COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

Sub-Committee of Experts on the
Transport of Dangerous Goods

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LISTING, CLASSIFICATION AND PACKING

Transport of Lithium Batteries

Transmitted by the expert from the United States of America

1. Incidents involving lithium batteries (Lithium-ion and lithium metal batteries) continue to occur in transport and in particular, several recent incidents have underscored the risk that batteries can present in transport particularly when transported by air. The frequency and severity of the incidents has increased over the past two years. A list of incidents of which the Expert from the United States is aware is included as Annex 1. The causes of the incidents provide useful clues for considering and establishing corrective actions. Based on analysis of the incident data the most likely root causes for the lithium battery incidents appear to be:

External Short --- exposed battery terminal came in contact with metal objects to short circuit the battery. External short results in the generation of heat and may cause ignition of the surrounding combustible materials.

Internal Short --- this may happen as a result of manufacturing defects, or poor quality control, flawed designs, or when the battery is physically damaged.

In use situation ---- mostly involving improper “Charging” and/or “Discharging” conditions associated with the use of a equipment (i.e., computer or cell phone).

Non-compliance situation --- faulty design of the battery (cells or battery packs), lack of proper IEC or UL certification with applicable standards, undeclared shipments by consumers or companies, or improper packaging, testing and classification.

2. The expert from the United States of America is seeking comments from members of the Sub-Committee as to the best way forward to reduce the incidents that are occurring in transport. At its previous session, the Sub-Committee agreed to a number of amendments relative to the provisions for the transport of lithium batteries including enhancements to packaging and hazard communication included in Special Provision 188. These were agreed to for inclusion in the 15th Revised Edition of the UN Recommendations. An analysis of the incident data however suggests

that further action may be necessary to more comprehensively address the problem. The amendments agreed to by the Sub-Committee primarily address packaged batteries but do not comprehensively address unpackaged batteries or those transported in equipment. Many of the incidents which have been most severe have been related to the transport of such batteries in equipment. Millions of batteries have been recalled due to manufacturing defects. It is also suspected that batteries are being transported that are not capable of meeting the current UN tests.

3. In order to more comprehensively address the issue it is proposed that all available data be considered by the Sub-Committee with the objective of determining whether enhancements to the Model Regulations could decrease the risk and consequences of transport incidents. It is proposed that this effort include an analysis of the current testing provisions for lithium batteries. Although packaging and hazard communication requirements have recently been improved, a closer look at the root causes of the incidents could be undertaken to determine whether enhancements to battery design testing, production lot testing and manufacturing quality controls could ultimately improve the current transport situation. The intent of this paper is not to suggest that any one course of action is the most appropriate but rather to suggest that the Sub-Committee consider the incidents, probable root causes and current requirements in relation to the transport system with the objective of reducing incidents and their potentially significant consequences.

4. During a recent ICAO Dangerous Goods Panel (DGP) meeting, the DGP considered a number of proposals aimed at reducing lithium battery incidents in air transport including banning their transport on certain aircraft, removing the exceptions provided in SP 188 (A45 in the ICAO TI), limiting the quantities permitted on an aircraft and requiring notification of the cargo to pilots. The ICAO DGP has established a working group that includes representatives from the battery industry to consider the requirements for lithium batteries but recognizes that incidents have occurred in other modes of transport and that the matter is multimodal in nature. It is anticipated that the ICAO Secretariat will provide details to the Sub-Committee by way of an information paper. The Expert from the United States believes that it would be beneficial for members of the Sub-Committee to participate in the ICAO working group meeting in order to consider what actions may be appropriate to enhance the requirements of the UN Model Regulations relative to the requirements for the transport of lithium batteries.

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Annex 1
Known or Suspected Lithium Battery Incidents

