

Report of the ICAO DGP Ad-hoc Working Group on Lithium Batteries

As a result of proposals submitted to DGP-WG/07, the Panel agreed to convene an ad-hoc working group to address lithium battery safety in air transport. Mr. D. Brennan (IATA) chaired the meeting, Mr. D. Pfund (USA) acted as rapporteur. Mr. Brennan opened the meeting by providing a short introduction and the working group approved the agenda as follows:

1. Review incidents and probable root causes;
2. Discuss outreach and enforcement efforts and their effectiveness;
3. Potential revision to Special Provision A45;
4. Transport of lithium metal/lithium ion batteries on passenger aircraft;
5. Transport of lithium metal/lithium ion batteries on cargo aircraft;
6. Application of Special Provision A154 regarding batteries recalled for safety reasons;
7. Carriage of battery-powered equipment and spare batteries by passengers;
8. Considerations for the UN Model Regulations regarding multi-modal transport:
 - possible revisions to the UN Manual of Tests and Criteria (design test requirements);
 - possible review of packaging standards.

Agenda item 1. Review incidents and probable root causes.

- 1.1 Dr. C. Ke (USA) provided a presentation describing the probable causes of reported incidents involving lithium batteries in air transport. The analysis indicates that incidents are mostly caused by external short-circuit, internal short-circuit, in use situations related to charging and discharging, and non-compliance situations. He further identified the progress made by the battery industry to improve designs, manufacturing quality controls, and safety testing methods to detect potential defects. In addition, there is significant work being done by IEEE to enhance safety standards for cells, battery packs, and host devices.
- 1.2 Dr. V. Klein (ZVEI) informed the group of the various use applications for lithium batteries. He provided additional discussion on the incidents and possible solutions. He discussed the difficulties that would be presented if a proposal to prohibit the transport of lithium batteries by air were adopted and the implications to the industry.
- 1.3 Mr. G. Kerchner (PRBA) provided an overview of PRBA and its role in addressing the safe transportation of batteries. He advised that PRBA represents over 70 members that produce approximately 65% of the lithium ion cell supply worldwide. Mr. Kerchner introduced the PRBA working paper (DGP/21-WP/42) addressing PRBA's observations on the U.S. list of lithium battery incidents, explained the progress being made in relation to revising industry standards within IEEE, IEC, and UL to improve cell and battery reliability, and recommendations to restructure much of A45 into a packaging instruction to simplify the applicable requirements and improve compliance. He indicated that the lithium battery incidents largely result

from non-compliance and advocated collaborative efforts to educate shippers on the regulatory requirements applicable to lithium batteries.

Agenda item 2. Discuss outreach and enforcement efforts and their effectiveness.

2.1 Mr. R. Richard (USA) informed the working group of the various outreach and enforcement efforts underway in the US. He emphasized the importance of a multi-faceted approach that includes outreach, standards development, voluntary industry practices, regulatory amendments, and enforcement. He provided an overview of the US DOT efforts to enhance traveller awareness, and demonstrated the SafeTravel website (<http://safetravel.dot.gov/>), provide copies of the battery safety passenger awareness brochure and provided copies of the media kit developed to enhance the reach of the DOT outreach campaign.

He stressed the willingness and importance of partnering with industry and governments to leverage resources to maximize the effectiveness of the outreach efforts. He explained that the SafeTravel website is currently being expanded to include other hazardous materials and articles of interest for raising passenger awareness and enhancing aviation safety. Mr. Richard requested comments to improve on the site and invited other to join in the outreach efforts stressing the importance of an international approach.

There was a suggestion that ICAO host passenger awareness information based on material already produced by States. States and operators could then link their websites to the ICAO information. This would provide for information to be available worldwide and also ensure that passengers received a consistent message.

Translation into the ICAO languages, and possibly others, would further help to publicise the issue.. Ms. Rooney agreed to investigate this option. Additionally, DOT is investigating the ability to get outreach material into in-flight magazines, electronic equipment media and user websites to improve awareness. Panel members further discussed working with e-bay and other on-line auction services to identify and communicate transport requirements with sellers of batteries or equipment containing batteries.

