DANGEROUS GOODS PANEL (DGP)

TWENTY-SEVENTH MEETING

Montréal, 16 to 20 September 2019

Agenda Item 2: Managing air-specific safety risks and identifying anomalies

2.3: Develop proposals, if necessary, for amendments to the *Supplement to the Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284SU) for incorporation in the 2021-2022 Edition

Agenda Item 3: Managing safety risks posed by the carriage of lithium batteries by air

3.3: Consider the need for amendments to address impact from proposed amendment to Annex 6, Volume I on cargo compartment safety *(Ref: Job Cards DGP.003.02* and *FLTOPSP.043)*

3.4 Consider measures to mitigate safety risks posed by lithium batteries carried and/or used by passengers, crew and the operator (*Ref: Job Card DGP.003.02*)

3.5: Consider the need for specific measures to mitigate safety risks posed by lithium batteries packed with or contained in equipment

AMENDMENT TO THE GUIDANCE TO STATES ON THE TRANSPORT OF LITHIUM BATTERIES AS CARGO CONTAINED IN THE SUPPLEMENT TO THE TECHNICAL INSTRUCTIONS

(Presented by the Secretary)

SUMMARY

Amendments to the guidance material for States on the transport of lithium batteries contained in Part S-1;4 of the Supplement to the Technical Instructions are included in this information paper as a basis for discussion of Agenda Items 3.3, 3.4 and 3.5. The amendments align the guidance in the Supplement with safety risk assessment provisions contained in Amendment 44 to Annex 6 and highlight the hazards associated with electronic devices powered by lithium batteries in checked baggage, recalled batteries/devices and undeclared lithium batteries.

The DGP is invited to consider including the amendments shown in Appendix A to this information paper in Part S-1;4 of the Supplement.

1. INTRODUCTION

1.1 An amendment to the guidance material for States on the transport of lithium batteries contained in Part S-1;4 of the Supplement to the Technical Instructions is included in Appendix A to this information paper for the sake of alignment with new risk assessment provisions in Annex 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport — Aeroplanes* and to highlight risks associated with portable electronic devices in checked baggage, recalled batteries or devices, and undeclared lithium batteries. The amendment includes information previously provided to States through electronic bulletins (EB) 2016/16, 2016/57, 2017/23, 2017/37, and State letter M 16/1 – 18/2.

2. ALIGNMENT OF GUIDANCE MATERIAL WITH NEW RISK ASSESSMENT PROVISIONS IN ANNEX 6

2.1 The Flight Operations Panel (FLTOPSP) Cargo Safety Sub Group (FLTOPSCS-SG) was tasked with introducing requirements for operators to conduct safety risk assessments on the carriage of all cargo on board aircraft in Annex 6, Part I and to develop supporting guidance material (see paragraph 3.8.1.1 of the DGP-WG/18 Report). Accordingly, provisions were developed for inclusion as a new Chapter 15 in Annex 6, Part I on cargo compartment safety (see Appendix B to this information paper). The provisions were subject to a final review by the Air Navigation Commission (ANC) following consultation with States and will be recommended for adoption by the Council with an applicability date of 5 November 2020. Guidance material to support implementation of these provisions will be published in a new *Cargo Compartment Operational Safety Manual* [working title] (Doc 10102). Since the need for the amendment was prompted by discussions on lithium batteries, the guidance material contains information on the hazards they pose and they are used in an example of a risk model to assist with the identification and management of risk. An update to the existing guidance to States on the transport of lithium batteries as cargo contained in Part S-1, Chapter 4 to the Supplement for the sake of alignment with these new Annex 6 risk assessment provisions is included in Appendix A to this information paper.

3. RISKS ASSOCIATED WITH PORTABLE ELECTRONIC DEVICES IN CHECKED BAGGAGE

3.1 The DGP was tasked with addressing the risks associated with the carriage of portable electronic devices containing lithium batteries through ANC job card DGP.006.01 entitled “Lithium batteries carried and/or used by passengers, crew and the operator”. The need for a greater level of awareness of the hazards and measures to address the risk was identified at DGP-WG/18 (see paragraph 3.3.4.1 of the report). Accordingly, the amendment to Part S-1, Chapter 4 provided in Appendix A to this information paper includes new provisions related to lithium batteries carried by passengers and crew. It provides a general overview of potential risks, including the potential for an explosion if there is a thermal runaway event involving a lithium battery packed in the same checked baggage as certain items containing permitted dangerous goods (e.g. aerosol cans).

