国际民用航空组织

工作文件

DGP/30-WP/30*
15/9/25

危险物品专家组（DGP）

第三十次会议

2025 年 10 月 6 日至 10 日，蒙特利尔

议程项目 4：管理航空载运储能装置带来的安全风险（编号：工作卡 DGP.003.05）

国际民航组织危险物品专家组代步工具工作队的报告

（由危险物品专家组代步工具工作队报告员提交）

摘要

本工作文件概述了危险物品专家组代步工具工作队（DGP-TF/MA）开展的工作。该工作队进行了一项安全风险评估，由此形成了一套国际民航组织技术细则第 7 部分和第 8 部分的综合修订提案。

危险物品专家组的行动：请危险物品专家组:

a) 注意到危险物品专家组代步工具工作队在 2024-2025 两年期开展的工作;

b) 批准对本工作文件附录所载对技术细则第 7 部分和第 8 部分的拟议修订；

c) 同意在下一个两年期开展进一步工作，包括:

1) 制定关于批准旅客携带电池驱动代步工具的指导材料；和

2) 考虑采取额外的安全缓解措施。

1. INTRODUCTION

1.1 Concerns were raised at the 2024 Dangerous Goods Panel Working Group Meeting (DGP-WG/24, 21 to 25 October 2024, Montreal) (paragraph 4.4.2 of the DGP-WG/24 report) regarding safety risks associated with lithium ion powered mobility aids carried by passengers. Airline operators had expressed particular concern with the increase in energy storage capacity of lithium ion batteries that often power mobility devices and the limited ability to manage a thermal runaway event involving those batteries. The Technical

* 仅提供了摘要和附录的翻译。

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Instructions impose a Watt-hour rating limit of 300 Wh for lithium ion batteries removed from the mobility aid and carried in the cabin, but not for the same batteries when installed in and protected by the mobility aid and loaded in the cargo compartment. Carriage of removed batteries in the cabin are also a concern, in particular in relation to the ability of crews to quickly respond to a thermal runaway event and subsequent fire in the cabin during flight, even more so during a critical phase of flight (i.e. take-off).

1.2 DGP-WG/24 established a DGP Task Force on Mobility Aids (DGP-TF/MA) to address the safety concerns related to high-energy lithium-ion batteries installed in mobility aids carried by passengers. The task force's mandate included the conduct of a structured safety risk assessment, the development of policy options and, if justified, the development of draft amendments to the Technical Instructions for consideration at DGP/30. The task force felt strongly that that while mitigating measures may be needed to address identified safety risks, they should not unnecessarily restrict access to air travel. It therefore emphasized the importance of balancing safety requirements with the needs of passengers with reduced mobility.

1.3 The Task Force began its work with a BowTie analysis (see DGP/30-IP/1) following DGP-WG/25. This step mapped threats, barriers, and escalation factors linked to the carriage of battery-powered mobility aids in both the cabin and in the cargo compartment. The BowTie analysis generated information used during a subsequent System-Theoretic Process Analysis (STPA) (DGP-30-IP/2). The results of the safety risk assessment are described in detail in paragraph 2.

1.4 DGP-TF/MA concluded that measures needed to be in place to mitigate the risk of thermal runaway in batteries with an unlimited energy capacity. It acknowledged the potential for one incident to result in a catastrophic loss of an airframe with everyone on board. The majority agreed that the status quo, of an unlimited watt hour rating, without any mitigating measures could not be sustained. The loss of an airframe in Korea in 2025, where the source of fire was believed to be a power-bank in the cabin, reinforced the need to act sooner. The approach preferred by the majority was to develop mechanisms that maintain current passenger access for those that require a mobility aid for movement, albeit with some additional communication and advance arrangement measures, and to only introduce mandatory additional safety risk requirements related to state of charge for devices with batteries larger than 300 Wh.

1.5 DGP-TF/MA developed draft amendments to Parts 7 (Operator's responsibilities) and 8 (Provisions concerning passengers and crew) of the Technical Instructions as shown in the appendix. Agreement was reached on all amendments except for the treatment of batteries above 300 Wh when installed in mobility aids. For this provision, two bracketed options are presented in Table 8-1, paragraph e) ii), for the panel's consideration.

