



WORKING PAPER

**DANGEROUS GOODS PANEL (DGP)
WORKING GROUP MEETING (DGP-WG/23)**

Rio de Janeiro, Brazil, 15 to 19 May 2023

- Agenda Item 2: Managing air-specific safety risks and identifying anomalies (REC-A-DGS-2025)**
2.2: Develop proposals, if necessary, for amendments to the *Technical Instructions for the Safe Transport of Dangerous Goods by Air* (Doc 9284) for incorporation in the 2025-2026 Edition

LITHIUM BATTERY CARRIED BY PASSENGERS OR CREW

(Presented by J. Luro)

SUMMARY

This working paper seeks to provide an opportunity for the DGP-WG to consider inclusion of references and conversion factors to be used in the transport of lithium batteries carried by passengers or crew in their baggage.

Action by the DGP-WG is in paragraph 2.

1. INTRODUCTION

1.1 Part 7;6 of the Technical Instructions provides that, in order to prevent passengers from taking on board dangerous goods not permitted in baggage, the operator must provide information to reservation and sales staff and passenger reception staff, and this information must be immediately available for their use.

1.2 Part 8;1, specifies which dangerous goods are prohibited for carriage as baggage and Table 8-1 lists which are permitted, including lithium cells and batteries and portable electronic devices (PEDs) powered by lithium cells and batteries.

1.3 The units of measurement used in Table 8-1 and related to lithium cells/batteries and PEDs powered by them are grams (g) for lithium metal cells/batteries and watt-hours (Wh) for lithium ion cells/batteries. Generally, batteries and PEDs carried by passengers do not usually indicate the nominal capacity of the battery in these units of measurement, but the capacity is usually expressed in Volts (V) and in some cases also in Amperes (Ah) or milliamps (mAh). This means that the passenger reception staff should calculate from this data whether these items can be transported as baggage, whether they can

be carried in checked baggage or must be carried as carry-on baggage and whether they can be switched on or switched off.

1.4 The Technical Instructions Part 1;3.2 provides the units of measurement and conversion factors. It specifies that the units of measurement to be used in the carriage of dangerous goods by air are those prescribed by the International System (SI), as amended for international civil aviation in Annex 5 — *Units of Measurement to be Used in Air and Ground Operations* to the Chicago Convention.

1.5 Exact conversion factors for the SI units commonly used in the transport of dangerous goods are given in Part 1;3.2.3. However, no formulas or calculations are given for determining, for example, the rated energy in watt-hours from the rated voltage and rated capacity.

1.6 Part 2;9.3 of the Technical Instructions indicates some of the general conditions that lithium batteries must meet in order to be carried as cargo, including in paragraph g) that the test summary must be provided, as specified in the UN Manual of Tests and Criteria, Part III, subsection 38.3, paragraph 38.3.5. This test summary is required to indicate the watt-hour capacity or lithium content, and therefore this information shall be available to the operator's personnel responsible for accepting the load.

1.7 Table B-3 "Specially named derived SI units" in Annex 5 indicates that Volts are derived from the division between Watts and Amperes ($V=W/A$).

Table B-3. SI derived units with special names

<i>Quantity</i>	<i>Unit</i>	<i>Symbol</i>	<i>Derivation</i>
absorbed dose (radiation)	gray	Gy	J/kg
activity of radionuclides	becquerel	Bq	1/s
capacitance	farad	F	C/V
conductance	siemens	S	A/V
dose equivalent (radiation)	sievert	Sv	J/kg
electric potential, potential difference, electromotive force	volt	V	W/A
electric resistance	ohm	Ω	V/A
energy, work, quantity of heat	joule	J	$N \cdot m$
force	newton	N	$kg \cdot m/s^2$
frequency (of a periodic phenomenon)	hertz	Hz	1/s
illuminance	lux	lx	lm/m^2
inductance	henry	H	Wb/A
luminous flux	lumen	lm	$cd \cdot sr$
magnetic flux	weber	Wb	$V \cdot s$
magnetic flux density	tesla	T	Wb/m^2
power, radiant flux	watt	W	J/s
pressure, stress	pascal	Pa	N/m^2
quantity of electricity, electric charge	coulomb	C	$A \cdot s$

1.8 Annex 5 does not provide a way to determine the quantity of grams of lithium from the Volts of the lithium metal batteries.

1.9 In 38.3.2.3 of the UN Manual of Tests and Criteria the following definitions are given:

Aggregate lithium content means the sum of the grams of lithium content contained by the cells comprising a batter.

Lithium content is applied to lithium metal and lithium alloy cells and batteries, and for a cell means the mass of lithium in the anode of a lithium metal or lithium alloy cell, which for a primary cell is measured when the cell is in an undischarged state and for a rechargeable cell is measured when the cell is fully charged. The lithium content of a battery equals the sum of the grams of lithium content contained in the component cells of the battery.

