DGP/24-IP/6
28/10/13

DANGEROUS GOODS PANEL (DGP)

TWENTY-FOURTH MEETING

Montréal, 28 October to 8 November 2013

Agenda Item 5: Resolution, where possible, of the non-recurrent work items identified by the Air Navigation Commission or the panel:
5.1: Review of provisions for the transport of lithium batteries

JANE'S AIRPORT REVIEW: "BURNING ISSUE: BATTERY SAFETY CREATES CONCERNS IN THE CARGO COMMUNITY"

(Presented by the Secretary)

SUMMARY

The attached is an article that was published in Jane's Airport Review.

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APPENDIX

JANE'S AIRPORT REVIEW: "BURNING ISSUE: BATTERY SAFETY CREATES CONCERNS IN THE CARGO COMMUNITY"

Burning issue: battery safety creates concern in the cargo community

Soaring demand for non-rechargeable and lithium-ion batteries should make them a lucrative prospect for the air freight sector, but airlines have safety worries

GEORG MADER, BEN VOGEL

IATA on 15 April 2013 held its first dedicated workshop on the hazards of transporting lithium-ion (Li-ion) batteries.

The workshop – led by IATA Head of Cargo Des Vertannes and Chris Glaeser, IATA director of global safety – included a briefing from Richard Howell, general corporate safety manager at Hong Kong-based Cathay Pacific.

Hong Kong International Airport shipped a sizeable proportion of the 4 billion Li-ion batteries that were produced legally in China in 2012 – 35% of the total was manufactured in Guangdong Province bordering Hong Kong, Howell noted. The legal distinction is important, because batteries are also produced illegally – and it is not possible to regulate the trade to distinguish 'authentic' Li-ion batteries from those not produced to international standards.

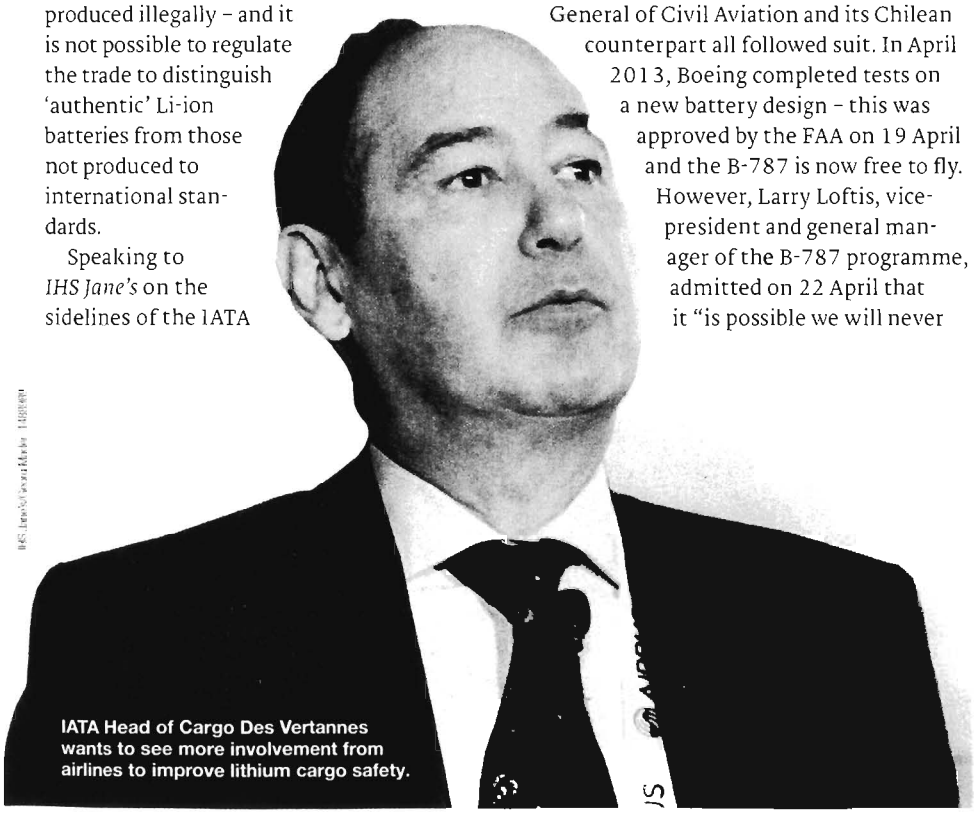
Speaking to *IHS Jane's* on the sidelines of the IATA event, some delegates described Howell's comments as "alarming".