2. SAFETY RISK ASSESSMENT

2.1 BowTie Analysis

2.1.1 The Task Force first conducted a BowTie analysis for mobility aids carried in the cabin and in the cargo compartment. The bowtie diagrams mapped the cause of a thermal runaway and identified barriers that prevent a thermal runaway and escalation factors that weaken the barriers. Consequences linked to lithium battery thermal runaway and factors that mitigate those consequences were also identified. The analysis identified that the extant controls designed to prevent a lithium battery thermal runaway rely on training and instructions provided to passenger check-in staff and ground handling personnel, and requirements for securing a mobility aid on the aircraft. Notably, smaller aircraft that require the mobility aid to be loaded directly into the cargo compartment places the mobility aid near other baggage that can potentially damage the mobility aid or provide a source of combustible material in the event of a thermal runaway event further weakening barriers to thermal runaway. Recovery barriers designed to mitigate the consequences of a thermal runaway were also identified and include fire detection and suppression systems, flight crew procedures in the event of a fire, the use of fire-resistant containers and fire containment covers, and airport emergency services available after landing. The analyses identified the following factors that weaken existing recovery controls: ineffectiveness of halon fire suppression systems against lithium ion battery fires, varying responses by flight crew, the propensity of thermal runaway to propagate in the battery and spread to adjacent combustible material, and a lack of standards for fire resistant containers and cabin fire containment bags.

2.1.2 The BowTie analysis also highlighted that vulnerabilities from device condition, poor design or the use of batteries not intended for the device could result in a thermal runaway. Non-OEM batteries, ageing cells, and inadequate protection create weak points. If a mobility aid does not shield the battery, damage during handling or stowage can trigger failure. Information flow was another critical barrier. Last-minute disclosures by passengers or incomplete details on device type often undermined risk controls. This was reflected in STPA derived causal scenarios where poor information led to unsafe acceptance or stowage decisions. The BowTie indicated, reducing state-of-charge, and requiring protective design are possible barriers for managing these risks.

2.2 **System-Theoretic Process Analysis**

2.2.1 After the Bowtie Analysis, DGP-TF/MA conducted a System-Theoretic Process Analysis (STPA). This method examined unsafe control actions in the system of passengers, operators, mobility aids, and aircraft. It was conducted through a series of four working group sessions led by a systems safety specialist from the Secretariat between June and August 2025, with experts from regulatory oversight, occurrence investigation, air operations, ground handling services, and dangerous goods. The STPA process followed four steps:

1) Identifying potential losses (life, aircraft, cargo, mission, reputation);

2) Defining hazards that could lead to those losses;

3) Modelling control structures (passenger → operator → ground staff → aircraft systems); and

4) Identifying unsafe control actions and causal scenarios.

2.2.2 Relevant interactions and scenarios that lead to unsafe actions were identified during the workshop sessions. For example, ground staff accepting a mobility aid with a damaged battery due to poor training or time pressure to load an aircraft. Another scenario involved passengers providing incomplete or misleading information at the time of booking, leading to passenger check-in staff relying on faulty information. Stowage practices were also flagged: overtightened straps or poor placement that could damage batteries, while reliance on halon suppression was seen as inadequate if a large battery failed in the cargo compartment. The STPA's findings included:

a) Acceptance personnel often lack the ability to determine the actual safety condition of a mobility aid. Information provided by passengers is frequently incomplete, late, or misleading.

b) Inspection and acceptance protocols are inadequate. They rely heavily on passenger declarations and visual checks, which are not sufficient in most cases to detect damaged or substituted batteries.

c) Stowage practices can introduce additional risks. Incorrect handling or securement may damage the energy source or allow carriage of mobility aids with damaged batteries.

d) Battery energy and fire suppression capabilities are not always aligned. Larger batteries may exceed aircraft fire suppression systems or cabin crew response capacity.

