



WORKING PAPER

**DANGEROUS GOODS PANEL (DGP)
WORKING GROUP ON LITHIUM BATTERIES**

SECOND MEETING

Montréal, 7 to 11 April 2014

Agenda Item 1: Mitigating risks associated with the carriage of lithium metal batteries

REPORT OF THE MEETING

(Presented by the Secretary)

1. INTRODUCTION

1.1 The meeting of the Dangerous Goods Panel Working Group on Lithium Batteries (DGP-WG/LB/2) was opened by Dr. Katherine Rooney, Chief of the Dangerous Goods Section, on 7 April 2014 in Montréal. Mrs. M. Paquette was elected Chairperson of the meeting and Mr. B. Firkins was elected Vice-Chairperson. The Secretary of the meeting was Dr. Rooney, assisted by Ms. McGuigan, Information Officer of the Dangerous Goods Section. Dr. Rooney advised the panel of changes in membership since DGP/24. These were the nominations of Mr. F-X. Dulac by France and Mr. P. Ros by Spain. She also advised that Mr. R. McLachlan would be the new panel member nominated by the United Kingdom. He would replace Mr. G. Leach who had been the chairman of DGP/24 and previous DGP meetings. She expressed her appreciation to Mr. Leach for his significant contributions to the panel's work and for successfully guiding the panel through many difficult meetings.

1.2 The need for a working group meeting was raised during discussions at DGP/24 on a proposal to forbid the transport of lithium metal batteries on passenger and cargo aircraft. Although there was agreement at DGP/24 that additional measures were needed to mitigate the risks lithium metal batteries posed and that the status quo was unacceptable, there was little support for a full prohibition on both passenger and cargo aircraft. Various options were discussed, but an agreement could not be reached. The meeting determined that a multidisciplinary approach involving experts from different aviation segments in addition to dangerous goods was needed to address the risks. To this end, the Federal Aviation Administration (FAA) William J. Hughes Technical Centre offered to host a multidisciplinary meeting on behalf of ICAO. This took place in Atlantic City from 4 to 6 February 2014. The meeting developed recommendations for DGP-WG/LB/2 to consider in developing provisions to mitigate risks related to lithium metal batteries (see paragraph 3.2.1 and Appendix A to this report).

2. ATTENDANCE

2.1 The meeting was attended by the following panel members, advisers and observers:

Members	Advisers/Observers	State/International Organization
B. Firkins		Australia
	M. Boehm	Austria
B. Carrara	H. Guedes	Brazil
M. Paquette	B. DiBacco D. Evans T. Howard	Canada
X. Sun (temporary replacement for Q. Xu)	J. Abouchaar	China
	J. Wiren Bengtsson	Denmark
P. Tatin (temporary replacement for F-X. Dulac)		France
H. Brockhaus		Germany
H. Sugimoto	A. Awano N. Iki F. Tanigawa K. Yanagawa	Japan
S. W. Park	S. Jin	Republic of Korea
T. Muller	R. Dardenne D. Kampman K. Vermeersch	The Netherlands
D. Mirko		Russian Federation
P. Ros		Spain
	W. Mathonsi T. A. Zembe	South Africa
	R. Joss	Switzerland

Members	Advisers/Observers	State/International Organization
H. Al Muhairi	Sultan Al Dhaheri P. Balasubramanian H. Jamil	United Arab Emirates
R. McLachlan	G. Leach	United Kingdom
C. Glasow	M. Givens S. Kelley S. Masterson J. McLaughlin S. Moates K. Leary	United States
D. Brennan	P. Oppenheimer D. Tindley	International Air Transport Association (IATA)
M. Rogers	S. Schwartz	International Federation of Air Line Pilots' Associations (IFALPA)
	A. Altemos N. McCulloch	Dangerous Goods Advisory Council (DGAC)
	J.-L. Ammeloot	European Aviation Safety Agency (EASA)
	H. Webster R. Hill	Federal Aviation Administration (FAA) William J. Hughes Technical Centre
	A. McCulloch B. McClelland M. Petzinger	Global Express Association (GEA)
	D. Ferguson V. Galotti P. Rohrbach	International Coordinating Council of Aerospace Industries Associations (ICCAIA)
	M. Boolish C. Monahan C. Updyke	National Electrical Manufacturers Association (NEMA)

Members	Advisers/Observers	State/International Organization
	G. Kerchner R. Jostes	PRBA — The Rechargeable Battery Association

3. AGENDA ITEM 1: MITIGATING RISKS ASSOCIATED WITH THE CARRIAGE OF LITHIUM METAL BATTERIES

3.1 The meeting was presented with three working papers and three information papers under this agenda item. These were as follows:

- a) a report on the outcome of the International Multidisciplinary Lithium Battery Transport Coordination Meeting (DGP-WG/LB/2-WP/1);
- b) a proposal to forbid the transport of lithium metal batteries as cargo on passenger aircraft (DGP-WG/LB/2-WP/2);
- c) a safety management review of the provisions for the transportation of lithium metal batteries on passenger aircraft (DGP-WG/LB/2-WP/5);
- d) information on extended diversion time operations (EDTO) and fire suppression capabilities and the potential impact the transport of lithium metal batteries may have on certification conditions (DGP WG/LB/2-IP/1);
- e) results of the Battery Association of Japan's tests on lithium coin cells; and
- f) facts and data related to lithium metal batteries compiled by an observer from the battery industry.

The content of these working papers is summarized in paragraph 3.2. Discussion was deferred until all these papers were presented; however, for the sake of clarity, significant comments raised during the discussion on specific papers (other than the proposal to forbid the transport of lithium metal batteries as cargo on passenger aircraft) are also provided with the summaries in paragraph 3.2. The paper which generated the most discussion was the proposal to forbid the transport of lithium metal batteries as cargo on passenger aircraft (DGP-WG/LB/2-WP/2). The discussion on this working paper is reported in paragraph 3.9.

3.2 Presentation of working papers

3.2.1 Report of the International Multidisciplinary Lithium Battery Transport Coordination Meeting (DGP-WG/LB/2-WP/1)

3.2.1.1 The Chairman of the ICAO International Multidisciplinary Lithium Battery Transport Coordination Meeting (FAA William J. Hughes Technical Centre, 4 to 6 February 2014) reported on the outcome, conclusions and recommendations of the meeting (hereafter referred to, for the sake of brevity, as the ICAO Multidisciplinary Meeting). The meeting was attended by experts in the fields of dangerous

goods, flight operations, airworthiness, by regulatory authorities and by representatives of the airframe and battery manufacturing industries.

3.2.1.2 Tests on batteries were performed to demonstrate how reactions were dependent on the battery type (i.e. lithium metal, lithium ion, nickel metal hydride), manufacturer and chemistry. Testing on various sizes of button cells demonstrated that their hazardous characteristics appeared to be proportionate to the size and significantly less reactive than larger lithium metal cells. Testing on one lithium metal size D cell containing a non-flammable electrolyte inside an otherwise empty shipping container resulted in overpressure to the container which rendered the container non-useable. The meeting also reviewed a video of full-scale testing of 4800 lithium metal cells in a B727 airframe which had been presented to DGP/24 (see paragraph 5.1.1.2 of the DGP/24 Report (reproduced in Appendix E of this report)).

3.2.1.3 The meeting concluded that fires in flight involving certain types and quantities of lithium metal batteries have the potential to result in an uncontrolled fire leading to a catastrophic failure of the airframe. This was substantiated by a safety risk mitigation analysis presented at the meeting which used tools contained in the *Safety Management Manual (SMM)* (Doc 9859). The outcome of the analysis suggested that the transport of certain types and quantities of lithium metal batteries on passenger aircraft posed an unacceptable risk under existing circumstances on the basis that the likelihood of an event occurring was remote but the severity of the consequence of the event would be catastrophic. The presence of airframe manufacturers at the ICAO multidisciplinary meeting highlighted the need for increased coordination between airframe manufacturers and dangerous goods regulators. It was revealed that airframe manufacturers operated on the basis that restrictions placed on dangerous goods by regulators provided an acceptable level of safety and that certification for cargo fire protection did not specifically address the risks posed by the carriage of dangerous goods, noting in particular the unique hazards presented by lithium metal batteries.

3.2.1.4 The meeting tabled the following four recommendations (reproduced in Appendix A to this report):

- 1) Further restrictions on the carriage of lithium metal batteries in commercial passenger carrying operations were recommended. Four options to achieve this were provided. The first was a prohibition on passenger aircraft until data supporting safe transport was available; the second was a prohibition with the possibility of transport through State approvals (provided guidance was developed which would include specific conditions to support the approval process); the third was an allowance to transport based on performance-based criteria and the fourth was an allowance to transport based on performance-based criteria plus an allowance to transport very small cells (the number and package configuration would be validated based upon a specification).
- 2) The establishment of a small multidisciplinary cargo safety group was recommended. This group would develop performance-based criteria for the transport of lithium batteries.
- 3) Risks associated with the transport of lithium metal batteries on cargo aircraft would need to be mitigated. It was recommended that this be considered at DGP-WG/14 based on lessons learned in relation to passenger aircraft.
- 4) A multidisciplinary approach involving all stakeholders was recommended as an essential step in advancing cargo safety.

3.2.2 Lithium Metal Batteries — Ban on Passenger Aircraft (DGP-WG/LB/2-WP/2)

3.2.2.1 A Secretariat proposal to forbid the transport of lithium metal batteries as cargo on passenger aircraft was presented to the working group. The proposal addressed Recommendation 1, Option 1 of the ICAO Multidisciplinary Meeting (Prohibition on passenger aircraft until such time as the data supporting safe transport is available) (see Appendix A).

3.2.2.2 Justification for the proposal was based on FAA test results which demonstrated that currently required packagings cannot mitigate a lithium metal battery fire and current fire suppression systems in cargo holds cannot adequately suppress a lithium metal battery fire. The presenter acknowledged concerns raised at DGP/24 that a prohibition on the transport of lithium metal batteries as cargo would serve only to stop compliant shipments of batteries and that non-compliant shipments would continue and likely increase in number. She believed, however, that while the risks related to non-compliant shipments of lithium batteries could not be ignored, to permit their carriage despite the known risks was not an acceptable mitigating strategy. A prohibition would ensure that large shipments of lithium metal batteries from compliant shipments did not end up on passenger aircraft thus reducing the exposure rate and eliminating a significant risk. She reminded the working group that there were risks posed by lithium metal batteries regardless of whether they were transported in compliance with the Technical Instructions, specifically the inability to suppress a fire involving these batteries. Manufacturing defects or damage to the batteries could lead to a thermal runaway event leading to a fire exceeding the capabilities of the fire suppression system. Test results had shown that the heat from an external, suppressed fire was capable of reaching temperatures that could ignite lithium metal batteries. The aircraft's cargo fire suppression system was the last line of defence in the event of a fire and, depending on the types and quantities of lithium metal batteries in the cargo hold, the ineffectiveness of Halon to suppress the fire would potentially result in a catastrophic event.

3.2.2.3 The proposal did not provide provisions for an approval (see Appendix A, Recommendation 1, Option 2) as conditions where the types, quantities and packagings containing lithium metal batteries which would not allow a fire from within the package to propagate beyond packaging or adversely affect flight safety had yet to be identified. It was believed that FAA test results indicating that the behaviour of a burning lithium cell was very dependent on the manufacturer, chemistry, size and design of the cell made determining appropriate conditions difficult. Likewise, in the absence of performance-based criteria for packaging for batteries, Options 3 (permission to transport certain batteries based on performance-based criteria) and 4 were not considered in the proposal.

3.2.2.4 The presenter acknowledged that a prohibition would not remove all of the risks associated with lithium metal batteries. Adequate training, oversight and enforcement were needed to reduce non-compliance. The working group was invited to provide recommendations on ways to improve oversight and enforcement activities in relation to the transport of lithium batteries.

3.2.2.5 Finally, the working group was invited to agree to address the remaining recommendations (2, 3 and 4) of the ICAO Multidisciplinary meeting during the next biennium (see Appendix A).

3.2.2.6 The discussion on this working paper is reported in paragraph 3.9.

3.2.3 **A Safety Management review of the Provisions for the Transportation Of Lithium Metal Batteries on Passenger Aircraft (DGP-WG/LB/2-WP/5)**

3.2.3.1 The meeting was provided with one member's comprehensive review of the current provisions for the carriage of lithium metal batteries on passenger aircraft and was invited to consider the issues raised in the paper. The member stated that his review was based on safety management principles in the *Safety Management Manual (SMM)* (Doc 9859) and included the current preventive and escalation controls and escalation factors that were in place with the current method of properly declared shipments of lithium batteries. Data the member collected from one operator in his State indicated a probability of 2×10^{-9} that a passenger aircraft might be carrying lithium metal batteries and experience an indication of a fire or smoke event (which included false alarms). Nevertheless, the presenter determined a safety risk severity of "catastrophic" and a safety risk probability to be either exceptional or probable (depending on individual viewpoints), and the resulting safety risk tolerability to be either high or moderate for large shipments of lithium metal batteries exposed to a fire in the cargo hold. It was suggested by a member of the FAA Tech Centre that a high safety risk could also apply to smaller shipments, noting the test which resulted in an explosion from one lithium metal size D cell containing a non-flammable electrolyte. The presenter suggested that although batteries displaying explosive properties should not be on passenger aircraft without further testing and risk mitigation, testing had indicated that in the event of high temperature or fire, other chemistries and other common larger batteries did not exhibit these properties.

3.2.3.2 The meeting expressed its appreciation for the work done. Several panel members noted that the data collected was specific to one State and that it would be difficult to extrapolate globally. One adviser suggested that regulations require that equipment, systems and installations be designed so that they do what they are supposed to do under any foreseeable operating conditions. That meant that in her State, the probability of a fire occurring was not taken into account in developing regulations; it was assumed that it would occur and that both fire detection and suppression systems would need to be able to deal with it.