Concerns were raised in January 2013 over the safety of lithium-cobalt-oxide batteries installed on the B-787 Dreamliner, after two high-profile onboard fires. The two Li-ion batteries are used to power the aircraft's brakes and lights. In one incident a battery caught fire in an aircraft parked at Boston Logan International Airport; in the other, a B-787 with a smoking battery was forced to make an emergency landing at Takamatsu Airport in western Japan.

As a result, the US Federal Aviation Administration (FAA) temporarily grounded all B-787s operating in the US pending a safety investigation. The European Aviation Safety Agency (EASA), the Indian Directorate General of Civil Aviation and its Chilean counterpart all followed suit. In April 2013, Boeing completed tests on a new battery design – this was approved by the FAA on 19 April and the B-787 is now free to fly.

However, Larry Loftis, vice-president and general manager of the B-787 programme, admitted on 22 April that it "is possible we will never know the root cause" of the malfunctions. (Another B-787 fire at Heathrow on 12 July does not seem to have been caused by this kind of battery malfunction.)

An interim amendment to the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air – a provisional ruling introduced in February 2013 – prohibited Li-ion aircraft batteries from being flown as cargo on passenger aircraft, but placed no restrictions on the shipment of other aircraft battery types on passenger flights. Nor did it place additional restrictions on Li-ion aircraft batteries being carried as freight on cargo aircraft.



IATA Head of Cargo Des Vertannes wants to see more involvement from airlines to improve lithium cargo safety.

Lithium meets popular demand

In the modern IT-dependent world, consumers demand small, lightweight communication and entertainment devices with a long battery life. They also want their laptops, tablets and smartphones to have bright screens and plenty of processing power. For these reasons, appropriate batteries have to be relatively small, while holding a lot of energy. Producing powerpacks that can hold more power for longer periods requires vital components, including the separators, to be small and thin.

The drive to produce more compact devices increases the risk that lithium powerpacks can fail, break, leak or short circuit – especially because millions of such batteries are manufactured by cheap labour in uncertified facilities, and shipped as 'classic' cargo or are ordered online in large numbers by individuals.

As a result, the risk of a short-circuit induced fire is increasing – but one airline delegate warned *IHS Jane's* that "some apathic regulators and national authorities ... are lagging behind against reality". The problem is exacerbated by the fact that untrained personnel working for uncertified shippers and forwarders are involved in shipping the temperature- and pressure-sensitive cargo.

A hazardous business

Howell referred to six "Li-fire events" worldwide at airports in 2012, describing these as "the tip of the iceberg and a very real risk that is getting bigger and bigger all the time".

Coincidentally, all six fires occurred on

The panel of speakers at the IATA cargo safety workshop sounded a stark warning on the hazards associated with shipping lithium batteries.

the 12th of the month, and in each incident the cargo was shipped legally and packed according to regulations: a mailbag fire on a Lufthansa flight at Helsinki Vantaa on 12 January; a fire at Heathrow on 12 April involving a checked-in bag containing a laptop battery ordered via eBay; a cargo fire while unloading an Air France A340 on 12 May at Warsaw Frederic Chopin; a cargo fire at Vancouver on 12 June; a warehouse fire in an Eva Air facility on 12 August; and a fire after a package fell 8 ft at Auckland on 12 November.

Such incidents are expected to be fuelled by booming online orders. Via eBay alone there are 90,000 daily shipments from China to the US – and LP Morgan estimates that global e-commerce will be worth USD2 trillion by 2016. Glaeser remarked that IATA is aware of two to three lithium battery "events" per month. Almost all countries ban the inclusion of lithium batteries in air mail shipments (notable exceptions being the US and Australia, for batteries fitted inside equipment and not loose), although the level of compliance is open to doubt.

Lithium batteries were described in Vienna as an "obvious factor" behind the loss of three cargo aircraft between 2006 and 2011. Howell referred to the crash of a UPS B-747-F at Dubai International in September 2010, in which two aircrew died. "The flight profile was very similar [to a Cathay Pacific flight, and] it could easily have been one of ours," he said. A preliminary report by air accident investigators in the UAE noted that although no hazardous materials were declared on the flight manifest, there were at least three shipments of 80,000 lithium batteries that met the US Department of Transportation definition of a Class 9 hazardous material.

Howell reminded delegates of the loss in July 2011 of an Asiana Cargo B-747-400F. Two of the loaded pallets were listed as containing dangerous goods, including Li-ion batteries for use in hybrid vehicles. Much of the damage occurred in an area adjacent to the two pallets.