DATE	TYPE OF BATTERY	**DEVICE (if applicable)**	**INCIDENT SUMMARY**
14-June-2007	Lithium CR123A	Ecoquest "Fresh Air Buddy" personal air purifier	While walking in the Long Beach, CA, airport terminal prior to flight, a passenger's personal air filter worn around her neck exploded in a streak of fire. The battery was ejected at high speed across the terminal and melted the carpet where it came to rest. Passenger was uninjured but suffered scorches/burns on her clothing. *Incident is still under investigation.*
11-June-2007	Lithium ion	Laptop computer	On June 11, 2007, a Piper Cherokee (PA-32) plane departed Kake Island Airport, AK (AFE) with two passengers, baggage and mail en route to Juneau, AK (JNU). Shortly after taking off, white-colored smoke began pouring into the cockpit and cabin area from the forward baggage compartment. The smoke forced the pilot to return and make an emergency landing at AFE. The pilot and both passengers exited the aircraft safely, but the aircraft eventually caught fire and was destroyed. The forward compartment contained U.S. Mail and baggage including a laptop computer. The incident is still under investigation by the U.S National Transportation Board and a definitive cause has not yet been determined; however preliminary indications are that the laptop's lithium battery pack is a potential candidate for the start of this fire.
5-June-2007	Lithium ion	Dell laptop computer	While waiting in the airport gate area, a passenger plugged his laptop computer into an electrical outlet on a column in the seating area. At some point the computer began smoking. Airline agent suggested the passenger unplug or shutoff the computer but passenger did not. The computer eventually burst into flames. Fire extinguishers were used to suppress—but not quickly extinguish—the fire.
15-May -2007	Lithium-ion battery pack for Sony PSP	No indication that battery was in or attached to Sony PSP device	Ramp worker removed checked bag that was on fire when loading passenger aircraft. Fire department determined that the fire was caused by a battery-pack for a Sony PSP handheld video game.

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10-May-2007	Lithium batteries		A driver smelled smoke in the cargo area of a delivery vehicle. The driver immediately removed the smoking package. The package did not burn or cause other damage. Investigation of the contents showed that the 30 lithium batteries were contained within the package and that some of them had short circuited. The carrier reported that the shipper used a plastic tray to hold the batteries, but that it did not provide sufficient protection against short circuit.
19-Mar-2007	"CR123" lithium metal *Reportedly; battery fragments were disposed of by crew*	Possibly a camera	1 ½ hours into a passenger flight from Buenos Aires to Miami a small explosion occurred in the Business Class section of the aircraft. There were sparks then a flash and smoke. Flight attendants, then the Captain, responded. Battery fragments were the only evidence found. It is suspected that the battery dropped into a seat and arced against a metal seat frame causing it to explode. The ruptured battery splattered debris on overhead bins. A fragment hit a passenger in the head burning her hair near her earlobe. Seven flight attendants were affected by smoke/fume inhalation. All refused medical treatment in Miami. One aircraft seat bottom and four seat covers were damaged and replaced.
9-Mar-2007	Lithium ion	Laptop computer and power converter.	Passenger flight from Toronto to Dallas/Ft.Worth diverted to St. Louis after strong electrical burning smell in the cabin. Source was laptop being used by a passenger while plugged in to aircraft power port via power converter. Power converter reportedly heated up. Aircraft power port and laptop reportedly in normal working condition afterwards.
1-Mar-2007	Twenty-four Surefire SF123A Lithium metal (non-rechargeable) batteries		US mail package from EBay internet vendor containing the batteries was transported on a passenger flight from LAX to Sydney and caught fire at the Sydney Mail Gateway Facility.

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10-Feb-2007	Energizer lithium metal 9-volt, Energizer lithium metal AA, and IDX NP-L50S lithium ion batteries were all present. One Energizer lithium metal 9-volt was destroyed in the fire and seems most likely to be source of the fire.	Packed with professional audio/video equipment	While still climbing after takeoff from JFK, smoke began pouring from an overhead bin in the passenger cabin. Passengers alerted the flight attendants who responded. A flight attendant opened the bin and saw thick black smoke and flames in the rear of the bin. As the plane returned to the airport for an emergency landing flight attendants were able to put out the fire, discharging two Halon fire extinguishers. Water was applied to some cloth embers that continued to burn after the Halon was used. Cockpit crew smelled some light smoke in the cockpit and donned O2 masks for approx. 20 seconds until the smoke dissipated. Source of fire, bag with audio-video equip was secured in a lavatory. Aircraft landed and taxied to the gate. One passenger complained of chest pains and needed assistance in exiting the aircraft. The fire apparently was caused by loose batteries that were packed in a bag with other audio-video equipment.
15-Dec-2006	One Lithium metal CR123A (probable)	"Fresh Air Buddy" personal air filter	On a Houston-Portland passenger flight, a personal air filter, being worn on a strap around a passenger's neck, started a fire in the cabin. The device started making hissing sounds and then emitted bright sparks/flash and a clap/bang sound. The passenger removed the device and it fell between two seat cushions where it continued to burn and smoke. Passengers dumped water on the device and then flight attendants put out the fire with a Halon fire extinguisher. The aircraft diverted to Colorado Springs. The passenger wearing the device suffered a superficial burn to his chest. Dozens of passengers were examined by EMT personnel, mainly for complaints related to inhalation of smoke and/or Halon fumes. Five or six passengers were taken to the hospital. The two fire-resistant aircraft seat cushions were replaced due to having holes burned in them.
14-Dec-2006	Counterfeit CR123A, lithium metal	Flashlight "Superfire WF-501B"	During a UPS cargo flight from Sydney, Australia to Guangzhou, China, at 38,000 ft., the crew heard a loud bang. A crewmember found that his flashlight in a bag next to his seat was warm and had a strong odor coming from it. The flashlight was opened and there was soot/residue from burning. One of the two batteries (now determined to be counterfeit) was damaged. Earlier the crewmember had dropped the flashlight about 6 inches into his bag and heard a thump.