3.2.3.3 The presenter suggested several risk mitigation strategies along with new preventive and escalation controls taking emerging materials and technologies into account. These included:

- a) additional testing requirements at the UN level;
- b) consideration of additional or different lithium battery classifications, taking into account the over twenty different chemistries for lithium batteries;
- c) new packaging options;
- d) research into potential security scanning technology for lithium metal batteries;
- e) safety education and promotion for the complete supply chain;
- f) emerging unit load device materials;
- g) emerging self-contained fire detection and suppression devices;
- h) effective regulation, oversight and enforcement;
- i) restrictions on the acceptance of bulk shipments;

- j) restrictions on the acceptance of overpacks containing excepted batteries from unknown shippers;
- k) segregation of lithium batteries from other dangerous goods; and
- l) keeping lithium batteries away from heat.

3.2.3.4 Advantages and disadvantages of a global prohibition on transporting lithium metal batteries on passenger aircraft were provided. The presenter concluded that while a prohibition on the transport of lithium batteries may have a positive effect on safety in large States with large cargo fleets, it would have a negative effect on smaller States with smaller or non-existing cargo fleets. The presenter expressed concern that deliberate non-compliance for commercial purposes would increase, particularly in States with limited oversight and enforcement systems. It was noted that security screening equipment could not differentiate between lithium metal and lithium ion batteries, although one State was currently exploring the feasibility of automatically detecting lithium batteries using existing x-ray technology. There was concern expressed that lithium metal batteries would be shipped as lithium ion batteries (which would still result in existing preventive and escalation controls remaining in place) or worse still, they could be declared and shipped as “non-restricted batteries” which would result in the removal of a number of preventive and escalation controls and increase the potential for a catastrophic outcome. Some voiced disagreement with the presenter’s conclusion, reiterating the belief that although non-compliance was a safety concern, allowing the transport of lithium metal batteries as cargo on passenger aircraft despite the known risks was not an acceptable mitigating strategy.

3.2.4 **Extended Diversion Time Operations (EDTO) And Fire Suppression Capabilities (DGP-WG/LB/2-IP/1)**

3.2.4.1 The meeting was provided with background information on the potential impact the transport of lithium metal batteries may have on certification conditions related to extended diversion time operations (EDTO) and cargo compartment fire suppression capabilities (contained in Annex 6 — *Operation of Aircraft, Part I — International Commercial Air Transport — Aeroplanes*). It was explained that the intent of EDTO provisions was to ensure that should a failure to a system occur, there would be a reasonable expectation that an aeroplane would be able to land safely. In the case of a cargo fire suppression system, it would need to be capable of suppressing a fire for the amount of time it would take to proceed to an aerodrome and land the aeroplane safely. It was suggested that the inability of current cargo fire suppression systems to suppress a lithium metal fire could preclude an aircraft’s certification for EDTO, recognizing that the cargo fire suppression time limitation of an aeroplane was considered to be an EDTO significant system time limitation.

3.2.4.2 The meeting was also reminded of the Standard in Annex 8 — *Airworthiness of Aircraft* requiring cargo compartment fire suppression systems, including their extinguishing agents, to be designed so as to take account of a sudden and extensive fire such as could be caused by an explosive or incendiary device or dangerous goods. It was noted that the Technical Instructions provided safety at the package level but not typically at the aircraft level. The meeting was urged to consider the capability of a cargo compartment fire suppression system to suppress a lithium metal battery fire when considering whether the batteries could be transported safely.

3.2.4.3 One adviser questioned whether the reference to dangerous goods in Annex 8 was intended for compliant dangerous goods or if it was also intended for non-compliant goods. He suggested that dangerous goods in full compliance with the Technical Instructions could not *cause* a fire; if they could they would be forbidden for carriage under any circumstances. He further suggested that if the Annex 8 reference included both compliant and non-compliant dangerous goods all cargo would need to

be prohibited from transport as it was well known that undeclared dangerous goods, including lithium metal batteries, were not uncommon. Others believed that the known risk posed by certain types and quantities of lithium metal batteries could be addressed without banning all dangerous goods as not all dangerous goods were known to pose a threat that could not be mitigated by aircraft fire suppression systems. Some noted that even fully compliant batteries posed a special risk due to their intrinsic hazard as they contained a material (lithium metal) normally forbidden on passenger aircraft. The meeting was advised of a security element to certification which involves a level of predictability of what could potentially end up in a cargo hold and suggested that this would also apply to dangerous goods. There was some sympathy in that the Standard could be clarified; those members interested would continue discussions following the meeting.

3.2.5 Testing of lithium coin cells (DGP-WG/LB/2-IP/2)

3.2.5.1 The meeting was provided with results from testing performed by members of the battery industry on lithium coin cells as packaged for transport by air. The presenter concluded that, based on the results, the lithium metal coin cells tested presented a *de minimis* risk in air transportation and should continue to be allowed as cargo on passenger aircraft.

3.2.6 Lithium primary batteries (DGP-WG/LB/2-IP/3)

3.2.6.1 Facts and data compiled by an observer from the battery industry based on shipments of lithium metal batteries by air to, from and within the United States were provided, including:

- a) Lithium metal batteries are used in medical, military, aerospace, automotive, consumer, industrial and information technology applications;
- b) Batteries are not always manufactured in the same facility as the devices to which they provide power, which results in shipment of the battery to the equipment manufacturer.
- c) A manufacturing defect that results in a failure of a unit would only extremely rarely develop into an event presenting a safety risk during transport.
- d) The manner in which batteries travel from the place they are manufactured to the end consumer is complex. They may be shipped multiple times by multiple modes of transport. This makes it difficult to obtain precise data on the amount transported by air.
- e) Over 2.5 billion lithium metal batteries were manufactured and shipped globally in 2013. Most travelled by surface modes, but some were shipped by air at least once and in some cases multiple times.

3.3 Discussion

Support for proposal to prohibit the carriage of lithium metal batteries on passenger aircraft

3.3.1 Although the majority supported the proposal to forbid the transport of lithium metal batteries as cargo on passenger aircraft, several members did not support it believing that a prohibition would result in an increase in non-compliance and have a negative effect on safety. These members did not feel there was data to support a complete prohibition because they believed there had never been an

incident involving compliant shipments of lithium metal batteries. Although they agreed further restrictions should be considered for larger lithium metal batteries, they believed that certain types and quantities of smaller batteries could be transported safely and that provisions for these smaller batteries should be provided. They also questioned the justification in allowing these batteries on cargo aircraft if it was believed they posed such a significant danger.

3.3.2 Those who supported the prohibition believed that allowing unlimited quantities of batteries on a passenger aircraft despite the known risks was unacceptable and that whether or not there had been any incidents involving shipments proven to be compliant was not a sufficient basis for determining appropriate safety standards. The potential for the batteries to auto-ignite, the fact that lithium metal batteries could serve as fuel for an independent fire, the fact that current packaging requirements could not mitigate a fire and the lack of an effective fire system necessitated proactive action. They agreed that non-compliance was a serious safety concern but believed this was a separate risk that needed to be mitigated and should not influence decisions related to developing provisions that affect safety. They also believed that full compliance did not guarantee the safe transport of lithium metal batteries. Manufacturing defects or damaged batteries could lead to a thermal runaway event resulting in an uncontrollable fire. The fact that fully compliant lithium metal batteries could serve as fuel for an independent fire was a significant risk that could not be ignored. Many of the arguments supporting a prohibition raised at DGP/24 were repeated at the working group meeting. An extract from the DGP/24 Report on the discussions on the proposal presented at DGP/24 is produced in Appendix C to this report.

3.3.3 The meeting was reminded that the original proposal presented by the Secretariat at DGP/24 was to prohibit the transport of lithium metal batteries on both passenger and cargo aircraft. Although there was some support for a prohibition on passenger aircraft at that time, the member nominated by IFALPA was the only one who supported a prohibition on both. Observers from the International Coordinating Council of Aerospace Industries Associations (ICCAIA) who did not attend DGP/24 but did participate at the ICAO Multidisciplinary Meeting noted that cargo compartment fire standards were developed prior to the proliferation in shipments of lithium batteries and without the knowledge of their risks. They believed that a layered approach providing for safety at the battery, then the packaging, then the compartment, then the aircraft level was necessary. The lack of an effective fire suppression system for lithium metal batteries would remove that last layer of protection. On that basis they believed that consideration should be given to forbidding the transport of the batteries on both passenger and cargo aircraft. The Secretariat acknowledged that, with few exceptions, ICAO did not distinguish between passenger and cargo aircraft in any other aviation area when setting safety standards, but that there were differences with regards to dangerous goods. It had been noted at DGP/24 that higher quantity limits were permitted on cargo aircraft, and certain substances forbidden on passenger aircraft were permitted on cargo aircraft. It had been agreed that more needed to be done to mitigate risks on cargo aircraft, but a full prohibition was considered to be too extreme. Those who supported the new proposal believed that mitigating the risks for both cargo and passenger aircraft was a formidable task that the group would likely not be able to complete during the week. The meeting's task was to focus on passenger aircraft and that cargo aircraft would be addressed during the next biennium. The ICAO Multidisciplinary Meeting also recommended (Recommendation 3) that risks associated with lithium metal batteries on cargo aircraft be mitigated using the lessons learned in the development of a performance-based approach to controlling the risks associated with the transport on passenger aircraft which that meeting also recommended (Recommendation 2) (see Appendix A).

3.3.4 Members who did not support the prohibition expressed concern that the only mitigating strategy being discussed was a prohibition. It was noted, however, that the proposal to prohibit was the only one submitted to the meeting. On that basis a new proposal was developed in an attempt to reach a consensus. There was considerable discussion on whether or not members could give proper consideration to it, as it was offered for discussion halfway through the week. As it strayed significantly

from the proposal to prohibit, some members would need more time to consult with experts within their States. It was decided not to discuss the paper, recognizing that a majority had already supported a prohibition and the new proposal was not based on any of the options contained in the ICAO Multidisciplinary Meeting's recommendations. It was suggested the paper contained new concepts which should be discussed at the next working group meeting of the panel.

Additional risks not mitigated by the prohibition of lithium metal batteries on passenger aircraft

3.3.5 While those who supported a prohibition believed it would significantly reduce the number of batteries in transport and therefore the probability and risk, they agreed that the prohibition would not eliminate the risk. Both deliberate and unintentional non-compliance was a significant concern for all members. Several helpful suggestions for addressing this were raised during discussions. These included educating consumers on the hazards batteries present, effective training for the entire supply chain to reduce unintentional non-compliance, effective enforcement for the entire supply chain to reduce intentional non-compliance, and effective outreach and oversight. A working group was established to build upon these ideas and to develop recommendations on how ICAO could assist in these efforts. The working group stressed the importance of developing a safety culture from start to finish between each entity of the entire supply chain. It recognized the lack of awareness, technical expertise and oversight procedural expertise in many States and the need to provide assistance to them. It proposed that efforts be taken to ensure manufacturers were manufacturing cells and batteries under a quality management programme in compliance with UN Recommendations provided for in the Technical Instructions and that they were subjecting their cells and batteries to the applicable UN tests.

3.3.6 In light of the above, the meeting developed the following recommendation:

Recommendation 5/3 — Development of a safety oversight and awareness programme for the safe transport of dangerous goods

That ICAO take measures to increase awareness of the risks posed by the transport of lithium batteries and to assist States in developing oversight and awareness programmes related to the safe transport of all dangerous goods, with an emphasis on lithium batteries through:

- a) awareness campaigns (including training);
- b) the development of guidance material; and
- c) focused audits of States manufacturing large quantities of lithium batteries.

This could be achieved through the establishment of a small working group tasked with developing awareness and guidance material and setting up a plan of action for ICAO to implement.

Provision of exemptions or approvals

3.3.7 The meeting had lengthy discussions on whether to include provisions to allow for the transport of lithium metal batteries on passenger aircraft through an approval or whether an exemption would be more appropriate. Some members supported a provision or an approval instead of an exemption

on the basis that exemptions, which involve prior approval from States of Overflight, were so difficult to obtain. Others did not support a provision for an approval, recognizing that there are normally only two States for which prior approval is required — the State of Origin and the State of the Operator. This might sometimes result in cases when the State of the Origin and the State of the Operator are the same, resulting in only one State in the approval process. One member noted that the exemption process provided the benefit of allowing States which may not have the expertise to understand the risks posed to see the conditions required by the multiple States involved in the exemption process. The majority believed that provision for an approval should be included.

3.3.8 A working group was established to determine what should be the conditions for an approval. The group suggested that an approval should only be considered when transport by cargo aircraft to the specified region was not possible. The group also suggested that guidance be developed for inclusion in the Supplement explaining the reasoning and rationale for restricting the carriage of lithium metal batteries. Whether or not States other than the State of Origin and of the Operator should be involved in the approval process was discussed, recognizing that States could file variations extending the requirement to other States when shipments were going through or to them.

3.3.9 Developing performance standards as recommended by the ICAO Multidisciplinary Meeting was seen by some to be the only possible way that lithium metal batteries could be transported safely. Draft packaging performance criteria and test methods for lithium metal button cells had been initiated by the FAA Technical Centre. A sub-group of panel members, advisers and observers was formed to review the draft standard. The group believed that tests should be required to ensure that any event within a package would stay within the package. It was recognized that certain types and quantities of lithium metal cells and batteries (e.g. small cells containing 0.3 grams of lithium or less) would not act as the source of ignition based on the small amount of energy present in each cell. But the number of cells in each package and the number of packages in a cargo hold may need to be restricted in order to ensure that they would not contribute to the intensity of an external fire. However, these restrictions would need to be determined based on additional testing, research and consultation. It was suggested that larger cells should be excluded in order to eliminate the risk of the cells contributing to an external fire on the aircraft. Although the document was not yet mature, it was a good starting point and could be developed into an acceptable standard with further discussion and coordination through correspondence. The rapporteur of the working group noted support for development by industry of packaging performance criteria and test methods for cells and batteries with above 0.3 grams of lithium metal content.