Agenda item 3. Potential revision to Special Provision A45.

3.1 The working group decided to address DGP/21-WP/20 next in the agenda because many of the members felt that discussions or recommendations related to this paper would directly affect other proposals submitted for consideration. Mr. M. Rogers (IFALPA) presented the proposals outlined in WP/20. He discussed the difficulties and ineffectiveness of applying a “quasi-regulatory” scheme to lithium battery shipments.

Mr. Rogers pointed out that the ICAO Technical Instructions provides a system for packaging, marking, labelling, documentation, pilot notification, etc. to address dangerous goods in transport. The current regulatory scheme works as intended and he supports applying that scheme equally to lithium batteries as it is applied to other materials or articles that pose comparable hazards in transport. Therefore, IFALPA proposes to eliminate the application of A45 to lithium batteries except when contained in equipment.

Other working group members felt this might be too extreme and expressed concern over the cost of eliminating A45 for all packaged lithium battery shipments. These include direct costs for packaging, package preparation, documentation and training, as well as indirect costs such as shipment delays and problems in locations not serviced by cargo aircraft operators.

- 3.2 To assist in the discussions, the working group found it helpful to consider DGP/21-IP/1 presented by Mr. G.A. Leach (UK). This paper provided an overview of current and proposed ICAO Technical Instructions requirements related to lithium batteries. In particular, the paper provided the new A45, as amended by the recent changes to SP 188 in the 15th Revised Edition of the UN Model Regulations. The amended SP 188 provides enhanced packaging, marking, and documentation requirements beyond those currently required by A45. Some working group members suggested these enhancements, along with amendments to differentiate lithium metal and ion descriptions, would significantly improve safety and that the Panel should evaluate the effectiveness of these provisions before making any additional amendments.
- 3.3 Capt. Jiang Rui (CAAC) presented a proposal to require training for individuals preparing and transporting lithium battery shipments in accordance with the A45 provisions. He identified that many of the reported incidents were the result of non-compliance; therefore, shippers of lithium batteries should be required to complete training commensurate with their responsibilities. The working group generally supported the need for relevant training but questioned the appropriateness of applying the full training requirements under Part 1; Chapter 4 to lithium batteries subject to A45. However, the possible addition of lithium batteries to the excepted quantity provisions would address Capt Jiang Rui's concern.
- 3.4 Mr. R. Richard (USA) presented a proposal under DGP/21-WP/21 to prohibit the transport of lithium metal batteries as cargo on passenger aircraft (except when installed in equipment under specific conditions). This proposal was based on evaluations of the risk posed by lithium metal batteries in air transport with particularly on the basis of the inability of standard aircraft fire suppression systems to extinguish a fire involving such batteries. He explained that this prohibition has been in place within the US over two years. There was general support for the proposal at WG/07; however it was agreed to forward the proposal to this working group to consider the issue in context with other potential amendments.

Some members expressed concern that the Panel would agree that a shipment of lithium metal batteries posed a significant enough hazard to prohibit shipment by passenger aircraft, but could be considered excepted under A45. Others expressed concern with the marking requirements under the proposed revisions to A45 (i.e. "LITHIUM METAL BATTERIES-FORBIDDEN FOR TRANSPORT ABOARD PASSENGER AIRCRAFT") and that the statement would be in English. It was also noted that based on the adoption of the recent UN amendments packages would already be required to be marked "LITHIUM METAL BATTERIES". It was suggested to consider a CAO label, although others did not agree with that approach.

Another suggestion was to consider applying the newly amended Excepted Quantities mark from the UN Model Regulations, as the ICAO DGP will likely adopt it. The

information required by A45 could be added underneath the EQ symbol. There was general support for the proposal, taking into account the need to develop a better marking for the prohibition.