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11-Nov-2006	Lithium ion cell phone batteries		After being shipped by air from China to the US, some batteries were selected for inspection by US Customs. While on the desk of an import specialist, the battery started emitting sparking flames and smoke.
15-Sep-2006	Lithium-ion laptop battery	IBM Laptop computer	Approximately 15 minutes prior to departure of a LAX-LHR transatlantic flight, the laptop computer of a passenger began to smoke. The relief pilot and purser assisted the passenger in removing the laptop from the airplane. The laptop was placed on the floor of the gate area where it continued to smoke from the battery pack area and a small flame appeared. A customer service representative discharged a fire extinguisher on the fire. The battery pack continued to smoke for an additional couple minutes with white smoke and a strong odor. The Fire Department responded and discarded the burnt battery pack. The passenger stated the laptop was an IBM that belonged to his company and had been in his possession the entire time, having original parts and never having been serviced. The passenger was reportedly not using aircraft power to operate the computer. The airplane remained in service and departed on time without the incident passenger.
17-Jul-2006	EaglePicher-Kokam Lithium ion/polymer (used for remote control models), 122 batteries of various sizes		The unlabeled/marked package was discovered to have caught fire while being held in bond for customs clearance in Korea. Package had traveled to Korea in FedEx system from Vienna via Paris and Subic Bay.
02-June-2006	Lithium ion / polymer, 7.4-volt; 10000 mAh		An Air China passenger flight from Guangzhou to Chengdu diverted takeoff due to a lithium battery fire in the cargo hold. While taxiing for departure the fire alarm for the lower deck cargo compartment activated. The Captain immediately released the fire extinguisher and the aircraft stopped taxiing. Passengers were evacuated. A burnt package containing lithium polymer batteries was discovered in the cargo hold up against the ceiling of the compartment on top of the other packages. Burn marks were visible on the ceiling. Shipment was declared as electric parts; there was no indication of lithium batteries or Dangerous Goods. No UN test report was available for the batteries. Eleven other boxes were in the shipment.

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15-May-2006	Lithium-ion (VGP-BPL2/VGP-BPS2 or equivalent)	Laptop with spare battery	Shortly before flight departure, a burning smell was detected in the first-class cabin of a Lufthansa ORD-MUC flight. Maintenance personnel were called to check and found it was coming from hand luggage inside an overhead luggage bin above seat 2A. The flight attendants evacuated the passengers in first class and first 2 rows of coach class. Crew used extinguishers to prevent setting off what was seen as the beginning of a slow fire. Maintenance immediately brought the bag outside the aircraft onto the ramp where it started to catch fire. Fire dept was called to assist. Fire was eventually put out after reigniting once. Fire apparently started from the extra battery pack for a laptop which was purchased on eBay. Flight departed 1 hour 18 minutes late.
03-Mar-2006	Lithium ion button cells, mfr. by Lixing		US-bound package was noticed to be smoking at outbound FedEx station in Shenzen, China. Upon inspection, the package of lithium ion batteries was discovered to be on fire.
29-Jun-2005	Lithium Ion	Battery-pack	At UPS in Ontario, Calif., during unloading of a ULD from Shanghai, it was discovered that a fire had taken place inside the ULD. A package containing a lithium-ion battery pack was identified as the source of the fire. Upon discovery, the burnt package and its contents were cool to the touch and there was no smoldering evident.
11-Feb-2005	Lithium battery, solid cathode, manufactured by Eagle Picher of Surrey, BC, Canada.	None	An undeclared package containing 18 lithium batteries caught fire while being unloaded from a conveyor belt at the FedEx facility in White Bear Lake, MN. FedEx cargo handlers report hearing a “pop” sound and then seeing the box “lifted” off the conveyor belt by the force. The shipment had flown from Los Angeles to Minneapolis and was to be trucked to Clear Lake, WI. Only one battery caught fire.
29-Oct-2004	Ultralife 9-volt lithium (traditional 9-volt form: rectangular with two terminals on top)	Camera equipment	Shortly after departure, the battery exploded in the hand of a cameraman traveling on the VP campaign plane of Sen. Edwards (the cameraman reportedly was in the process of changing batteries). It spewed shrapnel and ignited a fire in the seat which was extinguished by flight attendants and others. The flight crew declared an emergency and returned to Raleigh-Durham airport without further incident.