3.3.10 The conditions for an approval, including the performance standards, would be finalized through correspondence. These would be added to the 2015-2016 Edition of the Supplement to the Technical Instructions, subject to the approval by the ANC and the Council.

3.4 Conclusion

3.4.1 The proposal to forbid lithium metal batteries from transport as cargo on passenger aircraft, subject to a number of consequential amendments, was agreed. The agreed amendment is presented in Appendix B to this working paper.

3.4.2 An observer from the battery manufacturing industry requested a transitional period of at least six months before the amendment became applicable due to the significant implications these new regulations would have on shippers, carriers, freight forwarders and other entities in the supply chain. The Secretary reminded the group of statements made at the opening meeting suggesting that the working group would need to consider whether the amendments agreed by the meeting should be incorporated in the current edition of the Technical Instructions by way of an addendum on the basis that they would address a safety concern. She suggested that 1 January 2015, the date when all other amendments to the

Technical Instructions proposed by DGP/24 would become applicable, was an appropriate compromise between an immediate implementation date and the transitional dates suggested by industry.

3.5 **Future work**

3.5.1 The working group agreed to address the remaining recommendations of the ICAO Multidisciplinary Meeting during the next biennium (Recommendations 2, 3 and 4). This would include consideration of the development of a performance-based approach for the conditions to transport lithium metal batteries as cargo by air and the mitigation of risks associated with their transport. A decision on the way forward would be taken at the next meeting of the DGP working group in the fourth quarter of 2014. A multidisciplinary approach involving all stakeholders would be seen as an essential step to advancing cargo safety.

3.5.2 The meeting acknowledged the extensive review of the current provisions for the carriage of lithium metal batteries on passenger aircraft and recognized that many of the suggestions in the review could be considered as mitigation strategies for lithium batteries (DGP-WG/LB/2-WP/5). The document would be referred to by the DGP during future deliberations.

3.5.3 The observers from the ICCAIA noted that although the main focus of this working group meeting had been to mitigate risks related to the transport of lithium metal batteries as cargo on passenger aircraft, they also had concerns with lithium ion batteries. They suggested that the same general hazards were posed by lithium ion batteries; the difference was only a matter of timing (i.e. lithium ion and metal are both capable of thermal runaway, but it would take longer for lithium ion to have a dangerous effect (e.g. smoke in the cockpit)). Mitigation of risks related to both lithium metal and ion batteries on cargo aircraft was something they hoped the panel would address in the near future.

4. **AGENDA ITEM 2: GUIDANCE ON PROCEDURES FOR CABIN CREW TO ADDRESS CABIN INCIDENTS INVOLVING LITHIUM BATTERIES IN THE EMERGENCY RESPONSE GUIDANCE FOR AIRCRAFT INCIDENTS INVOLVING DANGEROUS GOODS (DOC 9481)**

4.1 **Proposed Amendments to the Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods (DGP-WG/LB/2-WP/3)**

4.1.1 New guidance material on procedures for addressing incidents involving lithium batteries in the cabin were agreed by DGP/24 for incorporation in the *Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods* (Doc 9481), subject to a review by members of the ICAO Cabin Safety Group (ICSG). The ICSG developed a revised proposal for consideration by the DGP-WG/LB. DGP-WG/LB/2 took advantage of the fact that the ICSG was meeting at ICAO Headquarters that same week. The groups jointly discussed and agreed to revised guidance material. The DGP-WG/LB expressed its appreciation for the input and expertise provided by the ICSG.

5. **AGENDA ITEM 3: FUTURE WORK RELATED TO SAFE TRANSPORT OF LITHIUM BATTERIES**

5.1 **Class 9 Hazard Communication (DGP-WG/LB/2-WP/6)**

5.1.1 The working group was invited to provide comments on a draft paper on lithium battery hazard communication being submitted by the expert from the United Kingdom to the United Nations Sub-Committee of Experts on the Transport of Dangerous Goods. The comments would be forwarded to the Sub-Committee for its consideration during at its next session.

6. **AGENDA ITEM 4: ANY OTHER BUSINESS**

6.1 **Provision for Krill Meal (DGP-WG/LB/2-WP/4)**

6.1.1 DGP/24 had agreed to add entries to Table 3-1 which, although assigned UN numbers and listed in the UN Model Regulations, were not currently listed in the Instructions. One of the entries added was UN 3497 — **Krill meal**. The panel determined that it should be forbidden for transport on both cargo and passenger aircraft (see paragraph 2.3.5 of the DGP/24 Report (DGP/24-WP/81) with the recognition that it would not be required to be shipped by air and there would therefore be little value in determining appropriate packing requirements. It had since been identified, however, that small quantities of this substance were being shipped as UN 3088 — **Self-heating solid, organic, n.o.s.** either to prospective customers for product evaluation or for the purposes of testing. The new entry for **Krill meal** would therefore preclude the shipment of this substance unless under an approval on cargo aircraft. An amendment which would allow for the transport of Krill meal in small quantities was therefore proposed. The amendment was agreed without objection.

6.2 **Dangerous Goods Awareness Training (DGP-WG/LB/2-WP/7)**

6.2.1 The working group was invited to comment on new text on dangerous goods awareness training developed by the Aviation Security Branch (AVSEC) for inclusion in the *Security Manual for Safeguarding Civil Aviation Against Acts of Unlawful Interference* (Doc 8973). A technical officer from the Aviation Security and Facilitation Policy (SFP) Section explained that the material was intended to be high level general awareness material and not detailed training.

6.2.2 Some DGP members questioned the completeness of the material and suggested that more work needed to be done. It was agreed that DGP members would work with AVSEC officers to develop text to address concerns raised. Members stressed the importance of increased collaboration between the DGP and the AVSEC Panel through the joint task force established by the Secretary General.

APPENDIX A

RECOMMENDATIONS OF THE INTERNATIONAL MULTIDISCIPLINARY LITHIUM BATTERY TRANSPORT COORDINATION MEETING

Recommendation 1 — Further restrictions on the carriage of lithium metal batteries in commercial passenger carrying operations

That the carriage of lithium metal batteries as cargo should be further restricted, up to and including a potential ban, on passenger carrying aircraft in commercial air transport. Options for these restrictions should be considered and decided upon by the DGP at its Working Group of the Whole on Lithium Batteries (7 to 11 April 2014) and implemented as soon as possible.

Options include:

Option 1 — Total prohibition on passenger carrying aircraft until such time as the data supporting safe transport is available

Option 2 — Prohibition with an approval provision (guidance to be provided in the *Supplement to the Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284SU))

The specific conditions to support an approval process, where the types, quantities and packaging containing lithium metal batteries would not allow a fire from within the package to propagate beyond the packaging or adversely affect flight safety, would be developed for inclusion in the Supplement to the Technical Instructions. Guidance would be developed no later than the next regular amendment to the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284).

Option 3 — Permission to transport certain limited lithium metal batteries based upon a performance-based criteria for packaging such batteries. Performance-based criteria would be developed for inclusion in the Technical Instructions.

Option 4 — Option 3, plus permission to transport very small cells (e.g. button cells). The number and package configuration would be validated based upon a specification (may or may not be fully declared)

Recommendation 2 — Performance based approach

That a small multidisciplinary cargo safety group be formed to develop a performance-based approach to the conditions of carriage on passenger aircraft using the draft flow chart prepared by the FAA Technical Center (see Appendix F) as the basis for its deliberations.

Recommendation 3 — Cargo aircraft

That risks associated with lithium metal batteries on cargo aircraft be mitigated using the lessons learned in the development of a performance-based approach to controlling the risks associated with the carriage of lithium metal batteries on passenger aircraft, as well as any other potential strategies. A decision on the way forward to be taken during the next DGP working group of the whole meeting in October 2014.

Recommendation 4 — Multidisciplinary approach to cargo safety

That a multidisciplinary approach involving all stakeholders be taken as an essential step to advancing the issue of cargo safety.

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APPENDIX B

PROPOSED AMENDMENTS TO PROVISIONS RELATED TO LITHIUM BATTERIES IN THE
TECHNICAL INSTRUCTIONS FOR THE SAFE TRANSPORT OF DANGEROUS GOODS
BY AIR

Note.— Changes in addition to those agreed at DGP/24 are highlighted with grey shading.

Part 3

DANGEROUS GOODS LIST,
SPECIAL PROVISIONS AND
LIMITED AND EXCEPTED QUANTITIES

...

Chapter 2

ARRANGEMENT OF THE
DANGEROUS GOODS LIST (TABLE 3-1)

...

Table 3-1. Dangerous Goods List

Name	UN No.	Class or division	Subsidiary risk	State variations	Special provisions	UN packing group	Excepted quantity	Passenger aircraft		Cargo aircraft	
								Packing instruction	Max. net quantity per package	Packing instruction	Max. net quantity per package
1	2	3	4	6	7	8	9	10	11	12	13
Lithium metal batteries (including lithium alloy batteries)†	3090	9		US 2 US 3	A88 A99 A154 A164 A183 <u>A201</u>	⚠	E0	See <u>FORB</u>	<u>968</u> <u>DDEN</u>	See	968

...

Chapter 3

SPECIAL PROVISIONS

...

TIs UN

...

A201

Lithium metal batteries may be transported on passenger aircraft, only with the prior approval of the appropriate authority of the State of Origin and the State of the Operator under the written conditions established by those authorities. The conditions must include the quantity limitations, size limitations and packing requirements established in the Supplement (see S-3.4, Table S-3.1). Copies of the documents of approval, showing the quantity limitations and packing requirements, must accompany the consignment and must be sent to the Secretary of the Dangerous Goods Panel via email at DGS@icao.int or via post to the following address:

Secretary, Dangerous Goods Panel
International Civil Aviation Organization
999 University Street
Montreal, Quebec
CANADA H3C 5H7

When States, other than the State of Origin and the State of the Operator, have notified ICAO that they require prior approval of shipments made under this special provision, approval must also be obtained from these States, as appropriate.

...

Part 4

PACKING INSTRUCTIONS

Chapter 11

CLASS 9 — MISCELLANEOUS DANGEROUS GOODS

Packing Instruction 966

Passenger and cargo aircraft for UN 3481 (packed with equipment) only

1. Introduction

This entry applies to lithium ion or lithium polymer batteries packed with equipment.

Section I of this packing instruction applies to lithium ion and lithium polymer cells and batteries that are assigned to Class 9. Certain lithium ion and lithium polymer cells and batteries offered for transport and meeting the requirements of Section II of this packing instruction, subject to paragraph 2 below, are not subject to other additional requirements of these Instructions.

2. Lithium batteries forbidden from transport

The following applies to all lithium ion cells and batteries in this packing instruction:

Cells and batteries, identified by the manufacturer as being defective for safety reasons, or that have been damaged, that have the potential of producing a dangerous evolution of heat, fire or short circuit are forbidden for transport (e.g. those being returned to the manufacturer for safety reasons).

I. SECTION I

~~Section I requirements apply to each cell or battery type that has been determined to meet the criteria for assignment to Class 9.~~

Each cell or battery must **meet all the provisions of 2:9.3.3.**

~~1) be of the type proven to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3;~~

~~Note 1.— Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.~~

~~Note 2.— Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria, Part III, subsection 38.3 may continue to be transported.~~

~~2) incorporate a safety venting device or be designed to preclude a violent rupture under conditions normally incident to transport and be equipped with an effective means of preventing external short circuits; and~~

~~3) be manufactured under a quality management programme as described in 2:9.3.1 e).~~

~~Each battery containing cells or a series of cells connected in parallel must be equipped with an effective means, as necessary, to prevent dangerous reverse current flow (e.g. diodes, fuses).~~

I.1 General requirements

Part 4:1 requirements must be met.

UN number and proper shipping name	Package quantity (Section I)	
	Passenger	Cargo
UN 3481 Lithium ion batteries packed with equipment	5 kg of lithium ion cells or batteries	35 kg of lithium ion cells or batteries

Packing Instruction 966

I.2 Additional requirements

- Lithium ion cells and batteries must be protected against short circuits.
- Lithium ion cells or batteries must:
 - be placed in inner packagings that completely enclose the cell or battery then placed in an outer packaging. The completed package for the cells or batteries must meet the Packing Group II performance requirements; or
 - be placed in inner packagings that completely enclose the cell or battery, then placed with equipment in a package that meets the Packing Group II performance requirements.
- The equipment must be secured against movement within the outer packaging and must be equipped with an effective means of preventing accidental activation.

DGP-WG/LB/2 (was discovered that this provision was missing during review of lithium metal battery packing instructions) (text aligned with text in Section II):

- The number of cells or batteries in each package must not exceed the appropriate number for the equipment's operation, plus two spares.
- For the purpose of this packing instruction, "equipment" means apparatus requiring the lithium ion batteries with which it is packed for its operation.
- Batteries manufactured after 31 December 2011 must be marked with the Watt-hour rating on the outside case.

I.3 Outer packagings

<i>Boxes</i>	<i>Drums</i>	<i>Jerricans</i>
Aluminium (4B)	Aluminium (1B2)	Aluminium (3B2)
Fibreboard (4G)	Fibre (1G)	Plastics (3H2)
Natural wood (4C1, 4C2)	Other metal (1N2)	Steel (3A2)
Other metal (4N)	Plastics (1H2)	
Plastics (4H1, 4H2)	Plywood (1D)	
Plywood (4D)	Steel (1A2)	
Reconstituted wood (4F)		
Steel (4A)		

II. SECTION II

With the exception of Part 1;2.3 (Transport of dangerous goods by post), 7;4.4 (Reporting of dangerous goods accidents and incidents), 8;1.1 (Dangerous goods carried by passengers or crew) and paragraph 2 of this packing instruction, lithium ion cells and batteries packed with equipment offered for transport are not subject to other additional requirements of these Instructions if they meet the requirements of this section.