3.5 The working group realized some progress through this discussion. The Chairman suggested to convene a smaller working group after closure of the meeting on the first day to develop some suggested text in response to IFALPA's proposal. This smaller group identified that:

- a. It may be necessary to separate the A45 exception for lithium metal and lithium ion batteries. It may further be necessary to significantly reduce the A45 exception for lithium metal batteries to only button cells (as defined in the UN Manual of Test and Criteria) transported on cargo only aircraft.
- b. The group identified that A45 allows packaged batteries up to 30 kg gross mass per package. However, UN3090 and the new UN3480 only allow up to 5 kg gross mass per package on passenger aircraft. This was viewed as an inconsistency that should be addressed.
- c. The group was in favor of using an already recognized dangerous goods mark, such as a modified EQ mark, to identify batteries under the A45 exception. Using an established dangerous goods mark will aid training and improve awareness by transport personnel. The modified EQ mark would be patterned on the voluntary industry mark.

3.6 When the working group reconvened they evaluated the suggestions developed the previous evening. Those suggestions are attached as Appendix 1. Although there was not full agreement, the working group agreed the work presented in Appendix 1 could serve as the basis for further work and discussion.

- a. IFALPA expressed concern that these suggestions did not take into account large consignments of batteries on one aircraft. IFALPA were seeking to establish a limit on the aggregate quantity of batteries that could be transported on a single aircraft. Although there was recognition by the group that larger consignments posed a different hazard than smaller shipments, most members did not feel there was a practical means to implement a per aircraft limitation. Some felt that significantly reducing the per package amount, would achieve IFALPA's objectives by limiting the numbers of actual batteries that would be able to be loaded on a pallet.
- b. PRBA and members of the battery industry expressed concern with reducing the per package weight from 30 kg to 5 kg. They indicated this would result in a significant cost increase and only result in more packages being required and more packaging material entering the waste stream after use.
- c. Some members also expressed concerns that limiting the A45 exception to only lithium metal button cell batteries was too severe. They identified numerous product and shipping configurations, such as CR2 and CR123A lithium metal batteries in retail blister packs, as being safe for transport and deserving of the A45 exception for transport.

- d. The Chairman indicated that the result of the group's work, as identified in Appendix 1, was the closest to consensus that the group could achieve. He suggested the working group submit this progress to DGP 21 for consideration and encouraged Panel members and participants to submit proposals as appropriate.

Agenda item 4. Transport of lithium metal/lithium ion batteries on passenger aircraft.

- 4.1 The issues related to this agenda item and DGP 21-WP/21 (R. Richard) were addressed under consideration of agenda item 3. The working group expressed general support for the proposal to prohibit the transport of lithium metal batteries as cargo on passenger aircraft, except under specific conditions, as specified in the proposal. However, some Panel members stated they would have difficulty if the A45 exception for transport of lithium batteries on cargo aircraft were maintained. The suggestion, as provided in Appendix 1, to greatly reduce the application of A45 for lithium metal batteries could possibly resolve the concern of those Panel members and result in their agreement in principle to the prohibition as presented in WP/21.
- 4.2 A member suggested that Special Provision A1 should be added to UN 3090 – Lithium metal batteries to permit the competent authority to approve the transport of these batteries on passenger aircraft to address circumstances where movement on cargo aircraft was not possible. Some members commented that there should be some specific guidance to competent authorities added to the Supplement to the Technical Instructions to address this issue.
- 4.3 A number of airlines recommended that there should also be provision to permit aircraft spares, such as lithium metal batteries for defibrillators, to be moved on passenger aircraft. This could perhaps be addressed through a specific SP similar to A144 for PBE.

Agenda item 5. Transport of lithium metal/lithium ion batteries on cargo aircraft.

- 5.1 The issues related to this agenda item and DGP 21-WP/19 (M. Rogers) was also addressed under consideration of agenda item 3. Mr. Rogers expressed further concern over the lack of fire suppression capability on cargo aircraft related to the transport of lithium metal batteries. The proposal in WP/19 states that the risk posed in the event of a fire is significant enough to prohibit the transport of lithium metal batteries by all aircraft. Most working group members did not agree and identified the difficulties that would be encountered by a complete prohibition of lithium metal batteries by air. There was some discussion that the suggestions in Appendix 1 might lead toward a resolution to this issue and all agreed to further consideration in preparation for DGP 21.