Note. — The need for guidance on responding to a thermal runaway event involving electronic flight bags in the cockpit was discussed at DGP-WG/18 (see paragraph 3.3.4.2 of the DGP-WG/18 Report). While including guidance in the Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods *(Doc 9481) was considered an appropriate place, the importance of having it in a document that was visible to the appropriate personnel of all operators was recognized, as was the need for input from operations and airworthiness experts to address the complexities of emergency response in the cockpit. Accordingly, a new job card superseding DGP.006.01 has been assigned to the Flight*

Operations Panel (FLTOPSP) Safe Carriage of Goods Specific Working Group (SCG-SWG), with DGP as a supporting expert group, with the intent of addressing the issue holistically.

4. RECALLED BATTERIES OR DEVICES

4.1 Discussions involving recent recalls by manufacturers of portable electronic devices have suggested a need for guidance. Accordingly, new provisions on recalled batteries or devices are included in the amendments to S-1;4 of the Supplement shown in Appendix A to this information paper.

5. UNDECLARED LITHIUM BATTERIES

5.1 Risks posed by the introduction of undeclared dangerous goods into the air transport stream have been the subject of discussion for many years, particularly with respect to lithium batteries. Work on the issue will be on-going through a job card assigned to the FLTOPSP SCG-SWG with DGP as a supporting expert group. In the meantime, it is proposed that general text be added to the guidance in Part S-1;4 of the Supplement, at the very least to alert States to the need to take the risk into account as part of their safety management responsibilities.

6. CONCLUSION

6.1 The DGP is invited to consider including the amendments in Appendix A to this information paper in Part S-1;4 of the Supplement.

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APPENDIX A

PROPOSED AMENDMENT TO PART S-1;4 OF THE SUPPLEMENT

Part S-1. GENERAL

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Chapter 4

GUIDANCE TO STATES ON THE TRANSPORT OF LITHIUM BATTERIES AS CARGO

4.1 INTRODUCTION

4.1.2 This chapter provides an overview of the hazards associated with the transport of lithium batteries by air and information related to restrictions on their transport. States should ensure that operators are taking this information into account when conducting their specific safety risk assessments for the transport of items in the cargo compartment required by Annex 6 — *Operation of Aircraft*, Part I — *International Commercial Air Transport — Aeroplanes*, Chapter 15 — *Cargo Compartment Safety*.

4.1.3 The requirement for operators to conduct specific safety risk assessments for the transport of items in the cargo compartment and related Standards and Recommended Practices (SARPs) on cargo compartment safety were introduced through Amendment 44 to Annex 6, Part I which became applicable on 5 November 2020. The SARPs were developed in response to concerns raised by airframe manufacturers that a fire involving high-density packages of lithium batteries could exceed the ability of cargo compartment fire protection systems to suppress or extinguish it. This led to the introduction of more restrictive requirements in the Technical Instructions for the transport of lithium batteries as cargo and the identification of a need for SARPs and supporting guidance material on conducting safety risk assessments for cargo compartment safety. Although the impetus for the amendment was the safety concerns related to lithium batteries, the need to consider the risks associated with all items transported in the cargo compartment was identified. The SARPs include a general list of items operators are required to consider as part of their safety risk assessment, i.e. the hazards associated with the properties of the items to be transported, capabilities of the operator, operational considerations, capabilities of the aeroplane and its systems, containment characteristics of unit load devices, packing and packaging, safety of the supply chain for items to be transported, and quantity and distribution of dangerous goods items to be transported. The list of items is intended as a minimum requirement; items may need to be further specified and the list may need to be expanded depending on the operator's unique operations.

Note 1.— Guidance to support the implementation of the SARPs contained in Annex 6, Part I, Chapter 15 is provided in the Cargo Compartment Operational Safety Manual [working title] *(Doc 10102), including guidance on conducting a specific safety risk assessment in accordance with the* Safety Management Manual *(SMM) (Doc 9859).*

Note 2.— Annex 19 — Safety Management *contains SARPs intended to assist States in managing aviation safety risks. Supporting guidance is provided in the* Safety Management Manual *(SMM) (Doc 9859).*

Editorial Note.— The replacement of current S-1;4.1.1 (below) is proposed for the sake of alignment with the description of lithium battery hazards in the *Cargo Compartment Operational Safety Manual* [working title] (Doc 10102).