Lithium ion cells and batteries may be offered for transport provided that each cell and battery meets the provisions of 2;9.3.1 a) and e) and if they meet all of the following:

- 1) for lithium ion cells, the Watt-hour rating (see the Glossary of Terms in Attachment 2) is not more than 20 Wh;
- 2) for lithium ion batteries, the Watt-hour rating is not more than 100 Wh;
 - the Watt-hour rating must be marked on the outside of the battery case except for those batteries manufactured before 1 January 2009;
- 3) ~~each cell or battery is of the type proven to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3;~~

~~— *Note 1. Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.*~~

~~— *Note 2. Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria, Part III, subsection 38.3 may continue to be transported.*~~

- 4) ~~cells and batteries must be manufactured under a quality management programme as described in 2;9.3.1 e).~~

Packing Instruction 966

II.1 General requirements

Cells and batteries must be packed in strong outer packagings that conform to Part 4;1.1.1, 1.1.3.1 and 1.1.10 (except 1.1.10.1).

<i>Contents</i>	<i>Package quantity (Section II)</i>	
	<i>Passenger</i>	<i>Cargo</i>
Net quantity of lithium ion cells or batteries per package	5 kg	5 kg

II.2 Additional requirements

- Lithium ion cells and batteries must:
 - be placed in inner packagings that completely enclose the cell or battery, then placed in a strong outer packaging; or
 - be placed in inner packagings that completely enclose the cell or battery, then placed with the equipment in a strong outer packaging.
- Cells and batteries must be protected so as to prevent short circuits. This includes protection against contact with conductive materials within the same packaging that could lead to a short circuit.
- The equipment must be secured against movement within the outer packaging and must be equipped with an effective means of preventing accidental activation.

DGP/24-WP/64 (paragraph 5.1.14 of this report)

- The ~~maximum~~ number of cells or batteries in each package must ~~be~~ not exceed the ~~minimum~~ appropriate number ~~required to power~~ for the equipment's operation, plus two spares.
- Each package of cells or batteries, or the completed package, must be capable of withstanding a 1.2 m drop test in any orientation without:
 - damage to cells or batteries contained therein;
 - shifting of the contents so as to allow battery to battery (or cell to cell) contact;
 - release of contents.
- Each package must be labelled with a lithium battery handling label (Figure 5-31).
- Each consignment must be accompanied with a document with an indication that:
 - the package contains lithium ion cells or batteries;
 - the package must be handled with care and that a flammability hazard exists if the package is damaged;
 - special procedures must be followed in the event the package is damaged, to include inspection and repacking if necessary; and
 - a telephone number for additional information.
- The words "lithium ion batteries, in compliance with Section II of PI966" must be placed on the air waybill, when an air waybill is used.
- Any person preparing or offering cells or batteries for transport must receive adequate instruction on these requirements commensurate with their responsibilities.

II.3 Outer packagings

Boxes

Drums

Jerricans

Strong outer packagings

II.4 Overpacks

When packages are placed in an overpack, the lithium battery handling label required by this packing instruction must either be clearly visible or the label must be affixed on the outside of the overpack and the overpack must be marked with the word "Overpack".

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Packing Instruction 968

~~Passenger and e~~Cargo aircraft ~~only~~ for UN 3090

1. Introduction

This entry applies to lithium metal or lithium alloy batteries. This packing instruction is structured as follows:

- Section IA applies to lithium metal cells with a lithium metal content in excess of 1 g and lithium metal batteries with a lithium metal content in excess of 2 g, which must be assigned to Class 9 and are subject to all of the applicable requirements of these Instructions;
- Section IB applies to lithium metal cells with a lithium metal content not exceeding 1 g and lithium metal batteries with a lithium metal content not exceeding 2 g packed in quantities that exceed the allowance permitted in Section II, Table 968-II; and
- Section II applies to lithium metal cells with a lithium metal content not exceeding 1 g and lithium metal batteries with a lithium metal content not exceeding 2 g packed in quantities not exceeding the allowance permitted in Section II, Table 968-II.

2. Lithium batteries forbidden from transport

The following applies to all lithium metal cells and batteries in this packing instruction:

Cells and batteries, identified by the manufacturer as being defective for safety reasons, or that have been damaged, that have the potential of producing a dangerous evolution of heat, fire or short circuit are forbidden for transport (e.g. those being returned to the manufacturer for safety reasons).

Waste lithium batteries and lithium batteries being shipped for recycling or disposal are forbidden from air transport unless approved by the appropriate national authority of the State of Origin and the State of the Operator.

DGP/24-WP/3 (paragraph 3.5.3) and paragraph 2.4.1.1 of this report

IA. SECTION IA

~~Section IA requirements apply to lithium metal cells with a lithium metal content in excess of 1 g and lithium metal batteries with a lithium metal content in excess of 2 g that have been determined to meet the criteria for assignment to Class 9.~~

Each cell or battery must meet all the provisions of 2:9.3:

- ~~1) be of the type proven to meet the requirements of each test in the UN *Manual of Tests and Criteria*, Part III, subsection 38.3;~~

~~———— Note 1. — Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.~~

~~———— Note 2. — Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN *Manual of Tests and Criteria*, Part III, subsection 38.3 may continue to be transported.~~

- ~~2) incorporate a safety venting device or be designed to preclude a violent rupture under conditions normally incident to transport and be equipped with an effective means of preventing external short circuits; and~~

- ~~3) be manufactured under a quality management programme as described in 2:9.3.1 e).~~

~~Each battery containing cells or a series of cells connected in parallel must be equipped with an effective means, as necessary, to prevent dangerous reverse current flow (e.g. diodes, fuses).~~

Packing Instruction 968

IA.1 General requirements

Part 4;1 requirements must be met.

Table 968-IA

UN number and proper shipping name	Net quantity per package	
	Passenger	Cargo
UN 3090 Lithium metal batteries	2.5 kg Forbidden	35 kg

IA.2 Additional requirements

- Lithium metal cells and batteries must be protected against short circuits.
- Lithium metal cells and batteries must be placed in inner packagings that completely enclose the cell or battery, then placed in an outer packaging. The completed package for the cells or batteries must meet the Packing Group II performance requirements.
- Lithium metal batteries with a mass of 12 kg or greater and having a strong, impact-resistant outer casing, or assemblies of such batteries, may be transported when packed in strong outer packagings or protective enclosures (e.g. in fully enclosed or wooden slatted crates) not subject to the requirements of Part 6 of these Instructions, if approved by the appropriate authority of the State of Origin. A copy of the document of approval must accompany the consignment.
- ~~— For lithium metal cells and batteries prepared for transport on passenger aircraft as Class 9:~~
- ~~— cells and batteries offered for transport on passenger aircraft must be packed in intermediate or outer rigid metal packaging; and~~
- ~~— cells and batteries must be surrounded by cushioning material that is non-combustible and non-conductive, and placed inside an outer packaging.~~

IA.3 Outer packagings

Boxes

Aluminium (4B)
Fibreboard (4G)
Natural wood (4C1, 4C2)
Other metal (4N)
Plastics (4H1, 4H2)
Plywood (4D)
Reconstituted wood (4F)
Steel (4A)

Drums

Aluminium (1B2)
Fibre (1G)
Other metal (1N2)
Plastics (1H2)
Plywood (1D)
Steel (1A2)

Jerricans

Aluminium (3B2)
Plastics (3H2)
Steel (3A2)

IB. SECTION IB

~~Section IB requirements apply to lithium metal cells with a lithium metal content not exceeding 1 g and lithium metal batteries with a lithium metal content not exceeding 2 g packed in quantities that exceed the allowance permitted in Section II, Table 968-II.~~

DGP/24-WP/55 (paragraph 5.1.10 of this report)

~~Quantities of lithium metal cells or batteries that exceed the allowance permitted in Section II, Table 968-II, must be assigned to Class 9 and are subject to all of the applicable provisions of these Instructions (including the requirements in paragraph 2 of this packing instruction and of this section) except for the following: the provisions of Part 6.~~

Lithium metal cells or batteries shipped in accordance with the provisions of Section IB must be described on a dangerous goods transport document as set in Part 5;4. The packing instruction number "968" required by 5;4.1.5.8.1 a) must be supplemented with "IB". All other applicable provisions of Part 5;4 apply.

- ~~— the provisions of Part 6; and~~
- ~~— the dangerous goods transport document requirements of 5;4, provided alternative written documentation is provided by the shipper describing the contents of the consignment. Where an agreement exists with the operator, the shipper may provide the information by electronic data processing (EDP) or electronic data interchange (EDI) techniques. The information required is as follows and should be shown in the following order:~~

Packing Instruction 968

- ~~1) the name and address of the shipper and consignee;~~
- ~~2) UN 3090;~~
- ~~3) Lithium metal batteries PI 968-IB;~~

DGP/24-WP/3 (paragraph 3.5.4) DGP/24-WP/55 and paragraphs 2.4.1.1 and 5.1.10 of this report

- ~~4) the number of packages and the gross mass of each package.~~

DGP/24-WP/3 (paragraph 3.5.3) and paragraph 2.4.1.1 of this report

Lithium metal or lithium alloy cells and batteries may be offered for transport **provided that each cell and battery meets the provisions of 2.9.3.1 a) and e) and** if they meet all of the following:

- 1) for lithium metal cells, the lithium content is not more than 1 g;
- 2) for lithium metal or lithium alloy batteries, the aggregate lithium content is not more than 2 g;
- ~~3) each cell or battery is of the type proven to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3;~~
~~Note 1. Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.~~
~~Note 2. Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria, Part III, subsection 38.3 may continue to be transported.~~
- ~~4) cells and batteries must be manufactured under a quality management programme as described in 2.9.3.1 e).~~

IB.1 General requirements

Cells and batteries must be packed in strong outer packagings that conform to Part 4;1.1.1, 1.1.3.1 and 1.1.10 (except 1.1.10.1).

DGP/24-WP/3 (paragraph 3.5.4) and paragraph 2.4.1.1 of this report

Table 968-IB

Contents	Net quantity per Ppackage quantity	
	Passenger	Cargo
Lithium metal cells and batteries	2.5 kg-G Forbidden	2.5 kg-G

IB.2 Additional requirements

- Cells and batteries must be packed in inner packagings that completely enclose the cell or battery then placed in a strong outer packaging.
- Cells and batteries must be protected so as to prevent short circuits. This includes protection against contact with conductive materials within the same packaging that could lead to a short circuit.
- Each package must be capable of withstanding a 1.2 m drop test in any orientation without:
 - damage to cells or batteries contained therein;
 - shifting of the contents so as to allow battery to battery (or cell to cell) contact;
 - release of contents.
- Each package must be labelled with a lithium battery handling label (Figure 5-31) in addition to the Class 9 hazard label **and the cargo aircraft only label (Figure 5-26)**.
- Each consignment must be accompanied with a document with an indication that:
 - the package contains lithium metal cells or batteries;
 - the package must be handled with care and that a flammability hazard exists if the package is damaged;
 - special procedures must be followed in the event the package is damaged, to include inspection and repacking if necessary; and
 - a telephone number for additional information.

Packing Instruction 968

DGP/24-WP/55 (paragraph 5.1.10 of this report)

Note.— This information may be provided on the dangerous goods transport document.

IB.3 Outer packagings

Boxes

Drums

Jerricans

Strong outer packagings

DGP/24-WP/3 (paragraph 3.5.3) and paragraph 2.4.1.1 of this report

II. SECTION II

With the exception of Part 1;2.3 (Transport of dangerous goods by post), 5:1.1 h), 5:1.1.k) (Shipper's responsibilities — general requirements), 7:2.1.1 (Loading restrictions on the flight deck and passenger aircraft), 7:2.4.1 (Loading of cargo aircraft), 7:4.4 (Reporting of dangerous goods accidents and incidents), 8;1.1 (Dangerous goods carried by passengers or crew) and paragraph 2 of this packing instruction, lithium metal or lithium alloy cells and batteries offered for transport are not subject to other additional requirements of these Instructions if they meet the requirements of this section.

Lithium metal or lithium alloy cells and batteries may be offered for transport provided that each cell and battery meets the provisions of 2;9.3.1 a) and e) and if they meet all of the following:

- 1) for a lithium metal cell, the lithium content is not more than 1 g;
- 2) for a lithium metal or lithium alloy battery, the aggregate lithium content is not more than 2 g;
- 3) ~~each cell or battery is of the type proven to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3;~~

~~Note 1.— Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.~~

~~Note 2.— Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria, Part III, subsection 38.3 may continue to be transported.~~

- 4) ~~cells and batteries must be manufactured under a quality management programme as described in 2;9.3.1 e).~~

II.1 General requirements

Cells and batteries must be packed in strong outer packagings that conform to Part 4;1.1.1, 1.1.3.1 and 1.1.10 (except 1.1.10.1).

Table 968-II

Contents	Lithium metal cells and/or batteries with a lithium content not more than 0.3 g	Lithium metal cells with a lithium content more than 0.3 g but not more than 1 g	Lithium metal batteries with a lithium content more than 0.3 g but not more than 2 g
1	2	3	4
Maximum number of cells / batteries per package	No limit	8 cells	2 batteries
Maximum net quantity (mass) per package	2.5 kg	n/a	n/a

The limits specified in columns 2, 3 and 4 of Table 968-II must not be combined in the same package.