Nominal energy or Watt-hour rating, expressed in watt-hours, means the energy value of a cell or battery determined under specified conditions and declared by the manufacturer. The nominal energy is calculated by multiplying nominal voltage by rated capacity expressed in ampere-hours.

1.10 Operators often incorporate guidance and calculations in their procedures manuals to enable the passenger reception staff to determine whether the batteries to be carried comply with the limitations established in the Technical Instructions, but it is observed that the Technical Instructions do not include clear references to Annex 5, the UN Manual of Tests and Criteria, neither do they provide a calculation for the conversion of Volt and Ampere-hours to Watt-hours or the determination of the number of grams of lithium.

1.11 It is also noted that the staff responsible for receiving passengers is a key filter to prevent items not permitted in Table 8-1 from being carried and must be able to determine whether PEDs, cells and batteries carried by passengers may be carried as hold or carry-on baggage, whether they may be switched on or whether they must be switched off, usually by reference only to battery descriptions because passengers often do not carry a product safety data sheet or the product manufacturer's data.

1.12 According to 38.3.2.3 of the UN Manual of Tests and Criteria and Annex 5 of the Chicago Convention to calculate the Watt-hour (Wh) rating it will be necessary to perform the following calculation:

$\text{Volts (V) x Ampere hour (Ah) = watt hours (Wh)}$

NOTE: for the calculation it is necessary to know the nominal capacity (Ah or mAh) of the cell/battery.

1.13 For lithium metal batteries, although the UN Manual of Tests and Criteria provides a way to determine the lithium content in grams, this can only be obtained if the number of grams of lithium in the cell/battery is known. This information is generally not indicated on the inscriptions of cells and batteries carried by passengers. The industry (courier) usually uses a calculation similar to the watt-hour calculation, as follows:

- It takes about 0.3 grams of lithium metal to produce 1 ampere hour of energy.
- Many batteries are not rated in ampere hours (Ah), but in milliamper hours (mAh). A milliamper hour is one thousandth of an ampere hour. To determine the Ah, divide the mAh by 1,000. Then:

Ah per battery x 0.3 g x number of batteries = grams of lithium metal content
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NOTE: for the calculation it is necessary to know the nominal capacity (Ah or mAh) of the cell/battery.

2. ACTION BY THE DGP-WG

2.1 The DGP-WG is invited to:

- a) consider including references and conversion factors to be used in the transport of lithium batteries as shown in the appendix to this working paper; and
- b) recommend to the Subcommittee of Experts on the Transport of Dangerous Goods the inclusion of a conversion factor to determine the amount of grams of lithium from the Volts and/or Amperes of a lithium metal cell/battery to the UN Manual of Tests and Criteria,

APPENDIX

PROPOSED AMENDMENT TO PART 1 OF THE TECHNICAL INSTRUCTIONS

Part 1

GENERAL

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Chapter 3

GENERAL INFORMATION

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3.2 UNITS OF MEASUREMENT AND CONVERSION FACTORS

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3.2.3 Conversion factors

Precise conversion factors for commonly used SI units are given in Annex 5 to the Chicago Convention. Tables 1-2 and 1-3 show conversion factors, to four significant figures, for some units widely used in dangerous goods transport.

Note.— When measurements related to lithium batteries appear in these Instructions, the conversion must be determined in accordance with this chapter, Annex 5 to the Chicago Convention and subsection 38.3, paragraph 38.3.2.3 of the UN Manual of Tests and Criteria.

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Table 1-3. Conversion from SI units*

To convert	to	Multiply by
<u>amperes-hour (Ah)</u>	<u>grams of lithium (g)</u>	<u>0.3</u>
amperes per metre (A/m)	oersted	0.012 57
degrees Celsius (°C)	degrees Fahrenheit (°F)	multiply by 9/5 and add 32°F
gray (Gy)	rad	100.0
kilograms (kg)	pounds	2.205
kilopascals (kPa)	bar	0.010 00
kilopascals (kPa)	kilograms per square centimetre	0.010 20
kilopascals (kPa)	pounds per square inch	0.145 0
litres (L)	gallons (Imperial)	0.220 0
litres (L)	gallons (U.S. liquid)	0.264 2
litres (L)	pints (Imperial)	1.760
litres (L)	pints (U.S.)	2.113
litres (L)	quarts (Imperial)	0.879 9
litres (L)	quarts (U.S.)	1.057
metres (m)	feet	3.281
millilitres (mL)	ounces, fluid (Imperial)	0.035 20
millilitres (mL)	ounces, fluid (U.S.)	0.033 81
millimetres (mm)	inches	0.039 37
newton (N)	kilogram-force (kgf)	0.1020
sievert (Sv)	rem	100.0
terabecquerel (TBq)	curie (Ci)	27.03

* Where a prefix is used, it indicates a multiplying factor as follows:

- tera (T) × 10¹²
- giga (G) × 10⁹
- mega (M) × 10⁶
- kilo (k) × 10³
- milli (m) × 10⁻³
- micro (μ) × 10⁻⁶
- nano (n) × 10⁻⁹

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