



WORKING PAPER

**DANGEROUS GOODS PANEL (DGP)
WORKING GROUP LB**

FIRST MEETING

Montréal, 6 to 10 February 2012

**Agenda Item 2: ANC work items:
2.3: Lithium battery related tests**

LITHIUM METAL BATTERIES

(Presented by NEMA)

SUMMARY

This paper is offered to present information from the lithium metal battery industry in the United States and to provide the working group with access to guidance and testing results the industry has generated in recent years.

1. INTRODUCTION

1.1 As an energy storage technology, lithium metal batteries do pose a risk in transportation if not properly handled or packaged. When handled properly and offered as air cargo in full compliance with applicable regulations, including the current ICAO Technical Instructions, lithium metal batteries (UN 3090), lithium metal batteries packed with equipment or contained in equipment (UN 3091) have been safely transported since the mid-1970s without reported incident.

1.2 Incidents involving transportation of lithium metal batteries invariably involve improper handling or shippers' failure to comply with the ICAO Technical Instructions or national regulations such that the known risks are not sufficiently mitigated.

2. TESTING OF LITHIUM METAL BATTERIES

2.1 At DGP/23, the Secretariat encouraged member states, advisors and observers to share reports and results of any testing they have conducted on lithium batteries. The United States Federal Aviation Administration William J. Hughes Technical Center made two presentations on its research up to that point, including fire testing of quantities of lithium batteries.

2.2 As part of an ongoing regulatory proceeding in the United States, in 2010 NEMA contracted with a well-respected independent third-party testing organization to test the fire risk of certain lithium metal batteries contained in equipment. The results of testing are summarized in Appendix A.

2.3 The requirements contained in Packing Instructions 969 and 970 of the Technical Instructions are effective and member states are advised to adopt and enforce them.

3. PREPARATION OF LITHIUM METAL BATTERY SHIPMENTS

3.1 At DGP/23, prompted by Information Paper 11, Panel members briefly discussed the utility of making a reference in the Technical Instructions to an existing international standard on lithium batteries. A vocal portion of the Panel declared unfamiliarity with the standard and recommended that such a reference not be included in the 2013-2014 Edition of the Technical Instructions.

3.2 International Electrotechnical Commission (IEC) Standard 62281, “Safety of primary and secondary lithium cells and batteries during transport”, includes sections on “Test methods and requirements” (Section 6), including those tests required under the United National Manual of Testing and Criteria and on “Information for safety” (Section 7), including packaging, handling, transport by all modes, and display and storage, “Instructions for packaging and handling during transport” (Section 8) and “Marking” (Section 9).

3.3 IEC 62281 is currently under review and an updated version is expected to be published later this year. Several representatives of NEMA member companies are active and voting members of the responsible IEC Committee. The Committee’s views definitively reflect that the IEC Standard can be a useful reference in and supplement to the Technical Instructions in terms of providing useful and accessible information to shippers and carriers, but should not be viewed in any way as an alternative to the Technical Instructions. In addition, IEC Committee members and IEC staff have expressed interest in coordinating with the Panel and the Secretariat in producing publications that are more accessible to small shippers of lithium batteries than an IEC standard or the Technical Instructions.

3.4 Several NEMA members were very involved in the strengthening in 2010 of the UN Manual of Tests and Criteria, Part III, Section 38.3, with which lithium battery types are required to comply in Packing Instructions 965-970.

4. EXCEPTIONS FOR SMALL QUANTITIES OF LITHIUM METAL CELLS AND BATTERIES

4.1 At DGP/23, many Panel members expressed sympathy for the proposals contained in Information Paper 11 and Flimsy 9 due to concerns about small packages of lithium batteries shipped under Section II of Packing Instructions 965 and 968 being consolidated onto a pallet and potentially presenting a significant risk in the case of a fire in the cargo compartment, a scenario that the Panel did not consider when the current Packing Instructions were first approved.