Packing Instruction 968

II.2 Additional requirements

- Cells and batteries must be packed in inner packagings that completely enclose the cell or battery, then placed in a strong outer packaging.
- Cells and batteries must be protected so as to prevent short circuits. This includes protection against contact with conductive materials within the same packaging that could lead to a short circuit.
- Each package must be capable of withstanding a 1.2 m drop test in any orientation without:
 - damage to cells or batteries contained therein;
 - shifting of the contents so as to allow battery to battery (or cell to cell) contact;
 - release of contents.
- Each package must be labelled with a lithium battery handling label (Figure 5-31) and the cargo aircraft only label (Figure 5-26).
 - The cargo aircraft only label must be located on the same surface of the package near the lithium battery handling label, if the package dimensions are adequate.
- Each consignment must be accompanied with a document with an indication that:
 - the package contains lithium metal cells or batteries;
 - the package must be handled with care and that a flammability hazard exists if the package is damaged;
 - special procedures must be followed in the event the package is damaged, to include inspection and repacking if necessary; and
 - a telephone number for additional information.
- The words “lithium metal batteries, in compliance with Section II of PI968,” and “cargo aircraft only” or “CAO” must be placed on the air waybill, when an air waybill is used.
 - Consignments of lithium metal batteries prepared in accordance with the provisions of Section II must not be consolidated with other shipments of dangerous goods or non-dangerous goods and must not be loaded into a unit load device before being offered to the operator.
- Any person preparing or offering cells or batteries for transport must receive adequate instruction on these requirements commensurate with their responsibilities.

II.3 Outer packagings

Boxes

Drums

Jerricans

Strong outer packagings

II.4 Overpacks

When packages are placed in an overpack, the lithium battery handling label and the cargo aircraft only label (Figure 5-26) required by this packing instruction must either be clearly visible or the labels must be affixed on the outside of the overpack and the overpack must be marked with the word “Overpack”.

Packing Instruction 969

Passenger and cargo aircraft for UN 3091 (packed with equipment) only

1. Introduction

This entry applies to lithium metal or lithium alloy batteries packed with equipment.

Section I of this packing instruction applies to lithium metal and lithium alloy cells and batteries that are assigned to Class 9. Certain lithium metal and lithium alloy cells and batteries offered for transport and meeting the requirements of Section II of this packing instruction, subject to paragraph 2 below, are not subject to other additional requirements of these Instructions.

2. Lithium batteries forbidden from transport

The following applies to all lithium metal cells and batteries in this packing instruction:

Cells and batteries, identified by the manufacturer as being defective for safety reasons, or that have been damaged, that have the potential of producing a dangerous evolution of heat, fire or short circuit are forbidden for transport (e.g. those being returned to the manufacturer for safety reasons).

I. SECTION I

~~Section I requirements apply to each cell or battery type that has been determined to meet the criteria for assignment to Class 9.~~

Each cell or battery must **meet all the provisions of 2:9.3.:**

- ~~1) be of the type proven to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3; and~~

~~Note 1.— Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.~~

~~Note 2.— Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria, Part III, subsection 38.3 may continue to be transported.~~

- ~~2) incorporate a safety venting device or be designed to preclude a violent rupture under conditions normally incident to transport and be equipped with an effective means of preventing external short circuits; and~~

- ~~3) be manufactured under a quality management programme as described in 2:9.3.1 e).~~

~~Each battery containing cells or a series of cells connected in parallel must be equipped with an effective means, as necessary, to prevent dangerous reverse current flow (e.g. diodes, fuses).~~

I.1 General requirements

Part 4;1 requirements must be met.

UN number and proper shipping name	Package quantity (Section I)	
	Passenger	Cargo
UN 3091 Lithium metal batteries packed with equipment	5 kg of lithium metal cells or batteries	35 kg of lithium metal cells or batteries

Packing Instruction 969

DGP-WG/LB/2 (inconsistencies discovered during review of lithium metal battery packing instructions) (shown as shaded text):

I.2 Additional requirements

- Lithium metal cells and batteries must be protected against short circuits.
- Lithium metal cells or batteries must:
 - be placed in inner packagings that completely enclose the cell or battery, then placed in an outer packaging. The completed package for the cells or batteries must meet the Packing Group II performance requirements; or
 - be placed in inner packagings that completely enclose the cell or battery, then placed with equipment in a ~~package~~ **packaging** that meets the Packing Group II performance requirements.
- The equipment must be secured against movement within the outer packaging and must be equipped with an effective means of preventing accidental activation.
- ~~The number of cells or batteries in each package must not exceed the appropriate number for the equipment's operation, plus two spares.~~
- For the purpose of this packing instruction, "equipment" means apparatus requiring the lithium batteries with which it is packed for its operation.
- For lithium metal cells and batteries prepared for transport on passenger aircraft as Class 9:
 - cells and batteries offered for transport on passenger aircraft must be packed in intermediate or outer rigid metal packaging surrounded by cushioning material that is non-combustible and non-conductive and placed inside an outer packaging.

I.3 Outer packagings

<i>Boxes</i>	<i>Drums</i>	<i>Jerricans</i>
Aluminium (4B)	Aluminium (1B2)	Aluminium (3B2)
Fibreboard (4G)	Fibre (1G)	Plastics (3H2)
Natural wood (4C1, 4C2)	Other metal (1N2)	Steel (3A2)
Other metal (4N)	Plastics (1H2)	
Plastics (4H1, 4H2)	Plywood (1D)	
Plywood (4D)	Steel (1A2)	
Reconstituted wood (4F)		
Steel (4A)		

II. SECTION II

With the exception of Part 1;2.3 (Transport of dangerous goods by post), 7;4.4 (Reporting of dangerous goods accidents and incidents), 8;1.1 (Dangerous goods carried by passengers or crew) and paragraph 2 of this packing instruction, lithium metal cells and batteries packed with equipment offered for transport are not subject to other additional requirements of these Instructions if they meet the requirements of this section.

Lithium metal cells and batteries may be offered for transport **provided that each cell and battery meets the provisions of 2;9.3.1 a) and e)** ~~if they meet all of~~ **and** the following:

- 1) for a lithium metal cell, the lithium content is not more than 1 g;
- 2) for a lithium metal or lithium alloy battery, the aggregate lithium content is not more than 2 g;
- 3) ~~each cell or battery is of the type proven to meet the requirements of each test in the UN Manual of Tests and Criteria, Part III, subsection 38.3;~~

~~———— Note 1. — Batteries are subject to these tests irrespective of whether the cells of which they are composed have been so tested.~~

~~———— Note 2. — Batteries and cells manufactured before 1 January 2014 conforming to a design type tested according to the requirements of the fifth revised edition of the UN Manual of Tests and Criteria, Part III, subsection 38.3 may continue to be transported.~~

- 4) ~~cells and batteries must be manufactured under a quality management programme as described in 2;9.3.1 e).~~

Packing Instruction 969

II.1 General requirements

Cells and batteries must be packed in strong outer packagings that conform to Part 4;1.1.1, 1.1.3.1 and 1.1.10 (except 1.1.10.1).

Contents	Package quantity (Section II)	
	Passenger	Cargo
Net quantity of lithium metal cells or batteries per package	5 kg	5 kg

II.2 Additional requirements

- Lithium metal cells or batteries must:
 - be placed in inner packagings that completely enclose the cell or battery, then placed in a strong outer packaging; or
 - be placed in inner packagings that completely enclose the cell or battery, then placed with the equipment in a strong outer packaging.
- Cells and batteries must be protected so as to prevent short circuits. This includes protection against contact with conductive materials within the same packaging that could lead to a short circuit.
- The equipment must be secured against movement within the outer packaging and must be equipped with an effective means of preventing accidental activation.

DGP/24-WP/64 (paragraph 5.1.14 of this report)

- The ~~maximum~~ number of cells or batteries in each package must ~~be~~ not exceed the ~~minimum~~ appropriate number ~~required to power~~ for the equipment's operation, plus two spares.
- Each package of cells or batteries, or the completed package, must be capable of withstanding a 1.2 m drop test in any orientation without:
 - damage to cells or batteries contained therein;
 - shifting of the contents so as to allow battery to battery (or cell to cell) contact;
 - release of contents.
- Each package must be labelled with a lithium battery handling label (Figure 5-31).
- Each consignment must be accompanied with a document with an indication that:
 - the package contains lithium metal cells or batteries;
 - the package must be handled with care and that a flammability hazard exists if the package is damaged;
 - special procedures must be followed in the event the package is damaged, to include inspection and repacking if necessary; and
 - a telephone number for additional information.
- The words "lithium metal batteries, in compliance with Section II of PI969" must be placed on the air waybill, when an air waybill is used.
- Any person preparing or offering cells or batteries for transport must receive adequate instruction on these requirements commensurate with their responsibilities.

II.3 Outer packagings

Boxes

Drums

Jerricans

Strong outer packagings

II.4 Overpacks

When packages are placed in an overpack, the lithium battery handling label required by this packing instruction must either be clearly visible or the label must be affixed on the outside of the overpack and the overpack must be marked with the word "Overpack".

APPENDIX C

PROPOSED AMENDMENTS TO THE EMERGENCY RESPONSE GUIDANCE FOR
AIRCRAFT INCIDENTS INVOLVING DANGEROUS GOODS

DGP/24-WP/38, Addendum/Corrigendum No. 2 (see paragraph 4.2 of the report on this agenda item) and DGP-WG/LB/2-WP/3 (see paragraph 3 of Addendum/Corrigendum No. 1 to the DGP/24 Report)

Replace Sections 3.3 and 3.4 with the following:

3.3 CABIN CREW CHECKLIST FOR DANGEROUS GOODS INCIDENTS
IN THE PASSENGER CABIN DURING FLIGHT

BATTERY / PORTABLE ELECTRONIC DEVICE (PED) FIRE / SMOKE	
Step	Cabin Crew Action
1.	<p>Identify the item</p> <p><i>Note. — It may not be possible to identify the item (source of fire) immediately. In this case, apply Step 2 first, and then attempt to identify it.</i></p> <p>Caution: <u>In order to avoid injury from a flash fire, it is not recommended to open the affected baggage when there is any indication of smoke or flames</u></p>
2.	<p>Apply fire-fighting procedure:</p> <ul style="list-style-type: none"> i. Obtain and use the appropriate fire extinguisher ii. Retrieve and use protective equipment, as applicable to the situation iii. Move passengers away from the area, if possible iv. Notify pilot-in-command / other cabin crew members <p><i>Note. — Actions should occur simultaneously in a multi-crew operation</i></p>
3.	<p>Remove power:</p> <ul style="list-style-type: none"> i. Disconnect the device from the power supply, if applicable <u>safe to do so</u> ii. Turn off in-seat power, if applicable iii. Verify that power to the remaining electrical outlets remains off, if applicable <p>Caution:</p> <ul style="list-style-type: none"> i. Do not attempt to remove the battery from the device
4.	<p>Douse the device with water (or other non-flammable liquid)</p> <p><i>Note.— Liquid may turn to steam when applied to the hot battery</i></p>
5.	<p>Leave the device in its place and monitor for any re-ignition</p> <ul style="list-style-type: none"> i. If smoke or flames re-appear, repeat Steps 2 then 4 <p>Caution:</p> <ul style="list-style-type: none"> i. Do not attempt to pick-up or move the device ii. Do not cover or enclose the device iii. Do not use ice or dry ice to cool the device

BATTERY / PORTABLE ELECTRONIC DEVICE (PED) FIRE / SMOKE	
Step	Cabin Crew Action
6.	When the device can be safely moved <u>has cooled (e.g. approximately 10 to 15 minutes):</u> <ul style="list-style-type: none">i. Obtain a suitable empty containerii. Fill the container with enough water (or other non-flammable liquid) to submerge the deviceiii. Using protective equipment, place the device in the container and completely submerge in water (or other non-flammable liquid)iv. Stow and (if possible) secure the container to prevent spillage
7.	Monitor the device and the surrounding area for the remainder of the flight
8.	After landing at the next destination: <ul style="list-style-type: none">i. Apply operator's post-incident procedures

OVERHEAD BIN BATTERY / PORTABLE ELECTRONIC DEVICE (PED) FIRE / SMOKE	
Step	Cabin Crew Action
1.	<p>Apply fire-fighting procedure:</p> <ol style="list-style-type: none"> i. Obtain and use the appropriate fire extinguisher ii. Retrieve and use protective equipment, as applicable to the situation iii. Move passengers away from the area, if possible iv. Notify pilot-in-command / other cabin crew members <p><i>Note. — Actions should occur simultaneously in a multi-crew operation</i></p>
2.	<p>Identify the item:</p> <p>If the device is visible and accessible, or If the device is contained in baggage and flames are visible:</p> <ol style="list-style-type: none"> i. Re-apply Step 1 to extinguish the flames, if applicable ii. Apply Steps 3 to 5 <p>If smoke is coming from the overhead bin, but the device is not visible or accessible:</p> <ol style="list-style-type: none"> i. Remove <u>other</u> baggage from the overhead bin <u>to access the affected baggage/item</u> ii. Identify the item iii. Apply Steps 3 to 5 <p>Caution: Do not <u>In order to avoid injury from a flash fire, it is not recommended to</u> not open <u>the affected</u> baggage when there is any indication of smoke or flames</p>
3.	<p>Douse the device (<u>baggage</u>) with water (or other non-flammable liquid)</p> <p><i>Note.— Liquid may turn to steam when applied to the hot battery</i></p>
4.	<p>When the device <u>has cooled</u> can be safely moved:</p> <ol style="list-style-type: none"> i. Obtain a suitable empty container ii. Fill the container with enough water (or other non-flammable liquid) to submerge the device iii. Using protective equipment, place the device in the container and completely submerge in water (or other non-flammable liquid) iv. Stow and (if possible) secure the container to prevent spillage
5.	Monitor the device and the surrounding area for the remainder of the flight
6.	<p>After landing at the next destination:</p> <ol style="list-style-type: none"> i. Apply operator's post-incident procedures

OVERHEATED BATTERY / ELECTRICAL SMELL INVOLVING A PORTABLE ELECTRONIC DEVICE (PED) - NO VISIBLE FIRE OR SMOKE	
Step	Cabin Crew Action
1.	Identify the item
2.	Instruct the passenger to turn off the device immediately
3.	<p>Remove power:</p> <ul style="list-style-type: none"> i. Disconnect the device from the power supply, if applicable <u>if safe to do so</u> ii. Turn off in-seat power, if applicable iii. Verify that power to the remaining electrical outlets remains off, if applicable iv. Verify that the device remains off for the remainder of the flight <p>Caution: Do not attempt to remove the battery from the device</p>
4.	<p>Keep <u>Instruct the passenger to keep</u> the device visible and monitor closely</p> <p>Caution:</p> <ul style="list-style-type: none"> i. Unstable batteries may ignite even after the device is turned off
5.	<p>If smoke or flames appear:</p> <ul style="list-style-type: none"> i. Apply BATTERY / PED FIRE / SMOKE checklist
6.	<p>After landing at the next destination:</p> <ul style="list-style-type: none"> i. Apply operator's post-incident procedures

