguish fires") the safety risks were too great to authorize this exemption. PHMSA further explained that the authorization of any additional flammable gas on an airplane, in addition to the gases contained in the toiletry and medicinal items already allowed, would need to take into account "the cumulative risk of the new authorization combined with existing authorizations." [78 FR 1104] PHMSA expressed willingness, however, to consider allowing certain fuel cells models on a case-by-case basis. For example, portable oxygen concentrators may be allowed at some point in the future, when experience and testing prove that safe designs exist.

Because of the risks presented by flammable gases, a number of safety requirements apply to shipments of flammable gas on passenger-carrying aircraft. PHMSA believes there is sufficient basis for its decision because, as previously stated, in the area of aviation safety, there is a very low tolerance for risk. In its decision, PHMSA considered the known risks of flammable gases, coupled with the uncertainties relating to the safety of new fuel cell technology, added to the already high volume of air travel and the catastrophic consequences of any failure.

#### Cumulative Risk

PHMSA's approach to aviation safety is not to permit items merely because they are similar to items already permitted. The authorization of any additional flammable gas on an aircraft, in addition to the toiletry and medicinal items already allowed, needs to take into account the cumulative risk of the new authorization combined with existing authorizations. A limited exception has existed since 1972 for small quantities of such gases in personal medicinal and toiletry items, such as the butane used as a propellant in a small aerosol can or a butane-powered curling iron (49 CFR 175.10(a)(1)(i)). However, most Division 2.1 (flammable gas) substances and articles are forbidden from transportation as cargo aboard passenger-carrying aircraft, and thus prohibiting the carriage of spare fuel cell cartridges containing flammable gas in checked baggage is consistent with the agency's longstanding position with regard to flammable gases.

#### Checked Baggage

The exceptions in 49 CFR 175.10 have not been expanded to permit additional flammable gases in checked baggage. As previously noted, allowing transportation of flammable gas in airline passengers' checked baggage would be inconsistent with the exceptions in 49 CFR 175.10. Airline passengers do not comply with the important packaging, labeling, and hazard communication requirements when they put items in their checked baggage, and they may not even be aware of such requirements. Without hazard communication and other notifications to handlers that the passenger's baggage contains flammable gas, checked baggage could be mishandled, damaging the integrity of an improperly packaged container of flammable gas. Negligent packing and excessive handling increases the potential that a container of flammable gas in checked baggage could rupture, creating conditions for an explosion. 76 FR 3337.

Beginning in 2009, the ICAO began considering whether to change its regulations to allow transport of fuel cells in checked baggage. Prior to that time, fuel cells had been allowed only in carry-on baggage or on one's person, in order to mitigate the risk of the fuel cell cartridge inadvertently coming into contact with an ignition source.<sup>4</sup> Although members of the ICAO Dangerous Goods Panel were generally supportive of permitting most fuel cells containing flammable liquids in checked baggage, "many were wary of permitting fuel cartridges containing substances of other classes." In particular, "[s]ome felt further consideration was needed with respect to fuel cell cartridges containing flammable gases." Some participants suggested that changes not be adopted to allow these new technologies until "experience based on a longer timeframe could be demonstrated."<sup>5</sup> In the end, ICAO included in its Technical Instructions a provision to allow two spare fuel cell cartridges containing flammable gas in checked baggage. It should be noted that the ICAO Dangerous Goods Panel does not operate solely on a consensus basis and that some delegates, including the U.S. Panel Member, were not in agreement with this decision. The U.S. Panel member spoke against the adoption of this provision when the amendment was discussed and agreed to by majority vote during the Dangerous Goods Panel's 22<sup>nd</sup> meeting (held in Montreal, Canada from October 5-16, 2009).<sup>6</sup>

#### FAA Technical Report

In Lilliputian's comments posted to the docket of the August 24, 2010 NPRM (PHMSA-2009-0126-2027), they posed five recommendations for conducting a proper risk analysis:

- Any analysis should begin with the risk of ignition or sparking.
- The analysis should examine the risk of catching fire as a result of an external fire.

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<sup>4</sup> With regard to the allowance of fuel cell cartridges in carry-on baggage or on one's person, the risk is mitigated because the fuel cells are contained in a supervised environment. Thus, a flight attendant would be able to extinguish any fires that might occur in a carry-on bag in the event of a fuel cell cartridge inadvertently coming into contact with an ignition source.

<sup>5</sup> <http://www.icao.int/safety/DangerousGoods/DGP%2022%20Working%20Papers/DGP.22.WP.100.en.pdf> at 2.9.4

<sup>6</sup> <http://www.icao.int/safety/DangerousGoods/DGP%2022%20Working%20Papers/DGP.22.WP.100.en.pdf>

- The analysis should examine whether a fuel cell fire, once ignited, can be effectively extinguished in a timely manner.
- The analysis should look to any experience involving similar materials.
- The analysis should evaluate whether the volume of the material is relevant in terms of the risk and managing that risk.