Agenda item 6. Application of Special Provision A154 regarding batteries recalled for safety reasons.

- 6.1 The Chairman brought this issue to the working group for discussion. He has received questions since the Panel agreed to the language in A154 and asked if others had experienced similar confusion. A154 prohibits from air transport defective batteries or those being returned to the manufacturer for safety reasons. The ICAO

Secretariat advised that the text proposed initially for A154 had been the subject of some discussion at the ANC and that the ANC had made some amendments to that text.

Some working group members provided their recollection from the work at WG/06 when this text was initially drafted. After some discussion the working group decided the text in A154 was adequate and the problem may be in ensuring proper implementation. The group agreed that outreach was extremely important and each Panel Member should communicate this requirement to their respective industries. Also, guidance could be placed on the ICAO website. Ms. Rooney agreed to consider this as she investigates the ability of ICAO to host passenger awareness information. Mr. Richard informed the group that US DOT had developed guidance for transporting recalled or defective batteries and that it could be accessed at: <http://SafeTravel.dot.gov/download>. He encouraged government and industry participants to circulate the guidance widely. PRBA indicated that they had been actively distributing the guidance.

Agenda item 7. Carriage of battery-powered equipment and spare batteries by passengers.

7.1 Mr. G. Kerchner (PRBA) discussed a proposal under DGP/21-WP/47 to revisit a decision by the Panel at WG06 to eliminate the passenger exception for lithium batteries containing an aggregate equivalent lithium content of more than 8 grams but not more than 25 grams. The proposal to eliminate this passenger exception was presented by Mr. R. Richard at WG/06, and was tentatively agreed to by the Panel pending justification from the industry of the need to maintain the exception and the implications of its removal. The PRBA proposal was to amend the 25 g lithium equivalent to become 160 Wh. The change to Wh as a measure of capacity for lithium ion batteries is consistent with the UN decision and 160 Wh represents approximately 13 g lithium equivalent.

There was no consensus within the working group on the PRBA proposal. Some members felt that eliminating the exception was appropriate. Those members cited the increased risk of larger batteries compared to known incidents and that allowing a larger size limit will lead to larger battery designs for passenger carry-on. Other members supported the proposal as it represented a reduction in the battery capacity currently permitted and recognised that there were already batteries larger than 100 Wh in use for items such as portable oxygen concentrators, video cameras and extended batteries for laptop computers. They felt there was not a demonstrated increase in risk and that if not authorized to hand-carry, these passengers might be motivated to carry the batteries in checked baggage. PRBA was encouraged to take all comments into account when they present their proposal to DGP 21.

7.2 Carriage by passengers of lithium batteries in carry-on baggage (DGP/21-WP/56). Mr. G.A. Leach (UK) invited discussion by the Panel on the merits of restricting the carriage equipment containing lithium batteries to carry-on baggage only. He compared the carriage of these articles to previous problems experienced with safety matches and cigarette lighters since experience has shown that such items are capable of igniting in baggage during transport. There was some discussion in favour of

restricting battery-powered equipment to carry-on baggage only, although it was recognised that smaller regional jets and commuter aircraft much of the passenger carry-on baggage was loaded in the cargo compartment. Based on the working groups input, Mr. Leach would consider submitting a flimsy to DGP/21.

7.3 Some members expressed concern at the information published by one battery distributor that recommended that passengers not use aircraft in-seat power systems to recharge battery-powered equipment. It was advised that this information was developed some time ago when early generation in-seat power system required the use of third-party devices to connect the equipment to the power supply and compatibility with OEM equipment could not be guaranteed. It was therefore believed to be a prudent recommendation.

IFALPA and PHMSA advised that despite being named as supporting the recommendation, they in fact had no policy with respect to the use of in-seat power systems and it was suggested that any recommendations should come from an authority such as the FAA.

Agenda item 8. Considerations for the UN Model Regulations regarding multi-modal transport:

- possible revisions to the UN Manual of Tests and Criteria (design test requirements);
- possible review of packaging standards.