<u>PED INADVERTENTLY CRUSHED OR DAMAGED IN ELECTRICALLY ADJUSTABLE SEAT</u>	
Step	Cabin Crew Action
1.	<u>Notify the pilot-in-command / other cabin crew members</u>
2.	<p><u>Obtain information from passenger, by asking him/her:</u></p> <ul style="list-style-type: none"> i. <u>To identify the item</u> ii. <u>Where he/she suspects that the item may have dropped or slipped into</u> iii. <u>If the seat was moved since misplacing the item</u>
3.	<u>Retrieve and use protective equipment, if available</u>
4.	<p><u>Retrieve the item.</u></p> <p>Caution:</p> <ul style="list-style-type: none"> i. <u>Do not move the seat electrically or mechanically when attempting to retrieve the item.</u>
5.	<p><u>If smoke or flames appear:</u></p> <ul style="list-style-type: none"> i. <u>Apply BATTERY / PED FIRE / SMOKE checklist</u>
6.	<p><u>After landing at the next destination:</u></p> <ul style="list-style-type: none"> i. <u>Apply operator's post-incident procedures</u>

FIRE INVOLVING DANGEROUS GOODS	
Step	Cabin Crew Action
1.	<p>Identify the item</p> <p><i>Note. — It may not be possible to identify the item (source of fire) immediately. In this case, apply Step 2 first, and then attempt to identify it.</i></p> <p>Caution: <u>In order to avoid injury from a flash fire, it is not recommended to not open the affected baggage when there is any indication of smoke or flames</u></p>
2.	<p>Apply fire-fighting procedure:</p> <ol style="list-style-type: none"> i. Obtain and use the appropriate fire extinguisher / check use of water ii. Retrieve and use protective equipment, as applicable to the situation iii. Move passengers away from the area, if possible iv. Notify pilot-in-command / other cabin crew members <p><i>Note. — Actions should occur simultaneously in a multi-crew operation</i></p>
3.	<p>Monitor for any re-ignition:</p> <ol style="list-style-type: none"> i. If smoke/flames re-appear, repeat Step 2.
4.	<p>Once the fire has been extinguished:</p> <ol style="list-style-type: none"> i. Apply SPILLAGE OR LEAKAGE OF DANGEROUS GOODS checklist, if required.
5.	<p>After landing at the next destination:</p> <ol style="list-style-type: none"> i. Apply operator's post-incident procedures

SPILLAGE OR LEAKAGE OF DANGEROUS GOODS	
Step	Cabin Crew Action
1.	Notify pilot-in-command/ other cabin crew members
2.	Identify the item
3.	Collect emergency response kit or other useful items
4.	Don rubber gloves and smoke hood
5.	Move passengers away from area and distribute wet towels or cloths
6.	Place dangerous goods item in polyethylene bags
7.	Stow polyethylene bags
8.	Treat affected seat cushions / covers in the same manner as dangerous goods item
9.	Cover spillage on carpet / floor
10.	Regularly inspect items stowed away / contaminated furnishings
11.	<p>After landing at the next destination:</p> <ol style="list-style-type: none"> i. Apply operator's post-incident procedures

3.4 AMPLIFIED CABIN CREW CHECKLIST FOR DANGEROUS GOODS INCIDENTS IN THE PASSENGER CABIN DURING FLIGHT

Note.— Although this guidance material presents sequences of tasks, some of these actions occur simultaneously when carried out by crew members.

3.4.1 BATTERY / PORTABLE ELECTRONIC DEVICE (PED) FIRE/SMOKE

1) IDENTIFY THE ITEM

It may not be possible to identify the item (source of fire) right away, especially if the fire has started in a seat pocket or the device is not readily accessible. In this case, fire-fighting procedures should be applied as a first step. Once it is possible to do so, identify the item after the fire is under control. If the item is contained in baggage, the crew's actions would be similar to the actions for a device that is visible or readily accessible.

Caution:

In order to avoid injury from a flash fire, it is not recommended to open the affected baggage when there is any indication of smoke or flames. However, in certain situations cabin crew members may assess and deem it necessary to slightly open baggage to allow entry of the extinguishing agent and non-flammable liquid. This should be done with extreme caution and only after donning appropriate protective equipment, available on the aircraft.

2) APPLY FIRE-FIGHTING PROCEDURE

Any occurrence concerning a fire in the cabin should be notified immediately to the pilot-in-command who should be kept informed of all actions taken and of the effect. It is essential that the cabin crew and the flight crew coordinate their actions and that each are kept fully informed of the other's actions and intentions.

Appropriate fire-fighting and emergency procedures must be used to deal with any fire. In a multi-cabin crew operation, the actions detailed in the fire-fighting procedure should be conducted simultaneously. On aircraft operated with only one cabin crew member, the aid of a passenger should be sought in dealing with the situation.

Halon, Halon replacement or water extinguisher should be used to extinguish the fire and prevent its spread to additional flammable materials. It is important to wear available protective equipment (e.g. protective breathing equipment, fire gloves) when fighting a fire.

If fire develops, cabin crew should take prompt action to move passengers away from the area involved and, if necessary, provide wet towels or cloths and give instructions for passengers to breathe through them. Minimizing the spreading of smoke and fumes into the flight deck is critical for the continued safe operation of the aircraft, therefore it is essential to keep the flight deck door closed at all times. Crew communication and coordination is of utmost importance. The use of the interphone is the primary means of communication unless the interphone system fails.

3) REMOVE POWER

It is important to instruct the passenger to disconnect the device from the power supply, if it is deemed safe to do so. A battery has a higher likelihood of catching fire due to overheating during or immediately following a charging cycle, although the effects may be delayed for some period of time. By removing the external power supply from the device, it will be assured that additional energy is not being fed to the battery to promote a fire.

Turn off the in-seat power to the remaining electrical outlets until it can be assured that a malfunctioning aircraft system does not contribute to additional failures of the passengers' portable electronic devices.

Visually check that power to the remaining electrical outlets remains off until the aircraft's system can be determined to be free of faults, if the device was previously plugged in.

The removal of power may occur simultaneously to other cabin crew actions (e.g. obtaining water to douse the device). Depending on the aircraft type, in-seat power may have to be turned-off by the flight crew members.

Caution:

Do not attempt to remove the battery from the device.

4) DOUSE THE DEVICE WITH WATER (OR OTHER NON-FLAMMABLE LIQUID)

Water (or other non-flammable liquid) must be used to cool a battery that has ignited to prevent the spread of heat to other cells in the battery. If water is not available, any non-flammable liquid may be used to cool the device.

Note.— Liquid may turn to steam when applied to the hot battery.

5) LEAVE THE DEVICE IN ITS PLACE AND MONITOR FOR ANY RE-IGNITION

A battery involved in a fire can re-ignite and emit flames multiple times as heat is transferred to other cells in the battery. Therefore, the device must be monitored regularly to identify if there is any indication that a fire risk may still exist. If there is any smoke or indication of fire, the device must be doused with more water (or other non-flammable liquid).

Caution:

- i. Do not attempt to pick-up or move the device; batteries may explode or burst into flames without warning. The device must not be moved if displaying any of the following: flames/flaring, smoke, unusual sounds (such as crackling), debris, or shards of material separating from the device;
- ii. Do not cover or enclose the device as it could cause it to overheat; and
- iii. Do not use ice or dry ice to cool the device. Ice or other materials insulate the device, increasing the likelihood that additional battery cells will reach thermal runaway.

6) WHEN THE DEVICE HAS COOLED (E.G. APPROXIMATELY 10-15 MINUTES) CAN BE SAFELY MOVED

The device can be ~~safely~~-moved with caution following a certain period, once it has cooled down and if there is no evidence of smoke, heat, or if there is a reduction in the crackling or hissing sound usually associated with a lithium battery fire (e.g. after approximatly 10-15 minutes). The waiting period may vary based on the device and its size. The different circumstances (e.g. types of devices, phase of flight, etc.) should be addressed in the operator's training programme. ~~Following this period, the device can be moved, with caution.~~

A suitable empty container, such as a pot, jug, galley unit or toilet waste bin, must be filled with enough water or non-flammable liquid to completely submerge the device. It is important to wear available protective equipment (e.g. protective breathing equipment, fire gloves), when moving any device involved in a fire. Once the device is completely submerged, the container used must be stowed and, if possible, secured to prevent spillage.

7) MONITOR THE DEVICE AND THE SURROUNDING AREA FOR THE REMAINDER OF THE FLIGHT

Monitor the device and the surrounding area for the remainder of the flight to verify that the device does not pose further risk.

8) AFTER LANDING AT THE NEXT DESTINATION

Upon arrival, apply the operator's post-incident procedures. These may include identifying to ground personnel where the item is stowed and providing all information about the item.

Complete the required documentation, as per operator procedures, so that the operator is notified of the event, proper maintenance action is undertaken and the emergency response kit or any aircraft equipment used is replenished or replaced, if applicable.

3.4.2 OVERHEAD BIN BATTERY / PORTABLE ELECTRONIC DEVICE (PED) FIRE / SMOKE

1) APPLY FIRE-FIGHTING PROCEDURE

Any occurrence concerning a fire in the cabin should be notified immediately to the pilot-in-command who should be kept informed of all actions taken and of the effect. It is essential that the cabin crew and the flight crew coordinate their actions and that each are kept fully informed of the other's actions and intentions.

Appropriate fire-fighting and emergency procedures must be used to deal with an overhead bin fire. In a multi-cabin crew operation, the actions detailed in the fire-fighting procedure should be conducted simultaneously. On aircraft operated with only one cabin crew member, the aid of a passenger should be sought in dealing with the situation.

Halon, Halon replacement or water extinguisher should be used to extinguish the fire and prevent its spread to additional flammable materials. It is important to wear available protective equipment (e.g. protective breathing equipment, fire gloves) when fighting a fire.

If fire develops, cabin crew should take prompt action to move passengers away from the area involved and, if necessary, provide wet towels or cloths and give instructions for passengers to breathe through them.

Minimizing the spreading of smoke and fumes into the flight deck is critical for the continued safe operation of the aircraft, therefore it is essential to keep the flight deck door closed at all times. Crew communication and coordination is of utmost importance. The use of the interphone is the primary means of communication unless the interphone system fails.

2) IDENTIFY THE ITEM

It may not be possible to identify the item right away, especially if the fire has started in the overhead bin and the device is not readily accessible.

If the device is visible and accessible or if the device is contained in baggage and flames are visible, the fire-fighting procedures should be applied as a first step.

If smoke is coming from the overhead bin, but the device is not visible or accessible, or there is no indication of fire, the fire-fighting procedures should be applied as a first step. Afterwards, all baggage should be removed from the overhead bin with caution until the item can be identified. Once the item is identified, apply steps 3 to 5 of the OVERHEAD BIN BATTERY / PORTABLE ELECTRONIC DEVICE (PED) FIRE / SMOKE checklist.

Caution:

In order to avoid injury from a flash fire, it is not recommended to open the affected baggage when there is any indication of smoke or flames. However, in certain situations cabin crew members may assess and deem it necessary to slightly open baggage to allow entry of the extinguishing agent and non-flammable liquid. This should be done with extreme caution and only after donning appropriate protective equipment, available on the aircraft. Do not open baggage when there is any indication of smoke or flame.

3) DOUSE THE DEVICE (**BAGGAGE**) WITH WATER (OR OTHER NON-FLAMMABLE LIQUID)

Water (or other non-flammable liquid) must be used to cool a battery that has ignited to prevent the spread of heat to other cells in the battery. If water is not available, any non-flammable liquid may be used to cool the device.

Note.— Liquid may turn to steam when applied to the hot battery.

4) WHEN THE DEVICE HAS COOLED ~~CAN BE SAFELY MOVED~~

The device should be moved from the overhead bin to prevent a hidden fire from potentially developing. The device can be ~~safely~~ moved with caution following a certain period, once it has cooled down and if there is no evidence of smoke, heat, or if there is a reduction in the crackling or hissing sound usually associated with a lithium battery fire. The waiting period may vary based on the device and its size. The different circumstances (e.g. types of devices, phase of flight, etc.) should be addressed in the operator's training programme. ~~Following this period, the device can be moved, with caution.~~

A suitable empty container, such as a pot, jug, galley unit or toilet waste bin, must be filled with enough water or non-flammable liquid to completely submerge the device. It is important to wear available protective equipment (e.g. protective breathing equipment, fire gloves), when moving any device involved in a fire. Once the device is completely submerged, the container used must be stowed and, if possible, secured to prevent spillage.

5) MONITOR THE DEVICE AND THE SURROUNDING AREA FOR THE REMAINDER OF THE FLIGHT

Monitor the device and the surrounding area for the remainder of the flight to verify that the device does not pose further risk.

6) AFTER LANDING AT THE NEXT DESTINATION

Upon arrival, apply the operator's post-incident procedures. These may include identifying to ground personnel where the item is stowed and providing all information about the item.

Complete the required documentation, as per operator procedures, so that the operator is notified of the event, proper maintenance action is undertaken and the emergency response kit or any aircraft equipment used is replenished or replaced, if applicable.

3.4.3 OVERHEATED BATTERY OR ELECTRICAL SMELL INVOLVING A PORTABLE ELECTRONIC DEVICE (PED) - NO VISIBLE FIRE OR SMOKE

1) IDENTIFY THE ITEM

Identify the source of overheat or electrical smell. Ask the passenger concerned to identify the item.