4.2 LITHIUM BATTERY HAZARDS

~~4.1.1 Lithium cells have the potential to create thermal runaway, a chain reaction which leads to repeated self heating and the release of a battery's stored energy. Once one cell experiences thermal runaway, it can generate enough heat to trigger thermal runaway in adjacent cells. Thermal runaway can occur for a number of reasons, including poor cell design, cell manufacturing flaws and external abuse.~~Lithium batteries pose a unique hazard to transport because they are capable of providing both fuel for a fire and an ignition source. They differ from other conventional batteries in that the cells are constructed with a flammable electrolyte which can be forcibly released when a cell is in a state of thermal runaway. Thermal runaway is a chemical reaction within the cell that results in a dramatic and uncontrolled rise in both temperature and pressure. This results in the battery expelling its contents, including the flammable electrolyte and flammable gas, which may then be ignited by the associated heat or burning surroundings of the battery. A cell in thermal runaway produces

enough heat to cause adjacent cells to enter thermal runaway, a process known as thermal runaway propagation. Typical fibreboard packaging does not prevent the propagation of thermal runaway to other packages. Another unique and significant hazard that may result from a lithium battery thermal runaway event is the expulsion of large quantities of flammable gas. The flammable gas has the potential to collect and ignite, resulting in a significant overpressure event.

Note.— Information related to the hazards produced by lithium cells in thermal runaway in aircraft cargo compartments has been derived from research at the United States Federal Aviation Administration (FAA) William J. Hughes Technical Center Aviation Research Division. A compilation of test data and results of this research is provided in a report available at http://www.fire.tc.faa.gov/pdf/TC-16-37.pdf.

4.2~~3~~ LITHIUM METAL AND LITHIUM ION BATTERIES TRANSPORTED AS CARGO

4.~~1.2~~3.1 A prohibition on the transport of UN 3090 — **Lithium metal batteries** as cargo on passenger aircraft was introduced into the 2015-2016 Edition of the Technical Instructions with the knowledge that aircraft cargo fire protection systems could not control a lithium metal fire. ~~More recent~~ Later test results demonstrated that a fire involving high-density packages of UN 3480 — **Lithium ion batteries** may exceed the capability of aircraft cargo fire protection systems. High-density packages of lithium ion batteries may consist of any number of batteries or cells having the potential to overwhelm cargo compartment fire protection features. The potential is dependent on a number of variables including the battery or cell chemistry, size, design type, quantities and the cargo compartment configuration. The inability to determine an absolute safe quantity limit for lithium ion batteries and the absence of a packaging standard to mitigate the risks ~~has~~ led to the decision to introduce a prohibition on the transport of UN 3480 — **Lithium ion batteries** as cargo on passenger aircraft.

4.1.3 ~~-~~Development of a performance-based ~~packaging~~ package standard ~~for lithium ion batteries~~ and a risk-based hazard classification system for lithium batteries is currently under way. It is anticipated that these elements, coupled with additional controls ~~once this standard is completed and any additional controls~~ established by the operator through its safety risk assessment process, will allow for the removal of certain restrictions on the transport of lithium batteries. ~~necessary to mitigate risks are established, an amendment to the Technical Instructions will be made to allow for their transport as cargo on passenger aircraft.~~

4.3.2 The transport of UN 3090 — **Lithium metal batteries** and UN 3480 — **Lithium ion batteries** is permitted as cargo on cargo aircraft. While the specific requirements for transporting lithium batteries contained in the Technical Instructions provide significant improvements to safety, they do not eliminate all risks and should be coupled with other mitigation strategies as part of a layered approach to safety. States should ensure cargo operators perform safety risk assessments to establish whether they can manage the risks posed. The transport of UN 3090 — **Lithium metal batteries** and UN 3480 — **Lithium ion batteries** may be transported on passenger aircraft under certain conditions through an approval or an exemption in accordance with Special Provision A201 of the Technical Instructions.