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07-Aug-2004	Lithium-ion	Lithium-ion batteries assembled together in a plastic case	Prototype lithium batteries shipped under a competent authority approval from California to Europe apparently started a fire in a ULD during the loading process at the FedEx Memphis hub. The ULD had just been loaded for a transatlantic flight (Memphis-Paris). The ULD and many other packages in it were damaged/destroyed by fire. Shipment apparently was in violation of the DOT approval allowing the prototype battery to be shipped.
01-Apr-2004	CR123 lithium batteries	Flashlight	A flight attendant lent a passenger a flashlight which was recently purchased in Beijing. The passenger dropped the flashlight while it was on. Later the passenger put the flashlight in a seatback pocket. A few minutes later, the flashlight began to emit smoke and noxious fumes. The flashlight became so hot it could only be handled with oven mitts.
12-Aug-2002	Lithium battery (excepted)	Samsung mini computer (palm pilot)	Burning odor detected by handlers at the Los Angeles FedEx inbound package sort center. Battery apparently short-circuited causing the bubble wrap in the package to burn and melt onto the unit.
12-Apr-2002	Lithium batteries	None	Lithium batteries shipped under exception by Abbott Labs did not have terminals protected from short circuit. Started fire inside package at FedEx Indy sort facility.
5-Mar-2002	Lithium batteries	None	A package containing lithium batteries transported in a delivery truck was damaged by other freight. The damaged batteries initiated a fire.
03-Nov-2000	Hawker lithium sulphur dioxide batteries	None	While in route by road to the FedEx Cargo facility in Portland, OR, a lithium battery shorted and ruptured, burning its packaging. The shorted battery had long flexible protruding positive and negative terminals. Two FedEx drivers were treated at a hospital after inhaling fumes from the incident.
22-Sept-1998	Lithium batteries	None	A drum containing lithium batteries was determined to be the probable cause for a fire which began in the back of a truck and eventually spread to an adjacent building.
20-Oct-1997	Lithium	None	Drums containing lithium batteries started a fire in the back of a delivery truck. It is suspected that the batteries short-circuited.
28-Apr-1999	Primary Lithium	None	120,000 lithium batteries were being shipped on

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	batteries, Sanyo CR2 (excepted)		two pallets. After being unloaded from a passenger flight from Japan, a cargo employee at LAX mishandled one of the two pallets causing lithium batteries to dislodge from their packaging. The pallet later caught on fire along with the second pallet which it was placed next to. Initial attempts to extinguish the blaze using water/chemical fire extinguishers failed.
26-Sep-1996	Lithium batteries	None	Eight lithium batteries were connected in a series and packed with bubble wrap inside a plastic express envelope. There were exposed connections on one end and loose wires on the other end. The batteries were not secured from movement within the package and a short-circuit resulted causing the packaging to burn. Burnt package discovered at Airborne sort center after first flight and prior to trans-Pacific cargo flight.
18-Nov-1995	Lithium batteries	None	A box containing lithium batteries in a rail car was involved in a fire which ensued after a train collision. It is not clear whether the lithium batteries in this case initiated the fire.
08-May-1994	Duracell lithium batteries (excepted from ICAO regulation by SP A45)	None	Consignment of lithium batteries found emitting smoke in ULD during truck transport to LHR. Fire damage. Batteries were smaller in diameter than a dime and about 5 mm high. They had been tossed loosely into a box. Positive and negative terminals had "tails" which were prone to short circuiting. The shipper was prosecuted by the UK CAA for failure to comply with Special Provision A45 of the ICAO Technical Instructions and fined £1200 with £300 costs.