2) INSTRUCT THE PASSENGER TO TURN OFF THE DEVICE IMMEDIATELY

It is important to instruct the passenger to turn off the device immediately.

3) REMOVE POWER

It is important to instruct the passenger or crew member to disconnect the device from the power supply, if it is deemed safe to do so. A battery has a higher likelihood of catching fire due to overheating during or immediately following a charging cycle, although the effects may be delayed for some period of time. By removing the external power supply from the device, it will be assured that additional energy is not being fed to the battery to promote a fire.

Turn off the in-seat power to the remaining electrical outlets until it can be assured that a malfunctioning aircraft system does not contribute to additional failures of the passengers' portable electronic devices.

Visually check that power to the remaining electrical outlets remains off until the aircraft's system can be determined to be free of faults, if the device was previously plugged in.

The removal of power may occur simultaneously to other cabin crew actions (e.g. obtaining water to douse the device). Depending on the aircraft type, in-seat power may have to be turned-off by the flight crew members.

It is important to verify that the device remains powered off for the duration of the flight.

Caution:

Do not attempt to remove the battery from the device.

4) INSTRUCT THE PASSENGER TO KEEP THE DEVICE VISIBLE AND MONITOR CLOSELY

The device must remain visible (not stowed such as in baggage or seat pocket or on a person (pocket)) and should be monitored closely. Unstable batteries may ignite even after the device is turned off. Verify that the device is stowed for landing.

5) IF SMOKE OR FLAMES APPEAR

If smoke or flames appear, apply the BATTERY / PORTABLE ELECTRONIC DEVICE (PED) FIRE / SMOKE checklist.

6) AFTER LANDING AT THE NEXT DESTINATION

Upon arrival, apply the operator's post-incident procedures. These may include identifying to ground personnel where the item is stowed and providing all information about the item.

Complete the required documentation, as per operator procedures, so that the operator is notified of the event, proper maintenance action is undertaken and the emergency response kit or any aircraft equipment used is replenished or replaced, if applicable.

3.4.4 PED INADVERTENTLY CRUSHED OR DAMAGED IN ELECTRICALLY ADJUSTABLE SEAT

Due to the design of some electrically adjustable passenger seats, a PED can slip under a seat covering and/or cushion, behind an armrest or down the side of a seat. Inadvertent crushing of the device poses a risk of fire.

1) NOTIFY THE PILOT-IN-COMMAND / OTHER CABIN CREW MEMBERS

Any occurrence concerning a risk of fire in the cabin should be notified immediately to the pilot-in-command who should be kept informed of all actions taken and of the effect. It is essential that the cabin crew and the flight crew coordinate their actions and that each are kept fully informed of the other's actions and intentions

2) OBTAIN INFORMATION FROM PASSENGER

Ask the passenger concerned to identify the item, and where he/she suspects it may have dropped or slipped into, and if he/she has moved the seat since misplacing the item.

3) RETRIEVE AND USE PROTECTIVE EQUIPMENT, IF AVAILABLE

If available, cabin crew members should don fire gloves before trying to retrieve the item.

4) RETRIEVE THE ITEM

To prevent crushing of the PED and reduce the potential fire risk to the device and the surrounding area, cabin crew members and/or passengers must not use the electrical or mechanical seat functions in an attempt to retrieve the item. Move the passenger and, if applicable, the passenger seated next to the affected seat from the area, to facilitate the search. Do not move the seat. If the cabin crewmember is unable to retrieve the item, it may be necessary to move the passenger to another seat.

5) IF SMOKE OR FLAMES APPEAR

If smoke or flames appear, apply the BATTERY / PORTABLE ELECTRONIC DEVICE (PED) FIRE / SMOKE checklist.

6) AFTER LANDING AT THE NEXT DESTINATION

Upon arrival, apply the operator's post-incident procedures. These may include identifying to ground personnel where the item is located and providing all information about the item.

Complete the required documentation, as per operator procedures, so that the operator is notified of the event, proper maintenance action is undertaken and any aircraft equipment used is replenished or replaced, if applicable.

3.4.4.5 FIRE INVOLVING DANGEROUS GOODS

1) IDENTIFY THE ITEM

Ask the passenger concerned to identify the item. The passenger may be able to give some guidance on the hazard(s) involved and how these could be dealt with. If the passenger can identify the item, refer to Section 4 for the appropriate emergency response drill.

It may not be possible to identify the item right away, especially if the source of the fire is unknown or the item is not readily accessible. In this case, fire-fighting procedures should be applied as a first step. Once it is possible to do so, identify the item after the fire is under control. If the item is contained in baggage, the crew's actions would be similar to the actions for an item that is visible or readily accessible.

Caution:

In order to avoid injury from a flash fire, it is not recommended to open the affected baggage when there is any indication of smoke or flames. However, in certain situations cabin crew members may assess and deem it necessary to slightly open baggage to allow entry of the extinguishing agent and non-flammable liquid. This should be done with extreme caution and only after donning appropriate protective equipment, available on the aircraft.

2) APPLY THE FIRE-FIGHTING PROCEDURE

Any occurrence concerning a fire in the cabin should be notified immediately to the pilot-in-command who should be kept informed of all actions taken and of the effect. It is essential that the cabin crew and the flight crew coordinate their actions and that each are kept fully informed of the other's actions and intentions.

Appropriate fire-fighting and emergency procedures must be used to deal with any fire. In a multi-cabin crew operation, the actions detailed in the fire-fighting procedure should be conducted simultaneously. On aircraft operated with only one cabin crew member, the aid of a passenger should be sought in dealing with the situation.

In general, water should not be used on a spillage or when fumes are present since it may spread the spillage or increase the rate of fuming. Consideration should also be given to the possible presence of electrical components when using water extinguishers.

If fire develops, cabin crew should take prompt action to move passengers away from the area involved and, if necessary, provide wet towels or cloths and give instructions for passengers to breathe through them.

Minimizing the spreading of smoke and fumes into the flight deck is critical for the continued safe operation of the aircraft, therefore it is essential to keep the flight deck door closed at all times. Crew communication and coordination is of utmost importance. The use of the interphone is the primary means of communication unless the interphone system fails.

3) MONITOR FOR ANY RE-IGNITION

Monitor the area regularly to identify if there is any indication that a fire risk may still exist. If there is any smoke or indication of fire continue to apply the fire-fighting procedure.

4) ONCE THE FIRE HAS BEEN EXTINGUISHED

In the event of a fire involving dangerous goods, the SPILLAGE OR LEAKAGE INVOLVING DANGEROUS GOODS checklist may need to be applied once the fire has been extinguished.

5) AFTER LANDING AT THE NEXT DESTINATION

Upon arrival, apply the operator's post-incident procedures. These may include identifying to ground personnel where the item is stowed and providing all information about the item.

Complete the required documentation, as per operator procedures, so that the operator is notified of the event, proper maintenance action is undertaken and the emergency response kit or any aircraft equipment used is replenished or replaced, if applicable.

3.4.56 SPILLAGE OR LEAKAGE INVOLVING DANGEROUS GOODS

1) NOTIFY PILOT-IN-COMMAND

Any incident concerning dangerous goods should be notified immediately to the pilot-in-command who should be kept informed of all actions taken and of their effect. It is essential that the cabin crew and the flight crew coordinate their actions and that each are kept fully informed of the other's actions and intentions.

Minimizing the spreading of smoke and fumes into the flight deck is critical for the continued safe operation of the aircraft, therefore it is essential to keep the flight deck door closed at all times. Crew communication and coordination is of utmost importance. The use of the interphone is the primary means of communication unless the interphone system fails.

2) IDENTIFY THE ITEM

Ask the passenger concerned to identify the item and indicate its potential hazards. The passenger may be able to give some guidance on the hazard(s) involved and how these could be dealt with. If the passenger can identify the item, refer to Section 4 for the appropriate emergency response drill.

On aircraft with only one cabin crew member, consult with the pilot-in-command as to whether the aid of a passenger should be sought in dealing with the incident.

3) COLLECT EMERGENCY RESPONSE KIT OR OTHER USEFUL ITEMS

Collect emergency response kit, if provided, or collect for use in dealing with the spillage or leakage:

- a supply of paper towels or newspapers or other absorbent paper or absorbent fabric (e.g. seat cushion covers, head rest protectors);
- oven gloves or fire-resistant gloves, if available;
- at least two large polyethylene waste bin bags; and
- at least three smaller polyethylene bags, such as those used for duty-free or bar sales or, if none available, airsickness bags.

4) DON RUBBER GLOVES AND SMOKE HOOD

The hands should always be protected before touching suspicious packages or items. Fire-resistant gloves or oven gloves covered by polyethylene bags are likely to give suitable protection.

Gas-tight breathing equipment should always be worn when attending to an incident involving smoke, fumes or fire.

5) MOVE PASSENGERS AWAY FROM AREA

The use of therapeutic oxygen bottles or the passenger drop-out oxygen system to assist passengers in a smoke- or fume-filled passenger cabin should not be considered since considerable quantities of fumes or smoke would be inhaled through the valves or holes in the masks. A more effective aid to passengers in a smoke- or fume-filled environment would be the use of a wet towel or cloth held over the mouth and nose. A wet towel or cloth aids in filtering and is more effective at doing this than a dry towel or cloth. Cabin crew should take prompt action if smoke or fumes develop and move passengers away from the area involved and, if possible, provide wet towels or cloths and give instructions to breathe through them.

6) PLACE DANGEROUS GOODS ITEM IN POLYETHYLENE BAGS

Note.— In the case of a spill of known or suspected dangerous goods in powder form:

- leave everything undisturbed;
- do not use fire agent or water;
- cover area with polyethylene or other plastic bags and blankets;
- keep area isolated until after landing.

With emergency response kit

If it is absolutely certain that the item will not create a problem the decision may be made not to move it. In most circumstances, however, it will be better to move the item and this should be done as suggested below. Place the item in a polyethylene bag as follows:

- prepare two bags by rolling up the sides and placing them on the floor;
- place the item inside the first bag with the closure of the item, or the point from which it is leaking from its container, at the top;
- take off the rubber gloves while avoiding skin contact with any contamination on them;
- place the rubber gloves in the second bag;
- close the first bag while squeezing out the excess air;
- twist the open end of the first bag and use a bag tie to tie it sufficiently tight to be secure but not so tight that pressure equalization cannot take place;
- place the first bag (containing the item) in the second bag, which already contains the rubber gloves and secure the open end in the same manner as that used for the first bag.

With no emergency response kit

Pick up the item and place it in a polyethylene bag. Ensure the receptacle containing the dangerous goods is kept upright or the area of leakage is at the top. Using paper towels, newspaper, etc., mop up the spillage, after having ascertained there will be no reaction between what is to be used to mop up and the dangerous goods. Place the soiled towels, etc., in another polyethylene bag. Place the gloves and bags used to protect the hands either in a separate small polyethylene bag or with the soiled towels. If extra bags are not available, place the towels, gloves, etc., in the same bag as the item. Expel excess air from the bags and close tightly so as to be secure but not so tight that pressure equalization cannot take place.

7) STOW POLYETHYLENE BAGS

If there is a catering or bar box on board, empty any contents and place the box on the floor, with the door upward. Place the bag(s) containing the item and any soiled towels, etc., in the box and close the door. Take the box or, if there is no box, the bag(s) to a position as far away as possible from the flight deck and passengers. If a galley or toilet is fitted, consider taking the box or bag(s) there, unless it is close to the flight deck. Use a rear galley or toilet wherever possible, but do not place the box or bag(s) against the pressure bulkhead or fuselage wall. If a galley is used, the box or bag(s) can be stowed in an empty waste bin container. If a toilet is used, the box can be placed on the floor or the bag(s) stowed in an empty waste container. The toilet door should be locked from the outside. In a pressurized aircraft, if a toilet is used, any fumes will be vented away from passengers. However, if the aircraft is unpressurized there may not be positive pressure in a toilet to prevent fumes from entering the passenger cabin.

Ensure when moving a box that the opening is kept upward or when moving a bag that either receptacle containing the dangerous goods is kept upright or the area of leakage is kept at the top.

Wherever the box or bag(s) have been located, wedge them firmly in place to prevent them from moving and to keep the item upright. Ensure that the position of the box or bags will not impede disembarkation from the aircraft.

8) TREAT AFFECTED SEAT CUSHIONS / COVERS IN THE SAME MANNER AS DANGEROUS GOODS ITEM

Seat cushions, seat backs or other furnishings which have been contaminated by a spillage should be removed from their fixtures and placed in a large bin bag or other polyethylene bag, together with any bags used initially to cover them. They should be stowed away in the same manner as the dangerous goods item causing the incident.

9) COVER SPILLAGE ON CARPET / FLOOR

Cover any spillage on the carpet or furnishings with a waste bag or other polyethylene bags, if available. If not, use airsickness bags opened out so that the plastic side covers the spillage or use the plastic covered emergency information cards.

Carpet which has been contaminated by a spillage and which is still causing fumes despite being covered, should be rolled up, if possible, and placed in a large bin bag or other polyethylene bag. It should be placed in a waste bin and stowed, when possible, either in the rear toilet or rear galley. If the carpet cannot be removed it should remain covered by a large bin bag or polyethylene bags, etc., and additional bags should be used to reduce the fumes.

10) REGULARLY INSPECT ITEMS STOWED AWAY / CONTAMINATED FURNISHINGS

Any dangerous goods, contaminated furnishings or equipment which have been removed and stowed away or covered for safety should be subject to regular inspection.

11) AFTER LANDING AT THE NEXT DESTINATION

Upon arrival, apply the operator's post-incident procedures. These may include identifying to ground personnel where the item is stowed and providing all information about the item.