8.1 The discussions relating to industry activities identified that battery manufacturers have been reviewing manufacturing processes for lithium ion batteries to develop quality assurance (QA) improvements. Some of these QA improvements have already been, or will be, adopted into ISO and IEEE standards. It was suggested that it might be appropriate to bring the development of these QA standards to the attention of the UN Subcommittee so that they could be referenced in the UN Manual of Tests and Criteria as appropriate.

8.2 The Battery Association of Japan (BAJ) has also been undertaking a review of manufacturing standards/processes. This review is due for completion by late 2007 or early 2008. The intention of the BAJ is that once complete the results of the review will be brought to the UN Subcommittee for their consideration. Based on the results and discussion at the UN, lithium battery manufacturing/testing standards may be an item for consideration for the 2009/2010 biennium.

8.3 Based on a recommendation from Mr. Richard, the group generally agreed that the UN Subcommittee should undertake a comprehensive review of the UN Test Methods for lithium batteries. It was also agreed that this review should include a review of the requirements that are commonly misunderstood and that clarifications should be proposed (e.g. definition of design type change).

8.4 It was noted that several of the incidents were related to improper or ineffective packagings. Retail packagings such as blister packs are very effective. Trays that allow movement of batteries continue to be a problem. Some members stated that the amendments recently adopted by the UN will result in enhanced packaging but agreed that continued outreach and enforcement will be necessary. Others indicated that additional packaging enhancements are needed.

Other Business – Approvals for the transport of prototype lithium batteries

9.1 Prototype lithium battery approvals (DGP/21-WP/56). Mr. G.A. Leach (UK) requested those that have experience granting approvals for the transport of prototype batteries to share that information with the Panel with the goal of developing guidance in the Supplement to the Technical Instructions. He stated that, although A88 provides for the transport of prototype lithium batteries with the approval of the appropriate authority of the state of origin, there are no defined standards for authorities to follow when granting such approvals. The working group agreed to the need to provide this information in the Supplement and it was identified that this work was underway with the effort to revise the Supplement. Mr. R. Richard also agreed to forward to the working group members examples of US issued approvals.

The working group concluded by identifying that:

- The suggestions developed in Appendix 1 to this report would be forwarded to DGP/21 for consideration. Working group members were encouraged to consider the benefits and implications of these suggestions and be prepared to discuss at the Panel.
- The report of the working group will be forwarded to DGP/21 for the Panel's consideration.
- Working group members were encouraged to consider the comments received and amend proposals submitted to DGP/21 as appropriate.

Appendix 1

Lithium metal batteries:

- a. Eliminate application of A45 (new SP 188 from the UN) except for button cells (as defined in the UN Manual of Tests and Criteria) and restrict these to cargo aircraft only. Re-write this SP as a new SP Axxx.
- b. Button cells could maintain the exception with a maximum gross weight per package of 5kg.
- c. Marking would be the Excepted Quantity (EQ) mark with additional information in the industry voluntary mark.
- d. Lithium metal batteries (including button cells) would be prohibited as cargo on passenger carrying aircraft.

Lithium ion batteries:

- a. Maintain application of A45 (new SP 188 from the UN).
- b. Reduce per package gross weight from 30 kg to 5 kg.
- c. Marking would be the Excepted Quantity (EQ) mark with additional information in the industry voluntary mark.

UN Number	Passenger Aircraft	Cargo Aircraft
UN 3090	Forbidden	Excepted AXXX 5 kg G per package 35 kg G per package (UN 3090)
UN 3091 contained in equipment	Excepted AXXX 5 kg per package	Excepted AXXX [35] kg G per package (UN 3091)
UN 3091 packed with equipment	Excepted AXXX 5 kg per package	Excepted AXXX 35 kg G per package (UN 3091)
UN 3480	Excepted A45 5 kg G per package 5 kg G per package	Excepted A45 5 kg G per package 35 kg G per package (UN 3480)
UN 3481 contained in equipment	Excepted A45 5 kg G (of batteries) per package	Excepted A45 [35] kg G per package (UN 3481)
UN 3481 packed with equipment	Excepted A45 5 kg G (of batteries) per package	Excepted A45 35 kg G per package (UN 3481)