COMMITTEE OF EXPERTS ON THE TRANSPORT OF DANGEROUS GOODS AND ON THE GLOBALLY HARMONIZED SYSTEM OF CLASSIFICATION AND LABELLING OF CHEMICALS

Sub-Committee of Experts on the
Transport of Dangerous Goods

Thirty-fifth session
Geneva, 22 - 26 June 2009
Item 4 of the provisional agenda

ELECTRIC STORAGE SYSTEMS

Report of the 2nd meeting of the working group on Lithium batteries

Transmitted by the expert from France on behalf of the working group

1. The WG on Li Batteries met in Paris from 20th to 22nd of April 2009. Delegates from competent authorities and other organisations mentioned in the annexed list participated (see annexIII)

2. The WG worked according to the mandate given by the UN SCETDG (see annexII)

3. Written documents have been submitted prior to the meeting :

a) Definitions issues from China

b) Paper on T2 test (from an ad hoc task group set up from the first session of this WG in Washington (November 2008)

c) Vibration test, submitted by COSTHA

d) Paper from BAJ concerning the T5 test

e) T6 impact test (from an ad hoc task group set up from the first session of this WG in Washington (November 2008)

The WG also looked at powerpoint presentations concerning :

(a) Battery assemblies (SAFT and 123Ssystems)

(b) T3 vibration test (JARI)

(c) T5 external short circuit test (BAJ)

4. All the papers and presentations relating to this WG can be consulted on the PRBA web site (http://www.prba.org/Laws_and_Regulations/Default.ashx)
5. In addition, the United Kingdom delegate informed the WG about papers submitted to the ICAO DGP that would be related the work of this working group: WP 42 (shipping requirements for prototype and low production Li batteries, PRBA), WP 51 (Li batteries, discussing clarifying issues in the manual of test and criteria, UK), INF 2 (Li batteries, Germany)

6. The working agreed on its agenda:

a) Definition issues
b) T2 test and mass loss criteria
c) Battery assembly issues
d) T3 vibration test
e) T5 external short circuit
f) T6 impact/crush test
g) Miscellaneous and future work

a) Definition issues

7. The working group considered the paper presented by China containing proposals to amend existing definitions and the addition of new ones.

8. As a principle, it was agreed that it was not useful to add new definitions for wordings that were not yet in use in the Manual of Tests and Criteria (4^{th} edition).

9. The working group agreed to clarify the concept of tested type by modifying 38.3.2.1. b) and c) mentioned in annex 1. However, PRBA questioned the necessity of listing examples of changes that would affect test results.

10. The WG went on looking at the definition that were not related to issues addressed elsewhere in the agenda. Definitions concerning battery assembly, mass loss would be discussed as part of discussions concerning other papers mentioned above (T2 paper concerning mass loss, and battery assembly discussion).

11. The WG agreed to modify the definitions of : *battery*, *large cell*, *primary cell or battery*, *rechargeable cell or battery*, *small cell*, *rated capacity* and add new definitions concerning : *nominal energy*, *nominal voltage*, *open circuit voltage* and *fire.* However, the definition for a fire is kept in square brackets because it was felt that further discussion was needed to qualify appropriate measurable criteria in relation with the fire threat such as trains of sparks other than sparks induced for instance by the testing impact that would not reveal any actual threat.

12. The working group accepted to define large and small cells according to a mass limit, as this principle was already accepted for batteries, but the number of 500 g is kept in square brackets because it needs to be verified in relation with the currently most produced cells size.

13. The definition of leakage has been modified in relation with the mass loss discussion (see point b) below. After this modification, the WG also decided that the mass loss definition could be deleted, as it has been included in the definition of leakage.

14. The WG did not follow the proposals from China concerning definitions for :

- *disassembly*: the existing criteria was deemed more appropriate and objective
- *first cycle*: change purely formal and not required for the understanding
- *anode, cathode, terminal and electrolyte*: terms already well-known by the industry
- *depth of discharge, close-circuit voltage and end-point voltage*: were not deemed necessary
- *battery energy, capacity*: were not introduced as such because the wording proposed by China for these definitions were introduced respectively in the definitions for nominal energy and rated capacity.

b) Mass loss and T2 "thermal test" discussion

15. After lengthy discussion, considering both mass loss definition proposed in the document from China and paper from the T2 task group, the WG agreed to look at this issue in a new way.