Complete the required documentation, as per operator procedures, so that the operator is notified of the event, proper maintenance action is undertaken and the emergency response kit or any aircraft equipment used is replenished or replaced, if applicable

APPENDIX D

PROPOSED AMENDMENTS TO THE TECHNICAL INSTRUCTIONS TO ADDRESS
UNTENDED CONSEQUENCES RESULTING FROM AMENDMENTS AGREED AT DGP/24

Part 3

DANGEROUS GOODS LIST,
SPECIAL PROVISIONS AND
LIMITED AND EXCEPTED QUANTITIES

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Chapter 2

ARRANGEMENT OF THE
DANGEROUS GOODS LIST (TABLE 3-1)

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Table 3-1. Dangerous Goods List

Name	UN No.	Class or division	Subsidiary risk	Labels	State variations	Special provisions	UN packing group	Excepted quantity	Passenger aircraft		Cargo aircraft	
									Packing instruction	Max. net quantity per package	Packing instruction	Max. net quantity per package
1	2	3	4	5	6	7	8	9	10	11	12	13
Krill meal	3497	4.2		Spontaneous combustion		A2 A3	II III	E2 E1	FORBI 467 469	DDEN 15 kg 25 kg	FORBI 470 471	DDEN 50 kg 100 kg

APPENDIX E

EXTRACT FROM THE DGP/24 REPORT

5.1 REVIEW OF PROVISIONS FOR THE TRANSPORT OF LITHIUM BATTERIES

5.1.1 LITHIUM BATTERY INFORMATION SESSION

5.1.1.1 A lithium battery information session was held at which representatives from the Federal Aviation Administration (FAA) William J. Hughes Technical Center, two cargo express carriers, and packaging companies were invited to provide information on developments in testing, packaging and fire suppression systems.

5.1.1.2 FAA Tech Center

5.1.1.2.1 The FAA Technical Center provided a brief summary of findings from previous tests related to lithium batteries, followed by a report on results from recent full-scale tests undertaken to demonstrate the characteristics of large battery fires in a realistic aircraft environment (B-727). Findings from previous lithium battery tests were summarized as follows:

- a) **Thermal runaway.** Lithium batteries were capable of thermal runaway through cell defect, cell damage, heat, rapid discharge, or overcharging resulting in temperatures exceeding 550°C (1100°F) for lithium ion and 760°C (1400°F) for lithium metal. A single cell in thermal runaway generates enough heat to cause adjacent cells to go into thermal runaway resulting in propagation from cell to cell and package to package. Thermal runaway results in the release of flammable electrolytes and, in the case of lithium metal, molten burning lithium.
- b) **Self ignition.** Lithium ion will generally not self-ignite, but high temperatures can ignite packing materials, which can ignite the electrolyte. Lithium metal can self-ignite and rapidly ignite packaging.
- a) **Fire suppression.** Halon 1301 suppresses open flames from lithium-ion cells in thermal runaway but does not stop the propagation from cell-to-cell. Halon 1301 has no effect on lithium metal cells.

5.1.1.2.2 The recent full-scale tests demonstrated the dangers of bulk shipments of lithium metal batteries under realistic conditions which included emergency in-flight air flow. In the main deck Class E cargo compartment, a fire triggered by a cartridge heater simulating a single cell in thermal runaway created conditions that jeopardized the cargo compartment and created smoke in the flight deck. From the first observation of fire, smoke was present in the flight deck in four minutes and the flight deck was completely obscured from smoke in less than six minutes. Testing in a Class C cargo compartment with Halon suppression was terminated because of high temperatures and smoke penetration into the main cargo compartment and flight deck. After the test was terminated, the oxygen levels in the cargo compartment increased, the Halon neared zero, and a single cell in thermal runaway ignited a flash fire in

the cargo compartment. The flash fire caused an explosion ultimately resulting in the breach of the main deck floor panels and the flight deck door being blown off its hinges into the flight deck.

5.1.1.2.3 Tests had also shown that the behavior of a burning lithium cell is very dependent on the manufacturer, chemistry, size and design of the cell. Testing on one particular chemistry, although employing a non-flammable electrolyte, resulted in an explosion when thermal runaway was induced by a cartridge heater.

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5.1.2 LITHIUM METAL BATTERIES (DGP/24-WP/9)

5.1.2.1 The panel was asked to consider forbidding lithium metal batteries on passenger and cargo aircraft. It was argued that the knowledge that current fire suppression systems in cargo holds had no effect on lithium metal fires and that currently required packagings could not contain a fire made it difficult to justify allowing their carriage as cargo. It was noted that one State and several airlines already banned lithium metal batteries as cargo on their passenger aircraft through State and operator variations. The meeting was reminded of discussions that had taken place earlier that week on safety management systems (SMS) (see paragraph 1.2 of the Report on Agenda Item 1), and it was suggested that continued carriage of lithium metal batteries went against these principles. A basic tenet of SMS was that layered defences against safety risks were necessary in ensuring that single-point failures were rarely consequential. It was suggested that the ineffectiveness of aircraft fire suppression systems on lithium metal fires was a single point of failure which, based on test results, would likely result in a catastrophic event. Continuing to transport lithium metal batteries despite the known risks was argued to be unacceptable.

5.1.2.2 The meeting was reminded of statements made by the Director of the Air Navigation Bureau during the opening of DGP/24 which provided insight into the Secretariat's growing concern with cargo safety and how the mandate of the Dangerous Goods Section would be expanded. Dangerous goods could no longer be thought of in isolation but would need to involve other parts of the aviation system such as operations, airworthiness and security. With that in mind, the Deputy Director, Safety Standardization and Infrastructure (DD/SSI), the Chief of the Flight Operations Section (C/OPS) and operations and airworthiness technical officers from the Air Navigation Bureau were present to provide insight into how other Annexes interacted with Annex 18 and how they might contribute to the panel's decisions. DD/SSI described how quantitative safety performance targets were used to make decisions on adding or amending Standards to Annexes in other aviation segments and urged the DGP to also apply this approach. C/OPS referenced the work that DGP and the Operations Panel (OPSP) had undertaken to introduce dangerous goods requirements in Annex 6 — *Operation of Aircraft* as an example of how interdependent aviation segments were. He suggested that other Annex 6 requirements needed to be taken into account in relation to dangerous goods such as extended diversion time operations (EDTO) and fire suppression capabilities. Annex 8 — *Airworthiness of Aircraft* requirements also needed to be taken into account. A disconnect between Annex 8 and Annex 18 was cited, whereby Annex 8 requires cargo compartment fire suppression systems, including their extinguishing agents, to be designed so as to take into account a sudden and extensive fire such as could be caused by dangerous goods (for aircraft certificated on or after 12 March 2000). It was suggested that since aircraft fire suppression systems could not extinguish a lithium metal battery fire, this requirement could not be met if such items were allowed to be carried as cargo by air.

5.1.2.3 The ensuing discussion highlighted the concerns of those who were in favour of banning lithium metal from transport and those who were not. Although those against the ban did agree that there were risks in transporting lithium batteries, they believed that these risks involved non-compliant and

counterfeit batteries and that many if not all reported incidents had involved these types of shipments. It was suggested that a ban would serve only to stop compliant shipments of batteries; non-compliant shipments would continue to be transported, and the number of undeclared batteries would likely increase, therefore increasing the risk to passengers and crew. A ban was seen to be unfair to the majority who did comply with the regulations and would have a negative effect on key industries such as communications, public health and safety. It was suggested that a ban would put the lives of people who depended on batteries to power medical devices such as pacemakers and defibrillators at risk. There was also a concern that the panel would be viewed as indecisive as yet more new rules would be introduced so soon after significant amendments were introduced into the current edition of the Technical Instructions. While appreciating the views expressed by operations, airworthiness and air traffic management experts, one member suggested that the world of air cargo and specifically dangerous goods could not be compared to those areas of aviation because they were closed systems, involving technically qualified staff with no choice but to comply with very strict and exacting requirements. The situation was very different with air cargo, where it was impossible to directly oversee the limitless number of shippers who offered cargo for carriage by air, despite the oversight requirements in Annex 18. The significance of the suggested disconnect between Annex 8 and Annex 18 was also questioned, noting that cargo aircraft did not require fire suppression systems. Did this mean that such aircraft should not be permitted to carry any flammable or explosive dangerous goods at all? It was suggested that the ineffectiveness of the fire suppression system should not be regarded as a potential single point failure, since the packaging was not relied upon as the only barrier against a fire propagating. There were many layers of risk mitigation in place including very stringent testing requirements, the establishment of quality management systems, and other requirements specific to the air mode which were applied to lithium batteries excepted from most of the requirements when transported by other modes. Members against a ban believed that risks would be better addressed through outreach and enforcement. It was suggested that these were lacking in many parts of the world and that efforts needed to be taken in States who were deficient in this area. This would be particularly important were a ban to come into force, because some States might believe that this would lessen the need for oversight. It was believed that even more oversight would be needed if a ban were in place, as the number of undeclared and non-compliant batteries being shipped would likely increase.

5.1.2.4 Other members supported a ban for the reasons presented with the proposal, but all but one of these members believed the ban should apply to passenger aircraft only. Although they agreed that more needed to be done to mitigate risks on cargo aircraft, a full ban was considered to be too extreme. While the Secretariat's philosophy in all segments of aviation was not to differentiate between passenger and cargo aircraft, it was acknowledged that there were differences with regards to dangerous goods. Higher quantity limits were permitted on cargo aircraft, and certain substances forbidden on passenger aircraft were permitted on cargo. The member nominated by IFALPA was the one member who supported the proposal as written. He stated that IFALPA'S position was that the requirements for passenger and cargo aircraft should be the same. He also disagreed with an earlier statement which implied that should the fire suppression Standard in Annex 8 be taken literally, there would not be any dangerous goods permitted for transport on cargo aircraft since there were no fire suppression requirements on such aircraft. He noted that depressurization was a method of fire suppression that could meet the Annex 8 requirement. However, tests had shown that although depressurization could suppress a fire involving dangerous goods other than lithium metal batteries, it was not effective on lithium metal battery fires. IFALPA's position, which he endorsed, was that there was currently no safe way to transport lithium metal batteries and until such time that there was, they should be banned on both passenger and cargo aircraft.

5.1.2.5 Based on the fact there was little support shown for a full ban, a revised proposal was presented to the meeting which would allow lithium metal batteries to be carried on cargo aircraft in

accordance with the current requirements and on passenger aircraft with the approval of the States of Origin and the Operator. Some were in favour of this approach, noting that a ban on passenger aircraft had been in effect for almost ten years in one large State. Although there had been logistical problems when the ban was first introduced, these had been effectively dealt with. Representatives from the battery industry stated that its members would likewise adapt to a ban if it were to be enforced internationally. Those members against even a partial ban believed there were parts of the world that cargo aircraft did not service and therefore there needed to be an allowance for lithium batteries to be transported on passenger aircraft. It was noted that the State that had a ban in place had an extensive cargo aircraft network, something many other parts of the world did not have. The need for replacement batteries for automatic external defibrillators (AEDs) was cited as one example where next day deliveries were often required and for which transport by air would be the only viable mode of transport to meet this need. But others felt that this was an economic argument which was not used in any other areas of aviation safety and should not be used if there were risks to safety. It was noted that the proposal did not ban lithium metal batteries packed with or contained in equipment and that that was done in order to take into account urgent medical needs.

5.1.2.6 All members agreed that non-compliant shipments were a problem and that better oversight and enforcement was needed, but those who supported a ban stressed that even fully compliant shipments posed risks. There was always the possibility of damage to perfectly manufactured and prepared shipments of batteries during transport. The probability of this happening would only increase with the upward trend in numbers of batteries being shipped. It had been cited by industry representatives that billions of batteries were being shipped each year. It was acknowledged that other dangerous goods could result in an aircraft fire, but the number of shipments of other commodities would be substantially lower than that for lithium batteries, making the risk posed correspondingly lower. Testing had shown that the heat from a suppressed fire could ignite lithium metal batteries. The fact that fully compliant lithium metal batteries could serve as fuel for an independent fire was a risk that could not be ignored. Concern was expressed that at some point a catastrophic fire would occur on an aircraft and that action had to be taken. If this resulted in an increase in non-compliance, it was thought this would affect only a small number of shipments and should not deflect the need to address the majority.

5.1.2.7 While there were differences of opinion, most believed that the results of the FAA Technical Center's full scale testing could not be ignored. Of those against the ban, all but one believed that maintaining the status quo was inappropriate, and that even if a ban on passenger aircraft were implemented, further work was needed to ensure safe transport on cargo aircraft. Developments in fire suppression systems and packaging standards were promising, and it was believed technology was available to establish conditions under which lithium metal batteries could be transported safely. It was recognized that finding a solution would involve a multi-disciplinary approach involving experts from outside the dangerous goods world including operations, airworthiness, battery manufacturing and packaging manufacturing. To that end, an offer was made to host a multidisciplinary meeting on behalf of ICAO at the FAA Technical Center at the beginning of 2014.

5.1.2.8 It became clear that a final decision on the revised proposal which would allow lithium metal batteries to be carried on cargo aircraft in accordance with the current requirements and on passenger aircraft with the approval of the States of Origin and the Operator could not be reached during DGP/24. The revised proposal, although less restrictive than the original, would still have a major impact on industry and some members wished for more time to consult with experts within their States. Others remarked that even if the proposal were agreed in principle, there were several consequential issues that needed to be taken into account, including how to ensure that smaller sized batteries which were not subject to an operator acceptance check did not end up on passenger aircraft. Several panel members wanted to consider options which would not include a ban, such as fully regulating all lithium metal batteries, determining what types and quantities of batteries could be carried without posing an

unacceptable risk, and limiting the numbers in a ULD or in a cargo compartment. Some members believed that without urgent action, a catastrophic event was inevitable and that an immediate change to the requirements was necessary. Others believed that a rushed decision would not necessarily be the right one and that every effort was needed to ensure a decision which would result in safe and stable regulations was made. On that basis, the panel agreed to continue work on the subject through correspondence and to schedule a working group in early 2014 at which time a final decision on the proposal to ban lithium metal batteries on passenger aircraft would be made.

— END —