4.2 Based on the discussion at DGP/23 and at previous Panel meetings, it is clear that a majority of Panel members recognize the need for retention of provisions in the Technical Instructions that allow for shipment of very small quantities of lithium cells and batteries under less stringent requirements than are necessary for bulk shipments of these products. These exceptions for small

quantities, such those in Section II of Packing Instruction 968, are necessary to allow for timely expedited shipment of small numbers of batteries, not only by battery manufacturers but also by Original Equipment Manufacturers (OEMs) and online retailers worldwide. As the Panel is also aware, lithium metal batteries are used not only in popular portable consumer-type devices but also in many critical applications, including public safety, military and medical equipment. Thus, the panel should not place limits on the small quantity of lithium metal cells and batteries that may be shipped under Section II or successor provisions that would be lower than what a private, professional or government consumer commonly needs to power their device. Lithium metal cells and batteries with a lithium content of not more than 0.3 g – small button-type and coin-type cells and batteries – are recognized to be of significantly lower risk and therefore should also be covered by small quantity exceptions. However, any limit placed on the gross weight of the package below 2.5 kg would force the battery industry to redesign current packaging without providing for any additional measure of safety.

APPENDIX

TESTING OF LITHIUM BATTERIES IN EQUIPMENT

The following is the title page and executive summary of a report on the results of flammability testing performed in 2010 for NEMA on lithium metal cells and batteries packed with or contained in equipment. The testing was conducted to aid NEMA in preparing a response to a notice of proposed rulemaking in the United States.

The full test report is available at <http://www.regulations.gov/#!documentDetail;D=PHMSA-2009-0095-0209>.



**US FAA-Style Flammability
Assessment of Lithium-
Primary Battery Packs Packed
With and Contained In
Equipment (UN3091)**

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Executive Summary

As part of an NPR published on January 11, 2010, PHMSA proposes to eliminate the regulatory exceptions (Special Provision 188 in 49 CFR Section 172.102(c)) for lithium cells and batteries when transported aboard aircraft. This would include the exception on lithium batteries with greater than 0.3 g of lithium that are “packed with” or “contained in” equipment. In order to assist NEMA (National Electrical Manufacturers Association) with a response to the NPR, Exponent conducted heat release analyses and testing of lithium batteries “contained in” and “packed with” equipment (UN3091) for air shipment: specifically, on lithium iron disulfide batteries packed with ruggedized flashlights, lithium manganese dioxide batteries contained in flashlights and weapon lights with lasers, and lithium thionyl chloride batteries contained in highway toll transponders.

Air shipment packages were analyzed to estimate the quantity of stored energy that would be released by complete combustion of all components (packing materials, plastics, and batteries) and to compare the contribution of the batteries to the total energy content of the entire package. Flame attack tests were conducted to compare the fire behavior of packages containing batteries to those not containing batteries. Exponent also conducted cell initiation testing to assess the effect of an internal fault occurring in a single cell contained in or packed with equipment. Test setups and procedures were similar to those described in the Federal Aviation Administration (FAA) report [1] titled “Flammability Assessment of Bulk-Packed, Nonrechargeable Lithium Primary Batteries in Transport Category Aircraft.”

Based on the analyses and tests conducted, Exponent concludes:

1. Batteries do contain stored chemical and electrical energy that can be released during a fire and add to the total heat release of the fire. However, analysis of flashlights, weapon lights with lasers, and highway toll transponders with cells “contained in” or “packed with” equipment as packaged for air shipment suggests that this contribution is fairly modest. Combustible materials such as cardboard, paper, and plastic within the package produce the bulk of the heat release.
2. Flame attack testing on packaged systems resulted in initial combustion of packaging materials. Flames typically self extinguished within five minutes due to limited airflow into the chamber. Initial flame impingement did not cause cell venting or thermal runaway when packaging materials were substantial (e.g. devices contained in a cardboard box). Cell venting did occur when packaging was minimal (e.g. a small device packed in a paper envelope). However, the lithium-primary (Li-primary) cells did not appreciably affect combustion of the surrounding packing materials.
3. Cell initiation testing (conducted on a single cell contained in or packed with equipment) resulted in heat damage to adjacent systems and/or packing materials. Cell thermal runaway did not propagate to adjacent systems (when present) and the external packaging was mostly intact.