16. The definition of leakage would be modified as proposed in annex I. This definition would include visible escape of material as well as loss of material measured by means of mass loss metrology. Given the fact that leakage can also include leakage of gas, it was mentioned that leakage also includes venting.

17. The WG also considered the problem of mass loss caused by the loss of non safety related materials, such as labels, handling devices, moisture, …This type of mass loss currently lead to a failure of the test in spite of the fact that they do not reveal any safety issue. To avoid this problem, the WG included in brackets a list of materials that need not to be considered in the mass loss calculation. However, some experts expressed concern about the relevancy and completeness of that list. Therefore, it is kept in square brackets for further consideration.

18. Also the mass loss table proposed in annex I has been kept empty, because during discussions from the task group paper, it has been pointed out that current values of the mass loss table turn to be irrelevant for large batteries. The task group has been invited to revisit the table in order to define adequate values for batteries.

19. Other proposals concerning decrease of test temperature (from 75°C to 55°C), cycling time duration (from 60 min to 30 min) , number of cycling (10 to 5) and extra exposure time for large batteries mentioned in the document were considered. The explanation provided for these decreases was based on the statistical analysis of actual conditions of transport. But the working group did not follow this proposal for the moment because the views on that was not unanimous. In particular, some experts have pointed out that the test procedure has been developed for classification purposes, and therefore additional safety margins to the normal conditions of

transport would be justified. It has also been pointed out that sometimes the conditions of transport may exceed 55°C.

c) Battery assembly discussion

20. The WG had the opportunity to consider two presentations clarifying the design of different battery assemblies (details available on the PRBA web site). The WG took note that some clarification might be needed on the definitions of cells, batteries, components (cells, modules…). However, no decision was met because no formal proposal has been submitted to the WG. These definitions have to be considered in relation with the test relevant with those different items and the WG welcomes further contributions from competent authorities and organisations (industry, testing labs…) to clarify this point.

21. It has been noted however that some modifications have been adopted in December in order to clarify the testing of battery assemblies and the testing of assembly of cells that are only parts of a battery under the T7 overcharge test . Some experts felt that a rationalised approach of these different testing conditions could clarify the requirements of chapter 38.3 of the Manual of Test and Criteria.

d) T3 vibration test discussion

22. In relation with vibration testing, the WG considered two documents, a presentation by JARI dealing with the test procedure and in particular the way the device under testing (DUT) is secured on the testing plateform, and document presented by COSTHA addressing the values of forces corresponding to peak acceleration during the vibration test procedures corresponding to small and large battery items.

23. The presentation by JARI illustrated that the mode of securing the device to be tested on a vibration platform (clamping or belting) may significantly affect the results. The WG agreed that this may justify improvements and a more accurate description of the test procedure, but the majority of experts did not follow the view from JARI that belting was the best option. Another important issue was related to the orientation of the device on the vibration platform.

24. Concerning the value of the peak acceleration for large batteries and cells, the WG agreed with the views presented by COSTHA, in particular with the reduction proposal of the peak acceleration of 2g instead of 8g for large batteries, but as there was no time to draft a formal text, the WG deferred this task for its next session.

e) T5 external short circuit

25. The WG considered a proposal from BAJ concerning the value of the external resistance to be applied during the external short circuit test procedure. BAJ proposed to define a resistance value between 60 and 100 mOhm. BAJ make the same proposal to some IEC standardisation Committee.

26. DGAC pointed out that in this case, it would not be possible to use the transport test for other circumstances where a lower external resistance value is required.

27. After a lengthy discussion, the WG noting that the devices under testing have an internal impedance equivalent to a resistance, and that it might be relevant to relate the external

resistance to the value of this internal impedance. As this principle was agreed by a majority, the WG decided to further investigate this idea at the next session, after additional information would be provided on the matter. BAJ and any other interested party is invited to send appropriate material to the WG.

f) T6 impact/crush test

28. The WG considered the proposal of the task group for an additional crush test for button cells. It has been recalled that by definition button cells are small cells. Because of their limited size and resistance, the impact test would not be relevant for them.

29. The WG agreed to the addition of the crush test procedure of these smaller button cells. In addition, some noted that this crush test procedure would be equally appropriate for other small cells (prismatic, cylindrical…). Interested organisations are invited to investigate this particular point and to provide adequate text to include all relevant items under the new crush test procedure. The WG agreed that the crush test procedure itself was correct as drafted.