We believe that the Preliminary Investigation of the Fire Hazard Inherent in Micro Fuel Cell Cartridges (Final Report)<sup>7</sup> prepared by the FAA Technical Center did address these recommendations posed by Lilliputian. The report examined the fire risk presented by fuel cells, including cells powered by flammable solids, liquids, and gas, including a test that exposed single, small fuel cells of various types to a low-intensity flame in a controlled environment. Only a few varieties of fuel cells were tested, because the technology was still developing; however, one of the fuel cells tested was a butane fuel cell manufactured by Lilliputian. The test results showed that, of the fuel types tested, “[b]utane produced the most vigorous fire.” The plastic cartridge used by Lilliputian was breached only 45 seconds after exposure to flame and the **“butane ignition was rapid, almost explosive”**<sup>8</sup> (emphasis added). It produced an approximately 1,000-degree Fahrenheit flame, by far the hottest flame produced by any of the materials in the study. While some of the other fuel cell fires were “easily extinguished using Halon 1211,” a fire suppression system commonly used in an aircraft, the butane fire burned so rapidly that the fire suppression system did not activate until after all the butane fuel had been consumed by the fire.

A Halon 1211 system is not designed to detect fires. The pilot must first see that there is an alert from the fire detection system. Once that happens, the pilot will engage the Halon 1211

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<sup>6</sup> See Document PHMSA-2009-0126-2366 in this docket.

<sup>8</sup> See Document PHMSA-2009-0126-2366 in this docket.

system, which will attempt to suppress, but not extinguish, the fire. While airplanes are equipped with fire detection systems, such as Halon 1211, there are no systems on board to detect a gas leak. Thus, if a fuel cell cartridge placed in checked baggage is damaged and allows butane gas to leak into the cargo compartment, there is no way for the pilot to be aware of this. The accumulation of the butane gas, if exposed to a spark, would then cause an explosion and would lead to a catastrophic failure of the airplane.

The FAA Technical Center tests were designed to determine the flammability characteristics of fuel cell cartridges. The tests were conducted on single cartridges exposed to a controlled fire. The tests did not take into account the interaction of one or more cartridges and any adjacent combustible material (i.e., clothing, electronic devices, etc.) or the effect of fuel cell cartridges in propagating a fire. We do know from the test results that butane produced the most vigorous fire, the cartridge provided the least amount of protection from an external fire and, once penetrated, the liquid butane burned rapidly and filled the test chamber with fire. The butane fire also registered the highest temperature (1000 degrees Fahrenheit) and heat flux measurements of all tests conducted. The plastic cartridge used by Lilliputian was breached only 45 seconds after exposure to flame, and the butane ignition was rapid, almost explosive. Thus, the test results from the Final Report support our concern that the inherent hazards of compressed flammable gases, as demonstrated by exposure to a fire involving a fuel cell cartridge containing an estimated volume of only 50 cc or less of butane, would pose an unacceptable risk in air transportation.

As PHMSA stated in the preamble to the January 19, 2011 final rule, Federal hazmat law (49 U.S.C. 5101 et seq.) and policy encourages the harmonization of domestic and international standards for hazardous materials transportation to the extent practicable, but the law also permits PHMSA to depart from international standards in order to promote public safety. When

considering the adoption of international standards under the HMR, PHMSA reviews and evaluates each amendment on its own merit, on the basis of its overall impact on transportation safety, and on the economic implications associated with its adoption. Our goal is to harmonize without diminishing the level of safety and without imposing undue burdens on the regulated public. In this instance, we believe that restricting the carriage of flammable gas fuel cell cartridges to be a necessary variation to the ICAO Technical Instructions that enhances the safety of aircraft passengers without imposing an unreasonable regulatory burden. Under Federal hazmat law, we are tasked with balancing the needs of public safety with economic burdens when considering harmonization with international standards. Consequently, because we elected not to revise the HMR to align with the ICAO Technical Instructions, we believe we did strike a balance by continuing to permit flammable gas fuel cell cartridges in carry-on baggage.

#### Disparate Treatment of Aerosols and Butane-Powered Articles

The Court of Appeals for the District of Columbia Circuit also was concerned that PHMSA did not provide a reasoned explanation and substantial evidence for the disparate treatment of fuel cell cartridges as opposed to other products, particularly medicinal and toiletry items that contain flammable gases (i.e. aerosols).

#### Aerosols

In order to determine if a hazardous material is permitted in checked baggage, PHMSA must take into account the cumulative risk of any new authorizations combined with any existing authorizations. Under certain conditions, 49 CFR 175.10 permits the carriage of aerosols in checked baggage on a passenger-carrying aircraft. This limited exception has existed since 1972 for aerosol containers in small quantities in personal medicinal and toiletry items. Such items include hair spray, deodorant, and certain medicinal products.