The most recent FAA reports cited 132 aviation incidents between 1991 and 2012, involving all types of batteries. A National Transportation Safety Bureau (NTSB) report counted 82 from 1994 to 2007. Of those, 14 involved secondary Li-batteries, including seven with items carried on cargo-only aircraft, six involving checked and carry-on baggage and one with cargo carried on a passenger aircraft. The passenger aircraft incidents included two in flight and five before takeoff (three on board, two at the airport). Of the seven cargo incidents, four occurred post-flight, two before the cargo was loaded and one in flight. In March 2012 the FAA conducted tests, for example simulating a Li-ion fire of 5,200 cells. It took the cells 27 minutes – enough time for an aircraft to taxi-out and take off – to burst into flames, but then the blaze escalated to a temperature of 815°C (1,500°F) before dying our after 55 minutes.

A different test inadvertently underlined

Remedial action to improve safety

Speakers at the IATA event urged regulators, the aviation industry, battery manufacturers and governments to implement the following measures:

- More systematic sharing of data regarding lithium-ion battery incidents. A centralised worldwide database has been discussed by the ICAO since early 2012.
- Airlines must be able to share information on shippers and freight forwarders that do not follow regulations or have misdeclared goods. Currently airlines can ban shippers from handling their cargo, but for legal reasons they cannot share this fact with other carriers.
- Information on future technologies from the battery manufacturers, to allow more effective risk-mitigation planning and efforts. It was explained to *IHS Jane's* that while charged batteries are more internally stable than empty or old ones, a post-production state-of-charge of 40% would be the ideal compromise between flight safety and device usability. On the other hand, some airlines offer to charge passengers' mobile devices during the flight – even though the charging process can affect the thermal/chemical interior of the battery.
- Packaging for lithium batteries to be reviewed and fire-retardant gels to be considered.
- Better pallet-tagging, with standardised labels pointing out the presence of lithium batteries and warning loading staff about the shipment.
- Aircraft manufacturers to research passive fire-containment, such as fire-resistant materials for cargo compartment ceilings, sidewalls and air-ducting. Cathay has already asked Boeing to come up with ideas.
- Aircraft manufacturers to research alternative active fire-supression methods, as current halon-based systems are being phased out (due to their weight and environmental impact).
- Ensure full adherence with regulations on packaging, documentation and declarations.
- Regulators need to get tougher with known consistent offenders.
- Improve education for shippers and freight forwarders (this is very difficult, given that there are 18,000 shippers in Southern China alone).
- Enhanced screening to be installed at airports and postal facilities.
- Regulators to ensure that postal services are able to differentiate between lithium batteries inside equipment and batteries being transported as separate goods.

Georg Mader

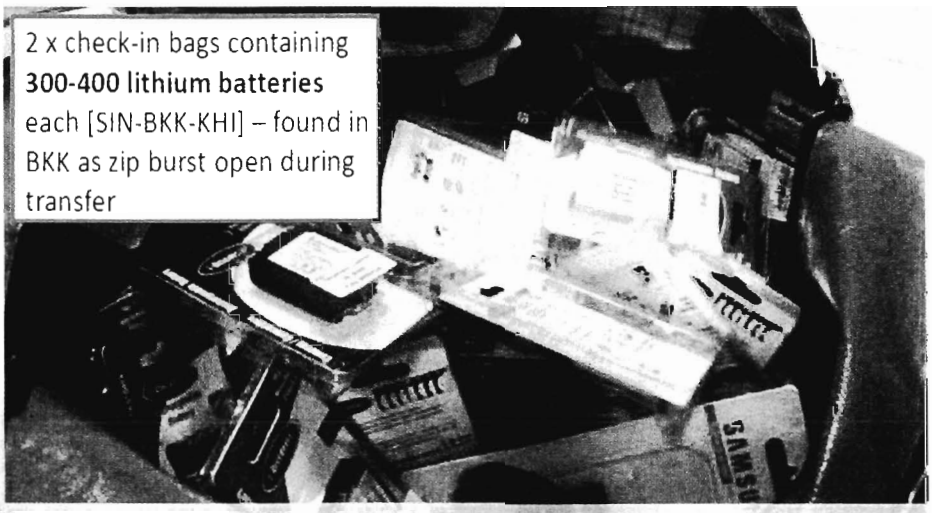
the force that such devices can develop, when in April 2012 a Li-ion E-car battery exploded while undergoing tests at a General Motors laboratory. The blast sent an employee to hospital and blew out three of the building's exterior windows and an 8 inch (20 cm) thick door.