30. Concerning the impact test itself, some issues were raised, inter alia 1) placement of the impact rod was not always easy to manage depending on the size of the tested cell and the impact mass of 9,1 kg would not be commensurate to the new stronger large cells. Interested organisations were also invited to provide information concerning a change of the impact mass, in particular in relation with the tested cell.

31. During the discussion on the impact test, it was recalled that before the modifications introduced in 2000, a mechanical crush test (old T4 test) was meant to verify the resistance to an internal short circuit. Some expert were on the opinion that this test was not really adapted for that purpose but It was generally recognised that internal short circuit may be a safety issue to be further investigated and that it may require a specific test. It was also mentioned that internal short circuit may result from different causes and that it may also happen during vibration and shock test and any other mechanical type test. Therefore, internal short circuit test is a complicated issue that deserves thorough examination.

g) Miscellaneous and future work

32. The attention of the Working Group was drawn to the large number of Working Papers concerning the transport of lithium/lithium ion batteries on the Agenda of the ICAO Dangerous Goods Panel Working Group of the Whole to be held in New Zealand at the beginning of May. The Working Group looked briefly at papers DGP-WG/09/42, 09/51 and IP/2.

33. The Working Group agreed with the interpretation by the expert nominated by the United Kingdom (09/51) that paragraph 38.3.2.1 of the Manual of Tests and Criteria requires that, although individual cells may already have been tested in accordance with the Manual, when used to form a battery that battery must itself be subject to the full UN test requirements. Views were evenly divided, however, on whether the proposed inclusion of an explanatory note was needed or not. Further, it was felt by some that the proposed text needed some improvement anyway. It was suggested that this matter should be remitted to the UN Sub-Committee of Experts for consideration.

34. The Working Group noted the proposals by PRBA in paper 09/42 to amend Special Provision A88 (which is related to UN Special Provision 310) in respect of prototype or low production large batteries. It was pointed out that, whilst addressing air mode specific issues, care should be taken not to introduce provisions which would not be compatible with the UN Model Regulations or other modal regulations such that inter-modal transport would become problematic.

35. In paper IP/2 the expert nominated by Germany had proposed that a number of issues that he had elucidated in respect of large rechargeable lithium batteries needed to be addressed. The Working Group recognised these issues and felt that this was exactly the remit that it was already working to on a multi-modal basis. Two issues, outside of the Working Group's remit, had been raised by the expert nominated by Germany – the use of a visible quality seal and a ten year reliable operational requirement. It was felt that this should be raised as a multi-modal issue with the UN Sub-Committee.

36. It was hoped that the Working Group report in respect of these issues could be drawn to the attention of the ICAO meeting. Mr Rogers (IFALPA) undertook to do this.

37. The WG decided to meet again on the 9th to 11th of November 2009 and the proposal of Japan to host the group has been accepted.

Annex I : provisionally approved amendments
Annex II : WG mandate
Annex III: list of participants

Annex I

AMENDMENTS DRAFTED BY THE WORKING GROUP

The sub committee is invited to comment on these amendments provisionnally agreed by the working group

Changes in section 38.3.2.1

(b) For rechargeable cells and batteries, a change in nominal energy in watt-hours of more than 20% or an increase in nominal voltage of more than 20%; or

(c) A change that would lead to failure of any of the tests,

NOTE: the type of change that might be considered to differ from a tested type, such that it might lead to failure of any of the tests, may include but is not limited to:

- A change in the material of the anode, the cathode, the separator, or the electrolyte;
- A change of protective devices, including hardware and software;
- A change of safety design in cells or batteries, such as a venting valve;
- A change in the number of component cells;
- A change in connecting mode of component cells

Definitions:

Battery means one or more cells electrically connected together ~~by permanent means~~, ~~including case, terminals, and markings~~ fitted with devices necessary for use, for example case, terminals, marking and protective devices.

Large cell means a cell with a gross mass of more than [500g.] ~~lithium content or lithium equivalent content of the anode, when fully charged, is more than 12 g.~~

leakage, including venting, means the visible escape of electrolyte or other material from a cell or battery or the loss of material [(except battery casing, handling devices, labels)] from a cell or battery such that the loss of mass exceeds the values in table 1.