To comply with the ban on chlorofluorocarbons (CFCs) that became effective January 1, 1994<sup>9</sup>, the aerosol industry changed the type of propellant used in their products. Unfortunately, this new type of propellant is flammable and, because of its widespread use, there was concern of a risk-risk tradeoff (ozone layer damage versus cargo compartment safety on passenger-carrying aircraft). PHMSA and FAA were concerned that static electricity inherent in cargo compartments could ignite a leaking flammable aerosol container in passenger baggage.

Based on its concerns, PHMSA reviewed incident reports in the Hazardous Materials Identification System (HMIS) database and specific incidents that occurred during baggage handling provided by the FAA. Accordingly, PHMSA and FAA agreed to work together in certain areas to improve the safe transportation of flammable aerosols by adopting regulatory and non-regulatory solutions. For example, each agency agreed to: (1) actively participate in the ICAO Dangerous Goods Panel that reviews the items that passengers are permitted to carry in the cabin and in checked baggage; (2) partner with the Consumer Specialty Products Association to enhance the design of aerosol products; and (3) amend the HMR to require or clarify that any release of hazmat in passenger baggage must be reported. Further, in a final rule published on December 20, 2004, PHMSA amended the HMR by requiring that release devices on aerosols be protected by a cap or other suitable means to prevent the inadvertent release of contents when placed in passenger or crew member baggage. [69 FR 76179; (HM-215G)] Because of the prevalence of aerosols in everyday travel, these adopted safety measures were deemed sufficient while not being overly burdensome to the traveling public. However, PHMSA continues to monitor this issue very closely and will respond to any negative trends accordingly.

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<sup>9</sup> <http://www.epa.gov/ozone/snap/aerosol/qa.html>

While PHMSA and FAA adopted safety measures to address the risks associated with permitting aerosols in checked baggage, the amount of butane in a fuel cartridge (200 mL) is approximately twice as much as the amount utilized in a typical 16 ounce aerosol can. Given the amount of electronic devices that passengers typically travel with, the cumulative volume of butane from fuel cell cartridges that passengers could bring aboard an aircraft is a concern. As a result, PHMSA has determined there is too much risk in allowing fuel cell cartridges in checked baggage in addition to the currently authorized flammable aerosols when stowed in inaccessible cargo compartments on passenger-carrying aircraft.

#### Butane-Powered Curling Iron Articles

As previously stated, 49 CFR 175.10 prescribes certain conditional exceptions to the HMR for passengers, crewmembers, and air operators for hazardous materials contained in their carry-on (including on one's person) and checked baggage. In paragraph (a)(6), hair curlers (curling irons), containing a hydrocarbon gas such as butane, are excepted from the requirements of the HMR in checked baggage. *Flammable gas refills for such curlers are not permitted in carry-on or checked baggage.* (emphasis added).

In an NPRM published January 23, 2015 (80 FR 3836; [HM-218H]), PHMSA is considering prohibiting butane-powered curling iron articles in checked baggage. We believe the risk posed by flammable gases in an inaccessible compartment on a passenger-carrying aircraft is clear. Flammable gases will burn if mixed with an appropriate amount of air and confined burning of a flammable gas can lead to detonation. As a result, we remain concerned with the flammability hazard posed by butane and other flammable gases and the ability of such gases to propagate or contribute to a fire in the cargo compartment of an aircraft. This concern is particularly relevant to carriage in checked baggage, where damage to the curling iron and the

subsequent release of a flammable gas may occur if the baggage is mishandled or the article itself is compromised.

### Conclusion

Because of the risks posed by flammable gas, a number of safety requirements apply to cargo shipments of flammable gas on passenger-carrying aircraft. As previously stated, most Division 2.1 (flammable gas) substances and articles are generally forbidden from transportation as cargo aboard passenger-carrying aircraft, and PHMSA's proposal to prohibit the carriage of butane-powered curling irons in checked baggage is consistent with this provision. In the area of aviation safety, where the high volume of travel and the catastrophic consequences of failure lead to a very low tolerance for risk, we firmly believe the known risks of flammable gas are sufficient basis for our decision.

We remain concerned with the flammability hazard posed by butane and other flammable gases and the ability of such gases to propagate or contribute to a fire in an inaccessible cargo compartment of a passenger-carrying aircraft. Moreover, in light of the well-established risks related to flammable gas and the long-standing prohibition of most flammable gas on passenger-carrying aircraft, PHMSA will continue to prohibit fuel cell cartridges that contain a class 2.1 flammable gas from being placed in checked baggage.

Dr. Magdy El-Sibaie  
Associate Administrator for Hazardous Materials Safety