Difficult to solve

Ordinarily, fire extinguishers can be used to defeat a blaze – but delegates at the Vienna conference were repeatedly reminded that halon-based fire extinguishers or fire-suppression systems are insufficient to fight a fire involving lithium. According to firefighters at Los Angeles International Airport, it took them 25 minutes to douse the flames (with water) from a pallet of primary Li-batteries that caught fire after being removed from a passenger flight from Japan. After falling from a forklift and put back on the trailer, the pallet began smoking and then caught fire, igniting an adjacent pallet of batteries.

Questioned about whether such fires can be contained automatically in flight, Howell noted that the NTSB has ruled that current FAA-approved automated suppression systems are ineffective in preventing fires involving disposable lithium batteries. It urged the Pipeline and Hazardous Materials Safety Administration to explicitly require that all shipments of these batteries be transported in FAA-approved fire-resistant containers, until a proven fire-suppression system becomes available. "However, that [ruling] concerns US operators and cargo shipped from and into the US, but what about Russia, India or Latin America?" Howell asked. Vertannes added that "we need more airlines and airports from the emerging markets at these panels and conferences".

Other airport systems are not geared towards dealing with the problem. Howell cited the baggage scanning machines at one international airport that screens up to 2 million items per month. These machines are not configured to alert screeners to the presence of lithium batteries, focusing instead on weapons, explosives, drugs and other contraband. Howell suggested to the panel that "we have to get from security screening to safety screening". ICAO has some guidance in place for this purpose, but there are no mandatory procedures. The US Department of Homeland Security is working with the US Postal Service and Cathay Pacific is working with the Hongkong Post to screen airmail, but, as Howell pointed out: "Who takes care of proper scanning in all the other post offices around the world?" The Universal Postal Union is yet to produce definitive regulations.



Smuggling is one of the problems surrounding the trade in lithium batteries – this undeclared cargo of up to 800 batteries was accidentally discovered at Bangkok Suvarnabhumi Airport in 2012.

Meanwhile, US and Australian airlines have banned loose, uninstalled or spare batteries from checked-in luggage, asking travellers to put these items into their carry-on luggage, since, unlike the cargo hold, there are many possible ways to discover and fight a battery fire in the aircraft cabin. Cathay Pacific also follows this policy, informing passengers that if undeclared lithium batteries are detected, the carry-on luggage will not be allowed onboard. Yet most other airlines do not make these enquiries to passengers at check-in, even though many fliers travel with spare powerpacks for cameras, phones or laptops.

Undeclared cargo

Without naming the airline, Howell referred to an incident in 2012 in which a passenger was intercepted because one of his bags opened by accident in transit at Bangkok Suvarnabhumi. The traveller had checked in two bags, each with 300 to 400 undeclared lithium batteries, and intended to sell them in Karachi.

The problem of undeclared dangerous cargo is not confined to lithium batteries. Howell told delegates that Cathay Pacific has received an advisory from the Hong Kong Civil Aviation Department (HKCAD) regarding undeclared consignments of mercury on flights from Hong Kong to destinations in Africa (Bamako in Mali and Khartoum in Sudan). These were consigned as general cargo and declared as 'jewellery', 'metal chains', 'iron' or 'mould' on the air waybill and were found leaking from their packages on arrival at their destinations.

The HKCAD reminded airlines that persons or organisations consigning misdeclared, undeclared or forbidden dangerous goods are liable to a maximum fine of USD250,000 and imprisonment for up to two years. Since mid-2012, Hong Kong Airlines Cargo does not accept consignments to Bamako or Khartoum, and includes interline consignments within the ban.

Glaeser remarked that the lithium battery issue is "a second shock to the cargo world after the US-bound ink-toner cartridge explosives from Yemen were discovered at Dubai and Heathrow in 2010. I think it is not overblown to say that in safety we [the cargo sector] are 15 years behind our passenger colleagues."

No 'simple' solutions

Des Vertannes, IATA head of cargo, put the number of incidents in a wider context of global air cargo operations. Air cargo accounts for around 35% of global trade and is a business worth USD6.2 trillion. He reminded delegates that all air cargo carriers want to ship thousands of tonnes of new smartphones, tablets or laptops: "We all want this business, don't get us wrong. But nobody should die because of it."

Yet no practical solutions are available to solve the battery problem. Vertannes appealed for airlines to lead the push for action and structural change, "not just debates", although he later acknowledged that the

onus to increase awareness and safety lies with freight forwarders. Their misdeclarations are reported overwhelmingly to be unwitting accidents – this may bear out comments from one security official at a European airline, who explained that 80% of global freight forwarders are not IATA-defined Regulatory Agents (Trusted Shippers in US terminology).