2.2.3 DGP previously reviewed research indicating Watt-hour (Wh) rating and state of charge both influence the likelihood and severity of thermal runaway in lithium-ion batteries (see Report: Summary of FAA Studies Related to the Hazards Produced by Lithium Cells in Thermal Runaway in Aircraft Cargo Compartments (www.fire.tc.faa.gov/pdf/TC-16-37.pdf), DGP-WG/22-IP/9, DGP/28-IP/9):

a) Higher Wh rating means more stored energy. If thermal runaway occurs, the energy released is greater, leading to more intense heat, gas generation, and potential fire or explosion.

b) Higher SoC increases the likelihood and severity of thermal runaway. Fully charged cells have more reactive material, which accelerates exothermic reactions and lowers the onset temperature for runaway events.

2.2.4 Together, the BowTie and STPA provided a structured view of the main hazards, barriers and operational challenges associated with the carriage of passenger owned lithium ion battery powered mobility aids. The findings were organized into a Policy Options Paper, which set out a range of possible measures for consideration. Drawing on this work, the Task Force prepared a draft package of amendments to the Technical Instructions (DGP-30-IP/3). These amendments, described in paragraph 3, translate the analytical results into specific provisions for passengers, operators and States. The Task Force consider the proposed actions 'first steps' to address the concerns raised and further work is needed aimed at implementing comprehensive measures to address the risks involved.

3. TASK FORCE'S PROPOSAL

3.1 Based on the outcomes of the safety risk assessment and the policy options paper, the Task Force developed proposed amendments to Parts 7 and 8 of the Technical Instructions as presented in the appendix to this working paper. They are intended to improve safety and predictability in the carriage of battery-powered mobility aids.

3.2 Part 7 – Operator responsibilities

3.2.1 **Operator approval (7;5.1).** The BowTie analysis showed that lithium ion batteries may exceed aircraft fire suppression capability, and the STPA found that acceptance staff cannot always determine the safety condition of a device. The proposed amendment would require operator approvals to be based on criteria and procedures supported by a safety risk assessment within the safety management system.

3.2.2 **Information to passengers (7;5.2)**. The STPA highlighted late or incomplete information as one factor leading to an operator accepting a potentially damaged or unsafe mobility aid. The proposed amendment would require operators to publish their conditions of carriage, with a recommendation that this information be made available prior to the boarding-pass issuance process, for example on their websites or other sources.

3.3 Part 8 – General framework for passengers and crew

3.3.1 **Proof of approval (8;1.1.1).** STPA causal scenarios showed unsafe outcomes when devices were accepted without full attention and examination by the operator. The proposed amendment therefore clarifies that carriage is only permitted once approval has been granted.

3.3.2 **Cross-references (8;1.1.2).** The BowTie and the STPA identified that an absence of specific acceptance and loading practices by the operator can lead to the loading of damaged batteries or damage to mobility aids during the loading process. The proposed amendment clarifies that operator approval, loading, staff information, and reporting requirements in Part 7 remain applicable.

3.4 **Part 8, Table 8-1 – Entry Mobility aids**

3.4.1 **Advance arrangements (paragraph b).** The STPA showed that lack of advance notice can lead to rushed acceptance. The proposed amendment would convert an existing recommended practice in the Technical Instructions for passengers to make advance arrangements with each operator and to provide details of the aid, the battery type, and handling instructions to a requirement. This aligns with existing frameworks such as existing EU Regulation 1107/2006, as the reference to "operator's conditions of carriage" naturally incorporates those obligations.

3.4.2 **Installed batteries above 300 Wh (paragraph e).** The BowTie showed that halon fire suppression systems are ineffective against a lithium ion battery in thermal runaway. Higher battery energy can result in prolonged fires and increased accumulation of gas that exceed what can be managed by suppression systems in either the cabin or the cargo compartment. The STPA confirmed that when mobility aids are carried without any controls, damaged or otherwise unsafe battery powered mobility aids can be loaded onto aircraft. To address this, the Task Force examined different ways of conditioning the carriage of larger batteries. Members agreed that 300 Wh is an appropriate threshold to consider additional controls as a first step. The task force recognized that while a thermal runaway event involving a 300Wh lithium ion battery presents a significant hazard, this is the limit applied to a single removed battery for carriage in the cabin. This presents a straightforward limit on the size of an installed mobility aid battery that can be applied in the Technical Instructions and implemented by operators. However, the Task Force did not reach consensus on how batteries above 300 Wh should be treated. Two possible formulations are therefore presented for the Panel's decision.

