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WORKING PAPER

DANGEROUS GOODS PANEL (DGP) WORKING GROUP MEETING (DGP-WG/24)

Montreal, 21 to 25 October 2024

Agenda Item 4: Managing safety risks posed by the carriage of lithium batteries by air (Ref: Job Card DGP.003.05)

IMPLEMENTATION OF THE SAE PERFORMANCE-BASED PACKAGING STANDARD FOR LITHIUM BATTERIES

(Presented by D. Pfund)

SUMMARY

This working paper seeks the views of the panel on the implementation of the SAE performance-based package standard for transporting lithium batteries as cargo on aircraft (SAE AS6413).

Action by the DGP-WG: Action by the DGP-WG is in paragraph 4.

1. INTRODUCTION

1.1 Since April 2016, the carriage of lithium cells and batteries, UN 3090 and UN 3480, has been prohibited on passenger aircraft, and lithium ion cells and batteries have been restricted to a state of charge not exceeding 30 percent of their rated capacity when transported on cargo only aircraft. Transport of lithium ion cells or batteries at higher states of charge is subject to approval from the appropriate national authorities of the State of Origin and the State of the Operator. When considering approvals to authorize transport at higher states of charge, Special Provision A331 in the Supplement to the Technical Instructions identifies the following criteria to mitigate risks posed by a lithium cell or battery heat, smoke, or fire event inside a package at the cell, battery, or package level:

a) no hazardous amount of flame is allowed outside the package;

b) the external surface temperature of the package cannot exceed the amount that would ignite adjacent packing material or cause batteries or cells in adjacent packages to go into thermal runaway;

c) no hazardous fragments can exit the package, and the package must maintain structural integrity; and

d) the quantity of flammable vapour emitted must be less than the amount of gas that when mixed with air and ignited could cause a pressure pulse that could dislodge the

overpressure panels of the aircraft cargo compartment or damage the aircraft cargo compartment liners.

These criteria are aimed at controlling the consequences of a failure within the package and preventing an uncontrolled fire and associated pressure pulses that may compromise existing fire suppression systems within the aircraft cargo compartment. The test method and determination as to whether a package meets these criteria is left to the appropriate national authorities.

1.2 The SAE G-27 committee was established at the request of ICAO to develop a package performance standard for lithium cells and batteries as cargo in air transportation with the expectation that this standard could form one of the controls necessary to establish an acceptable level of safety. The test standard is based on high-level performance standards developed by the ICAO Multidisciplinary Lithium Battery Transport Coordination Meetings (see report of the third meeting (Montréal, 28 to 30 July 2015). Special Provision A331 is based on the same high-level performance standards (see paragraph 5.4.9 of the DGP/25 report). In June 2024, a limited scope standard and a companion report that provides detailed background, rationale and calculations used in the standard was approved through a ballot by the SAE G-27 committee.

2. DISCUSSION

2.1 The DGP previously discussed how the standard, when completed, might be incorporated in the Technical Instructions, knowing that the standard would need to be evaluated by the DGP to determine whether it provided an acceptable level of safety. Now that a test standard has been approved by the SAE G-27 Committee, it is appropriate for the DGP to review the standard and discuss how it might be used to verify that the packaging and its contents have passed the test and is acceptable for transport. Feedback from the DGP regarding its scope and how it might be used by appropriate national authorities can guide the SAE G-27 committee as it continues to improve the standard.

2.2 A standardized testing protocol represents an improvement from the current situation by creating a framework for national authorities to evaluate the performance of a package against the criteria in Special Provision A331. The test described in the standard is intended to force a lithium ion cell into thermal runaway by heating the exterior of a cell. As currently drafted, the standard is limited to demonstrating whether a package of lithium-ion (UN 3480) cylindrical cells of a format of 21700 or smaller as prepared for air transport contains the potential hazardous effects to the aircraft resulting from the failure of a cell within the package.

2.3 Uncertainty and limitations remain with the current standard:

a) The standard includes criteria to evaluate changes to a tested package and whether certain changes require a retest. While these criteria are helpful, such evaluations introduce variability by allowing equivalency to be determined by analogy or other assessments rather than a test. The appropriate national authority approving the use of the package should determine the acceptability of such assessments.

b) A 10% safety margin added to the state of charge at which the cells are to be shipped is included to account for variations in determining the state of charge. The effectiveness of a 10% safety margin remains unverified and does not account for the potential of a relatively short transition from a non-energetic effect to an energetic effect at certain states of charge.

c) While a heating rate of 5° to 10°C/min is recommended to maintain consistency and repeatability, a broader heating rate of 5° to 20°C/min was agreed in the standard. Such a wide range in the heating rate introduces the potential for inconsistent results.

d) The reproducibility of results from one laboratory to another remains to be determined, and no conservative safety margin has been introduced into the standard to compensate for this uncertainty.

e) The narrow scope of the standard limits the direct application within the Technical Instructions to specific consignments.

f) The goal of the test is to force a cell into thermal runaway using thermal energy applied to the exterior of a cell. However, the standard lacks clarity on how to evaluate the acceptability of test results for cells that are not forced into thermal runaway when subjected to the test. While a cell might not be forced into thermal runaway through external heating, a cell may experience an energetic failure through another means such as overcharge or mechanical damage.

3. RECOMMENDATION

3.1 While the standard as written is not suitable for broad application it represents an improvement from the current situation by providing a test protocol for appropriate national authorities to evaluate a package against the criteria in Special Provision A331. Referencing the standard in the Supplement to the Technical Instructions would provide guidance to assess the package's ability to meet the criteria in Special Provision A331. External marks or approval documentation showing the quantity limitations and packaging requirements would provide the operator the ability to verify compliance. Further, including the standard as guidance for an approval consideration would enhance safety in the short term and allow the SAE G-27 committee time to continue developing enhancements to the standard to improve its usefulness including: a generic package, a battery test, external fire test, tests methods for pouch and prismatic cell formats, an oversize package, and a reduced cell configuration.

4. ACTION BY THE DGP-WG

4.1 The DGP-WG is invited to provide feedback to the SAE G-27 Committee on how this standard might be used by appropriate national authorities and suggest potential additions to the standard to improve its useability.

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