Table 1: Mass loss limit to be adapted

Mass *M* of cell or battery	Mass loss limit

NOTE: In order to quantify the mass loss the following procedure is provided:

$$\text{Mass loss (\%)} = \frac{(M_1 - M_2)}{M_1} \times 100$$

where M_1 is the mass before the test and M_2 is the mass after the test. When mass loss does not exceed the values in table 1, it shall be considered as "no mass loss".

Mass loss delete the definition of mass loss

Primary *cell or battery* means a cell or battery which is not designed to be electrically charged or recharged.

~~Rated capacity *means the electric charge in ampere hours which a cell or a battery can deliver, as measured by subjecting it to a load, , temperature, voltage cut-off point specified by the manufacturer*~~

Rechargeable *cell or battery* means a cell or battery which is designed to be electrically recharged.

Small cell means a cell with a gross mass of not more than [500g.] ~~lithium content of the anode, when fully charged, is not more than 12 g.~~

nominal energy 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.

Nominal voltage: means the approximate value of the voltage used to designate or identify a cell or a battery.

[*Fire* means that flames are emitted from the test cell or battery during a test.]

(further discussion needed to qualify appropriate measurable criteria in relation with the fire threat)

Open circuit voltage means the voltage across the terminals of a cell or battery when no external current is flowing.

Annex II

MANDATE

(Based on ST/SG/AC.10/C.3/68 par. 39)

a) Re-evaluation of criteria for the thermal test (T.2);

(b) Examination of the test method for the impact test (T.6) and consideration of alternative test methods;

(c) Review of definitions and terminology in section 38.3 of the Manual of Tests and Criteria, in the light of other recognized standards;

(d) Resistance requirements of the external short-circuit tests (T.5);

(e) Vibration and shock tests (T.3 and T.4) as applied to different sizes of batteries; and

(f) Overcharge tests for battery assemblies, and clarification of definitions for cells, batteries, modules and assemblies.

Annex III

LIST OF PARTICIPANTS

Working group on the testing of and criteria for lithium batteries – PARIS 20-22 April 2009 –participants list rev1

NAME - first name	ORGANIZATION	Comp. authority from or NGO...	ADRESS	PHONE	FAX	EMAIL
FICHTNER Holger	Magna Steyr Fahrzeugtechnik	AUSTRIA	Liebenauer Hauptstrasse 317, 8041 Graz, Austria	+43/664/8840/5051	+43/316/404/5955	holger.fichtner@magnasteyr.com
Yuk-Kwan Chloe WONG	Flying-Cam SA	BELGIUM	du Passage d'Eau, 1a, B-4681, Oupeye, Belgium	+ 852 6103 6364		chloe@flying-cam.com
PREVINAIRE Emmanuel	Flying-Cam SA	BELGIUM	du Passage d'Eau, 1a, B-4681, Oupeye, Belgium	+ 32 43 74 3023		jan@flying-cam.com
FENG zhuo	Shanghai Research Institute of Chemical Industry	CHINA	No. 345, East Yunling Road, Shanghai, 200062, China	0086-21-52815377-1725	0086-21-52801361	vida.feng@msds.gov.cn; vida.feng@gmail.com
LIU gang	Shanghai Research Institute of Chemical Industry	CHINA	No. 345, East Yunling Road, Shanghai, 200062, China	0086-21-52500134	0086-21-52808309	lg@msds.gov.cn; lgsh33@gmail.com
FERGUSON, Tom	Council on Safe Transport of Hazardous Articles (COSTHA)	COSTHA	7803 Hill House Court. Fairfax Station, VA 22039, USA	1-703-451-4031	1-703-451-4207	tom@costha.com
HOFF, Michael	123 Systems	ESG	10 Avenue E, Hopkinton MA 01748	508-497-7228 857-891-4918		mhoff@a123systems.com
PFAUVADEL Claude	MTMD	FRANCE		33 1 40818766	33 1 40811065	claude.pfauvadel@develeoppement-durable.gouv.fr
MARLAIR Guy	INERIS	FRANCE	Parc ALATA BP2 60550 Verneuil en Halatte	33 3 44556370	33 3 44556565	guy.marlair@ineris.fr
ADDA fatima	RENAULT SAS	FRANCE (RENAULT)	1, Av du Golf 78288 Guyancourt Cedex, France			fatima.adda@renault.com