4.3.3 ~~4.1.4~~ At a minimum, the following criteria should be identified as part of a safety risk assessment involving lithium batteries ~~when considering whether or not to grant an approval or an exemption to transport UN 3480 — **Lithium ion batteries** or UN 3090 — **Lithium metal batteries** as cargo on passenger aircraft under Special Provision A201~~:

Editorial Note.— The following list has been reordered to align with the order of the risk assessment provisions in new Chapter 15 to Annex 6, Part I. Amendments to the text have also been made for the sake of alignment with the Annex 6 provisions.

a) specific hazards and safety risks associated with each battery and cell type to be carried alone or in combination; ~~and~~

~~g~~b) chemical composition of the batteries and cells~~.~~;

~~a~~c) capabilities of the operator;

d) operational considerations (e.g. area of operations, diversion time);

~~b~~e) ~~overall capability~~capabilities of the ~~aircraft~~ aeroplane and its systems (e.g. cargo compartment fire suppression capabilities);

~~e~~f) containment characteristics of unit load devices;

~~c~~g) packing and packaging;

h) safety of the supply chain for lithium batteries or cells to be transported; and

~~d~~i) quantity and distribution of batteries and cells to be transported.~~;~~

~~e) containment characteristics of unit load devices;~~

~~f) specific hazards and safety risks associated with each battery and cell type to be carried alone or in combination; and~~

~~g) chemical composition of the batteries and cells.~~

4.3 LITHIUM METAL AND LITHIUM ION BATTERIES PACKED WITH OR CONTAINED IN EQUIPMENT TRANSPORTED AS CARGO

UN 3091 — **Lithium metal batteries contained in equipment,** UN 3091 — **Lithium metal batteries packed with equipment** ,UN 3481 — **Lithium ion batteries contained in equipment** and UN 3481 — **Lithium ion batteries packed with equipment** pose less of a risk than batteries on their own because of the level of protection which may be provided by the equipment. They are therefore permitted for transport as cargo on both passenger and cargo aircraft in accordance with the Technical Instructions. Although a lesser risk, there are still hazards associated with the transport of lithium batteries contained in or packed with equipment, including non-compliant shipments (see paragraph 4.6) and damaged or defective batteries (see paragraph 4.7), States should ensure the hazards associated with lithium batteries packed with or contained in equipment are addressed as part of their safety risk assessments.

4.4 LITHIUM BATTERIES CARRIED BY PASSENGERS AND CREW

Lithium batteries, including portable electronic devices, are permitted for carriage by passengers and crew provided all applicable criteria listed in Part 8 of the Technical Instructions are met. Spare lithium batteries, power banks, battery-powered portable electronic smoking devices, and some other devices, in certain conditions, are forbidden in checked baggage. The Technical Instructions do not forbid the carriage of most other portable electronic devices in checked baggage, but it is recommend that they be carried in the cabin where an incident may be more readily mitigated. The risk of an event involving portable electronic devices in checked baggage was not considered high when developing the provisions for passengers to carry them, as it was assumed that most passengers would choose to carry them in the cabin. However, data collected since that time suggests there may be a much higher number of batteries and battery-powered devices being carried in checked baggage than assumed. New hazards have also been identified since that time, including the potential for an explosion if there is a thermal runaway event involving a lithium battery packed in the same checked baggage as certain items containing permitted dangerous goods, such as aerosol cans. The ability of cargo compartment fire suppressions to effectively contain such an event, particularly when occurring in a Class D compartment, has been demonstrated to be limited. States should advise operators to take this information into account when conducting safety risk assessments related to the carriage of lithium batteries by passengers and crew and to ensure they have procedures in place aimed at mitigating the risks they pose.

Note 1.— More detailed information can be found through notices issued by the FAA (Information for Operators (InFO) No. 17008 dated 17 July 2017) and the European Aviation Safety Agency (EASA) (Safety Information Bulletin (SIB) No. 2017-04R1 dated 19 December 2017).

Note 2.— Guidance on responding to incidents involving portable electronic devices in the cabin is contained in the Emergency Response Guidance for Aircraft Incidents Involving Dangerous Goods *(Doc 9481) and the* Cabin Crew Safety Training Manual *(Doc 10002)*.

4.4 UNDECLARED AND MISDECLARED CONSIGNMENTS OF LITHIUM BATTERIES

There have been reports of both deliberate and unintentional non-compliance with respect to the transport of lithium batteries by air. Types of non-compliance include: batteries not packed in compliance with the Technical Instructions; batteries not meeting testing requirements; batteries classified as being contained in or packed with equipment when they are, in fact, packed on their own; and undeclared shipments. States should emphasize the importance of interface management to operators as described in the Safety Management Manual *(SMM) (Doc 9859)* and ensure that their safety risk assessments take non-compliance into account. States should also be considering non-compliance as part of their own safety management responsibilities. This may highlight the need for increased surveillance activities based on the assessed risk and, when necessary, effective enforcement measures. States should facilitate the sharing and exchange of information involving non-compliant shipments of lithium batteries, which may involve the establishment of sharing or exchange networks among entities both within and beyond the aviation system, unless their national law provides otherwise, in accordance with Annex 19. They are also encouraged to participate in cooperative efforts with other States concerning violations of dangerous goods regulations as recommended in Annex 18.