a) **Option 1** introduces a condition based on state-of-charge (SoC). Installed batteries above 300 Wh may be accepted provided the indicated SoC does not exceed 25%, unless the operator granting approval agrees to a higher charge or the device has no indicator (some mobility aids do not feature a charge indicator). This would be based on robust safety risk assessment and mitigations deemed necessary by the operator and in the case of a device without a charge indicator, a presumption that the batteries are at or near full charge. This approach introduces a practical control on available energy and provides a pathway for devices with higher-capacity batteries to continue travelling under defined conditions.

b) **Option 2** sets a clear threshold for installed energy. Only batteries up to 300 Wh, or two up to 160 Wh each, may remain installed in the mobility aid. This approach emphasizes predictability and ease of application at acceptance but removes the possibility of carriage of mobility aids with installed batteries exceeding 300 Wh. Clear limits would be easier to communicate to passengers and apply to interline operations but would not provide flexibility to operators that could accept more powerful devices based on a robust safety risk assessment and resultant procedures. Evidence presented by one operator, with a database of 3000 mobility devices, indicates that introducing a hard 300Wh limit would affect less than 3% of mobility devices; the number of affected passengers will be much less than 3% of those who require a mobility aid.

3.4.3 The panel is invited to consider these two formulations, noting that Option 1 provides a conditional pathway for higher-capacity devices, while Option 2 establishes a defined limit on installed battery energy.

4. ACTION BY THE DGP

4.1 The DGP is invited to:

a) note the work undertaken by DGP-TF/MA during the 2024–2025 biennium, including the BowTie analysis (IP/1), the STPA (IP/2) and the policy options paper (IP/3);

b) endorse the proposed amendments to Parts 7 and 8 of the Technical Instructions provided in the appendix to this working paper;

c) agree that further work in the next biennium should include:

1) development of guidance material on the approval for carriage of passenger battery powered mobility aids; and

2) consideration of additional safety mitigations such as requiring battery powered mobility aids to have certain design features (charge indicators, battery management systems, circuit breakers, etc), SoC requirements on removed batteries carried in the passenger cabin and the Wh-limit of installed batteries.

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附录

技术细则第7部分和第8部分的拟议修订

第7部分

运营人的责任

第5章

有关旅客和机组的规定

5.1 需经运营人批准方能允许的危险物品

5.1.1 运营人必须制定标准及相关操作程序，用于批准旅客或机组人员安全携带技术细则第8部分确定为仅能经运营人批准方可携带的危险物品。该标准及相关操作程序必须合理肯定地确保，在火势涉及危险物品的情况下能够发现起火，并能够加以充分抑制或控制直到飞机安全着陆。该程序的充分性必须通过根据安全管理体系开展的安全风险评估予以验证。

注：作为交运行李在飞机上运载的危险物品，必须接受《国际民用航空公约》附件6第 I 部分第15章就货舱中运输物品规定的具体安全风险评估。

5.~~1~~ 2 向旅客通报的信息

5.2.1 运营人必须在运营人运载条件中确立，当旅客根据表8-1要求就运输危险物品寻求批准时须满足的要求。

~~5.1.1~~ 5.2.2 运营人必须告知旅客关于禁止航空器运输的危险物品。其操作手册和/或其他适当手册必须对通知系统予以描述。如果一名旅客可以在无需他人参与的情况下完成购票和/或登机牌的发放，通知系统必须包含一项该旅客对已经收到该信息的确认。必须按照下列向旅客提供信息：

a) 在购票点，或如果不可行，在发放登机牌之前以另一种方式向旅客提供；和

b) 发放登机牌时，或在不发放登机牌时在登机前。

注：按照运营人手册中描述，可以以文字或图片形式通过电子或口头方式提供信息。

~~5.1.2~~ 5.2.3 运营人或运营人的服务代理人以及机场运营人必须保证有效地传达给旅客哪些类型的危险物品是禁止空运的信息。必须在机场每一售票处、发放登机牌处、旅客卸下行李处、登机区以及向旅客发放登机牌和/或托运行李被接受的任何其他地方提供这些信息。此类信息必须包括禁止用航空器运输的危险物品的直观示例。