ORIGUCHI Masato	RENAULT SAS	FRANCE (RENAULT)	1, Av du Golf 78288 Guyancourt Cedex, France	01 76 85 77 55	01 76 856 90 27	hela.diebolt@renault.com
BERMIS Philippe	SAFT	FRANCE (SAFT)	111 boulevard Alfred Daney 33074 Bordeaux	+33 (0)5 57 10 65 53 +33 (0)6 87 86 01 63		philippe.bermis@saftbatteries.com
INGO DOERING	Bundesanstalt für Materialforschung und prüfung BAM	GERMANY	Unter den Eichen 87 D -12205 Berlin , Germany	49-30-8104-3407	49-30-8104-1227	Ingo.Doering@bam.de
FURUKAWA-Akio	SANYO Electric.Co.LTD.	IEC	139-32, Toyohisa, Matsusige-Cho, Itano-Gun, Tokushima, 771-0213, JAPAN	81-88-699-9240	81-88-699-9046	akio.furukawa@sanyo.com
MORIWAKI-Kazuro	SANYO Electric.Co.LTD.	IEC	222-1, Kaminaizen, Sumoto City, Hyogo, 656-8555, JAPAN	81-799-23-3952	81-799-23-2980	kazurou.moriwaki@sanyo.com
NISHIMURA-Joji	PANASONIC	IEC	1-1, Matsushita-cho, Moriguchi, Osaka, 570-8511, JAPAN	81-50-3787-5219	81-6-6998-3179	nishimura.joji@jp.panasonic.com
Babiak, Michael	ENERGIZER	IEC	25225 Detroit Road Westlake, Ohio 44145	440-835-7527		michaelh.babiak@energizer.com
Rogers, Mark	IFALPA	NGO - IFALPA	1778 Hayes St., San Francisco, Ca 94117 USA	14152179595	None	Mark.Rogers@alpa.org
NOGAMI-MitSuzo	Battery Assosiation of Japan	JAPAN	3-5-8 Shibakoen, Minatoku, Tokyo.105-0011, JAPAN	81-3-3434-0261	81-3-3434-2691	nogami@baj.or.jp
CHO-Antoku	SONY Corporation	JAPAN	1-7-1 Konan Minato-ku, Tokyo, 108-0075, JAPAN	81-3-6748-4021	81-3-6748-4027	Antoku.Cho@jp.sony.com

FUKUZAWA, Tatsuhiro	Japan Automobile Research Institute	JAPAN (AESC)	Japan	+81-565-94-300	+81-565-94-3099	fukuzawa-t@eco-aesc.com
ASAKURA, Yoshitaka	Japan Automobile Research Institute	JAPAN (TOYOTA)	Japan	+81-565-94-3004	+81-565-94-3099	yoshi@asakura.tec.toyota.co.jp
Kerchner, George	PRBA - The Rechargeable Battery Association	P.R.B.A	1776 K Street, NW Washington, DC 20006	202.719.4109		GKerchner@wileyrein.com
Monahan, Charles	PRBA - The Rechargeable Battery Association (Panasonic)	P.R.B.A	Two Panasonic Way Secaucus, NJ 07094	201.392.6464		monahanc@us.panasonic.com
Wiaux Jean-Pol Mr.		RECHARGE aisbl	Avenue de Tervueren, 168 B-3 Bruxelles B-1150 Belgique	00 32 2 777 05 60	00 32 2 777 05 65	jpwiaux@rechargebatteries.org
CALLEJA BARCENA LIA	Dangerous Goods Commission Ministerio de Fomento	SPAIN	Paseo de la Castellana, 67 28071 Madrid Spain	0034-91-597-7548 0034-649-233561	0034-91-597-50-27	lcalleja@fomento.es
Ke, Charles	U.S. Department of Transportation	U.S.A	1200 New Jersey Ave.,S.E.., Washington, D.C. 20590	202-366-4495	202-366-3753	Charles.Ke@dot.gov
ALTEMOS, EDWARD A.	HMT Associates, LLC	DGAC	603 King Street, Suite 300, Alexandria, Virginina 22314, USA	001-703-549-0727	001-703-549-0728	ealtemos@pipeline.com
BRYER IAN	VCA DGO	UNITED KINGDOM	Cleeve Road Leatherhead Surrey UK KT 227NF	44 (0) 1372 226110	44 (0) 1372 226116	Ian.Bryer@vca.gov.uk
HART Jeffrey M.	Dept. For Transport	UNITED KINGDOM	2/26 great minster house 76 Marsham street London SWIP 4DR	44 (0) 79442758	44 (0) 79442039	jeff.hart@dft.gsi.gov.uk