FedEx, UPS and Cathay Pacific are looking into fire-containment covers for single cargo pallets. A cover weighs 53 kg and can contain a fire for four hours, however, it takes 10-15 minutes to fix each one onto a pallet. This creates an issue for the time-critical air cargo industry, if 20 or more such pallets must be loaded on one aircraft.

Cathay Pacific has also introduced two fire suppression systems to be installed in the passenger cabin for use in the event of a lithium battery fire (the Class D non-corrosive Firebane liquid from SpectrumFX and a special envelope with two fireproof gloves called FireSock from Aircare Access). Firebane and FireSock have been introduced into the flight deck of all Cathay, Dragon Air and Air Hong Kong aircraft.

A database to prevent or to blame?

Vertannes praised efforts undertaken by Carlos Eduardo Pellegrino, director of Brazilian national civil-aviation agency ANAC and member of the ICAO Regional Aviation Safety Group, Pan America. Pellegrino – who was also present at the event in Vienna – is finalising a database of all safety events involving hazardous air cargo in Latin America, covering all reports from airlines, airports, cargo-handlers and forwarders.

At the moment, information-sharing between cargo operators on unprofessional activities or even on identified violators is not allowed. IATA believes that poor inter-industry communication on this issue is a huge weakness, and it is therefore encouraging airlines to follow Pellegrino's example. It is likely that such a database would be hosted, maintained and funded by IATA – but questions were asked in Vienna about how much information should be accessible to the public.

Speaking to *IHS Jane's*, Pellegrino noted that his database needs to be refined. "For example, just to be able to link comparable data from different sources, it is necessary to develop and maintain standards for common taxonomies or be able to convert or translate between different ones."

He added: "Beyond standardisation, the paramount priorities are the legal aspects of data-sharing – their economic and financial implications." Pellegrino referred to the "inherent challenge" the database would face with airlines shielding themselves from reputational damage. One way of solving this would give them the option of submitting information anonymously.

The automotive industry may, in time, have to address the problem. Speakers at the IATA operations conference referred to the emerging market for electric-drive cars, scooters and bicycles – such as the new 740 hp Mercedes SLS AMG that includes 12 lithium batteries. "The industry changes [but] the issue is here to stay," Howell noted. ■

▶ ON THE WEB

- **Danger signal: IATA calls for concerted action on lithium batteries, 23.04.13**

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Explaining the risks of lithium batteries

Lithium batteries come in two types. Non-rechargeable primary batteries are used in watches and small devices. They contain lithium metal, which burns when exposed to air. Secondary or lithium-ion (Li-ion) batteries are found in laptop computers, tablets, smartphones and so on, and are made using electrically charged lithium-ions in a flammable liquid electrolyte. Overheating of the battery or forceful pressure-changes such a fall can result in the ignition of the flammable electrolyte. This process is known as thermal runaway – once the temperature reaches a certain level it spirals upwards, generating more heat until the device ceases operating or an explosion occurs.

In an Li-ion battery, pressurised containers house a coil of metal and a flammable, lithium-containing liquid. Lithium is extremely flammable. The manufacturing process creates tiny pieces of metal that float in the liquid. Manufacturers cannot completely prevent these metal fragments, but high-level manufacturing-techniques can limit their size and number.

The cells of a lithium battery also contain separators that keep the anodes and cathodes (or positive and negative poles) from touching each other. If the battery for some reason becomes affected by external temperature or pressure changes, these pieces of metal can move around, very much like grains of rice in a pot of boiling water. If a piece of metal gets too close to the separator, it can puncture the separator and cause a short circuit.

The aftermath of a lithium battery fire.

Cathay Pacific Y-004138

Several stages are involved in the build-up to thermal runaway and each one results in progressively more permanent damage to the cell. The phenomenon typically starts at 110°C but with some electrolytes it can be as as low as at 70°C. At around 135°C, the polymer separator melts and allows the short circuits between the electrodes.

Eventually heat from the electrolyte breakdown causes breakdown of the metal oxide cathode material, releasing oxygen that enables burning of both the electrolyte and the gases inside the cell. The cathode breakdown starts at around 200°C for lithium-cobalt-oxide cells but at higher temperatures for other cathode chemistries.

There are a few possible scenarios for what can go wrong in case of a short circuit: if it creates a spark, the flammable liquid can ignite, causing a fire. If it causes the temperature inside the battery to rise rapidly, the breakdown of the cathode is also highly exothermic, sending the temperature and pressure even higher. Under those circumstances the battery can explode. Once the hot gases are released to the atmosphere they can of course burn in the air and ignite any material around. If however, the anomaly causes the temperature to rise at a slower rate, the battery can melt and the liquid inside would leak out.

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