~~5.1.3~~ 5.2.4 在发放登机牌手续前，客机运营人应该在其网站或其他信息来源提供关于旅客按照 8;1.1.2 可以携带的危险物品以及根据表 8-1 要求寻求运营人运载批准的流程~~的~~等信息。

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第8部分

有关旅客和机组成员的规定

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第1章

旅客和机组成员携带危险物品的规定

本章部分内容受国家差异条款BR 10、MO 3、US 15、VE 9、VE 10的影响，见表A-1

1.1 旅客和机组成员携带的危险物品

1.1.1 旅客和机组成员禁止携带危险物品，不论该危险物品是作为随身行李还是放在随身行李中，也不论是作为交运行李还是放在交运行李中，或者随身携带，除非该危险物品：

a) 根据表8-1允许携带；~~和~~

b) 仅供个人使用~~。~~；和

c) 在需经运营人批准的情况下，已给予该项批准。

注：运营人进行评估并给予批准的进程，应基于与飞行安全相关的考虑因素。

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1.1.2 除7；5.1规定的所需运营人批准给予标准、7；2.13规定的装载要求、7；4.2规定的向雇员通报的信息，以及7;4.4和7;4.5的报告规定外，本细则的规定不适用于表8-1中允许的符合以下情况的危险物品：

a) 由旅客或机组成员携带，仅供个人使用；

b) 放在转运过程中已与物主分离的行李（如丢失行李或错运行李等处理不当的行李）中；或

c) 放在1;1.1.5.1 h)允许作为货物运输的超重行李中。

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表8-1. 关于旅客和机组成员携带的危险物品的规定

危险物品	位置		需经运营人批准	限制
	交运行李	随身行李		
……				
4) 由以下电池驱动的代步工具（如轮椅）： — 非防漏型电池； — 防漏型湿电池； — 干电池； — 镍金属氢化物电池；或 — 锂离子电池	是	（见e)）	是	a) 供由于身患残疾、健康或年龄问题或暂时性的行动困难（如腿断了）而行动不便的旅客使用； b) 旅客应当必须根据运营人运载条件提前与每一运营人做好安排，并提供代步工具的信息、所安装的（一个或多个）电池的型号信息和代步工具的操作信息（包括如何使电池绝缘的指示）； c) 如果是干电池或镍金属氢化物电池，每个电池必须分别符合特殊规定A123或A199。 d) 如果是防漏型湿电池： i) 每一电池必须符合特殊规定A67；和 ii) 每位旅客最多可以携带一个备用电池。 e) 如果是锂离子电池： i) 每一电池类型必须符合联合国《试验和标准手册》第III部分第38.3小节规定的每项试验的要求；
				选项1:
				ii) 代步工具安装的（一个或多个）电池额定功率合计超过300 瓦时，其指示电池充电量则不得超过25%，除非： 1) 更高电池充电量；或 2) 没有指示电池充电量的代步工具。 得到运营人根据其已给予旅客的批准许可予以接受。
				选项2:
				ii) 最多可安装一个不超过300瓦时的电池，或者两个各不超过160瓦时的电池。 iii) 当代步工具未对电池提供充分保护时： — 必须遵循制造商的指示将电池卸下； — 电池不得超过300 Wh；

危险物品	位置		需经运营人批准	限制
	交运行李	随身行李		
				— 必须保护电池两极以防止短路（使电极绝缘，例如在暴露的电极上贴胶带）； — 必须保护电池免受损坏（例如将每个电池放入一个保护袋中）；和 — 电池必须在客舱中携带； iiiv) 最多可携带一个不超过300Wh的备用电池，或两个各不超过160Wh的备用电池。备用电池必须在客舱中携带。 ~~注：当锂电池（一个或多个）仍安装在代步工具内时，无瓦时限制。~~

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