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DANGEROUS GOODS PANEL (DGP)

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Agenda Item 4: Managing safety risks posed by the carriage of energy storage devices by air *(Ref: Job Card DGP.003.05)*

REPORT OF THE ICAO DGP TASK FORCE ON MOBILITY AIDS

(Presented by Rapporteur of the DGP Task Force on Mobility Aids)

SUMMARY

This working paper provides an overview of the work conducted by the DGP Task Force on Mobility Aids (DGP-TF/MA). The task force conducted a safety risk assessment which led to a consolidated set of proposed amendments to Parts 7 and 8 of the ICAO Technical Instructions.

Action by the DGP: The DGP is invited to:

a) note the work undertaken by DGP-TF/MA during the 2024–2025 biennium;

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

c) agree that further work in the next biennium should be undertaken, including:

1) development of guidance material on approving the carriage of battery-powered powered mobility aids by passengers; and

2) consideration of additional safety mitigations.

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 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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APPENDIX

PROPOSED AMENDMENTS TO PARTS 7 AND 8 OF THE TECHNICAL INSTRUCTIONS

Part 7

OPERATOR'S RESPONSIBILITIES

Chapter 5

PROVISIONS CONCERNING PASSENGERS AND CREW

5.1 DANGEROUS GOODS PERMITTED WITH THE APPROVAL OF THE OPERATOR

5.1.1 The operator must establish criteria and associated operating procedures for approving a passenger or crew member to safely carry dangerous goods that are identified by Part 8 of the Technical Instructions as only being permitted with the approval of the operator. The criteria and associated operating procedures must ensure, to a reasonable certainty, that in the event of a fire involving the dangerous goods, it can be detected and sufficiently suppressed or contained until the aeroplane makes a safe landing. The adequacy of the procedures must be demonstrated through a safety risk assessment conducted in accordance with the safety management system.

Note.— Dangerous goods carried on an aeroplane as checked baggage are subject to the specific safety risk assessment on the transport of items in the cargo compartment required by Annex 6, Part I, Chapter 15.

5.~~1~~2 INFORMATION TO PASSENGERS

5.2.1 The operator must establish the requirements for passengers seeking approval for the transport of dangerous goods when so required by Table 8-1 within the operator's conditions of carriage.

~~5.1.1~~5.2.2 Operators must inform passengers about dangerous goods that passengers are forbidden to transport aboard an aircraft. The notification system must be described in their operations manual and/or other appropriate manuals. If the ticket purchase and/or boarding pass issuance can be completed by a passenger without the involvement of another person, the notification system must include an acknowledgement by the passenger of having been presented with the information. The information must be provided to passengers:

a) at the point of ticket purchase or, if this is not practical, made available in another manner to passengers prior to boarding pass issuance; and

b) at boarding pass issuance, or when no boarding pass is issued, prior to boarding the aircraft.

Note.— The information may be provided in text or pictorial form, electronically, or verbally, as described in the operator's manuals.

~~5.1.2~~5.2.3 An operator or the operator's handling agent and the airport operator must ensure that information on the types of dangerous goods which passengers are forbidden to transport aboard an aircraft is communicated effectively to them. This information must be presented at each of the places at an airport where tickets are issued, boarding passes are issued, passenger baggage is dropped off and aircraft boarding areas are maintained, and at any other location where passengers are issued boarding passes and/or checked baggage is accepted. This information must include visual examples of dangerous goods forbidden from transport aboard an aircraft.

~~5.1.3~~5.2.4 An operator, of passenger aircraft, should have information on those dangerous goods which may be carried by passengers in accordance with 8;1.1.2 and on the process for seeking the operator's approval for carriage when so required

by Table 8-1 made available prior to the boarding pass issuance process on their websites or other sources of information.

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Part 8

PROVISIONS CONCERNING PASSENGERS AND CREW

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Chapter 1

PROVISIONS FOR DANGEROUS GOODS CARRIED BY PASSENGERS AND CREW

Parts of this Chapter are affected by State Variations BR 10, MO 3, US 15, VE 9, VE 10; see Table A-1

1.1 DANGEROUS GOODS CARRIED BY PASSENGERS AND CREW

1.1.1 Passengers and crew are forbidden to carry dangerous goods either as or in carry-on baggage, checked baggage or on their person unless the dangerous goods are:

a) permitted in accordance with Table 8-1; ~~and~~

b) for personal use only~~.~~; and

c) where the approval of the operator is required, that approval has been granted.

Note.— The process for assessing and granting the approval of the operator is to be based upon considerations related to flight safety.

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1.1.2 Except for the criteria for granting operator approval required by 7;5.1; the loading requirements of 7;2.13; information to be provided to employees required by 7;4.2; and reporting provisions of 7;4.4 and 7;4.5, the provisions of these Instructions do not apply to the dangerous goods permitted by Table 8-1 when those dangerous goods are:

a) carried by passengers or crew for personal use only;

b) contained in baggage that has been separated from its owner during transit (for example, mishandled baggage such as lost baggage or improperly routed baggage); or

c) contained within items of excess baggage sent as cargo as permitted by 1;1.1.5.1 h).

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Table 8-1. Provisions for dangerous goods carried by passengers and crew

Dangerous Goods	*Location*		*Approval of the operator(s) is required*	*Restrictions*
	Checked baggage	*Carry-on baggage*		
. . .				
4) Mobility aids (e.g. wheelchairs) powered by: – spillable batteries; – non-spillable wet batteries; – dry batteries; – nickel-metal hydride batteries; or – lithium ion batteries	Yes	(see e))	Yes	a) for use by passengers whose mobility is restricted by either a disability, their health or age, or a temporary mobility problem (e.g. broken leg); b) the passenger ~~should~~ must make advance arrangements with each operator and provide information on the mobility aid, the type of battery(ies) installed and on the handling of the mobility aid (including instructions on how to isolate the battery) in accordance with the operator's conditions of carriage; c) in the case of a dry battery or nickel-metal hydride battery, each battery must comply with Special Provision A123 or A199, respectively; d) in the case of a non-spillable wet battery: i) each battery must comply with Special Provision A67; and ii) a maximum of one spare battery may be carried per passenger; e) in the case of a lithium ion battery: i) each battery must be of a type which meets the requirements of each test in the *UN Manual of Tests and Criteria*, Part III, subsection 38.3; Option 1: ii) a mobility aid with installed battery(ies) with a total power rating exceeding 300 Wh must have an indicated battery charge not exceeding 25%, unless: 1) a higher battery charge; or 2) a mobility aid that does not have an indicated battery charge~~.~~ is accepted by the operator in accordance with the approval it granted to the passenger. Option 2: ii) a maximum of one battery not exceeding 300 Wh or two batteries not exceeding 160 Wh each may be installed. iii) when the mobility aid does not provide adequate protection to the battery: — the battery must be removed in accordance with the manufacturer's instructions; — the battery must not exceed 300 Wh; — the battery terminals must be protected from short circuit (by insulating the terminals, e.g. by taping over exposed terminals); — the battery must be protected from damage (e.g. by placing each battery in a protective pouch); and

Dangerous Goods	*Location*		*Approval of the operator(s) is required*	*Restrictions*
	Checked baggage	*Carry-on baggage*		
				— the battery must be carried in the cabin; iii) a maximum of one spare battery not exceeding 300 Wh or two spare batteries not exceeding 160 Wh each may be carried. Spare batteries must be carried in the cabin. ~~*Note.— When the lithium battery(ies) remain installed in the mobility aid, there is no Watt-hour limit.*~~

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