Note. 1— Guidance on managing aviation safety risks, including safety assurance, interface management and safety information protection, sharing and exchange, is provided in the Safety Management Manual *(SMM) (Doc 9859).*

Note. 2— Specific guidance on managing aviation safety risks related to the safety of the supply chain, including undeclared and misdeclared consignments of dangerous goods, is provided in the Cargo Compartment Operational Safety Manual [working title] *(Doc 10102)*

4.5 DAMAGED OR DEFECTIVE LITHIUM BATTERIES OR DEVICES POWERED BY LITHIUM BATTERIES

The Technical Instructions forbid the transport of lithium batteries and lithium batteries packed with or contained with equipment as cargo if they are identified as being damaged or defective, including those subject to a safety recall (see Special Provision A154 and paragraph 2 of Packing Instructions 965 through 970 of the Technical Instructions). Passengers should be prevented from carrying such batteries on board aircraft. If they are carried on board the aircraft, passengers should be required to keep the battery or device turned off, to protect it from unintentional activation, to not charge it, and to keep it in carry-on baggage or on the person. States are encouraged to alert operators when they have been made aware of safety recalls and to ensure they have procedures in place aimed at mitigating the risks they pose, including the need to make personnel involved with cargo or passenger processing aware of the restrictions.

Note.— FAA Safety Alert for Operators (SAFO) No. 16011 dated 16 September 2016 and EASA SIB No. 2017-01 dated 9 February 2017 are examples of notices issued by aviation authorities alerting operators of risks associated with recalled lithium batteries. both of which include recommended action.

APPENDIX B

NEW RISK CARGO COMPARTMENT SAFETY PROVISIONS PROPOSED FOR ANNEX 6, PART I

Insert following new chapter:

CHAPTER 15. CARGO COMPARTMENT SAFETY

Note.— Guidance on the hazards associated with the transport of items in the cargo compartment, the conduct of a specific safety risk assessment in accordance with the Safety Management Manual (SMM) *(Doc 9859), and the responsibilities for the transport of dangerous goods, is contained in the* Cargo Compartment Operational Safety Manual [working title] *(Doc 10102).*

15.1 Transport of items in the cargo compartment

15.1.1 The State of the operator shall ensure that the Operator establishes policy and procedures for the transport of items in the cargo compartment which include the conduct of a specific safety risk assessment. The risk assessment shall include at least the:

a) hazards associated with the properties of the items to be transported;

b) capabilities of the operator;

c) operational considerations (e.g. area of operations, diversion time);

d) capabilities of the aeroplane and its systems (e.g. cargo compartment fire suppression capabilities);

e) containment characteristics of unit load devices;

f) packing and packaging;

g) safety of the supply chain for items to be transported; and

h) quantity and distribution of dangerous goods items to be transported.

Note.— Additional operational requirements for the transport of dangerous goods are contained in Chapter 14.

15.2 Fire protection

15.2.1 The elements of the cargo compartment(s) fire protection system as approved by the State of Design or State of Registry, and a summary of the demonstrated cargo compartment fire protection certification standards, shall be provided in the aeroplane flight manual or other documentation supporting the operation of the aeroplane.

Note.— Guidance on the elements of cargo compartment fire protection and associated demonstrated standards are provided in the Cargo Compartment Operational Safety Manual [working title] *(Doc 10102).*

15.2.2 The Operator shall establish policy and procedures that address the items to be transported in the cargo compartment. These shall ensure to a reasonable certainty that in the event of a fire involving those items, it can be detected and sufficiently suppressed or contained by the elements of the aeroplane design associated with cargo compartment fire protection, until the aeroplane makes a safe landing.

Note.— Guidance on policy and procedures that address the items to be transported in the cargo compartment are provided in the Cargo Compartment Operational Safety Manual [working title] *(Doc 10102).*

End of new chapter.

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