INF.52

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To: UN Subcommittee of Experts on the Transport of Dangerous Goods
From: KiloFarad International
Re: Proposed Shipping Name and regulations for ultracapacitors, basic principles requirements and input responses

Basic principles for serving as foundation for ultracapacitor proposal

General

- Major hazard in transport is the potential for short circuiting of a charged ultracapacitor
- It is possible to transport ultracapacitors individually and in modules in an uncharged state and this should be required
- Ultracapacitors utilizing a flammable liquid and those using a nonflammable solvent pose similar electrical risks in short circuit behavior and both should be subject to some degree of regulation, at the minimum specific to shipping in a charged state.
- Class 9 is appropriate in view of the potential electrical hazard and this permits regulation of both types (flammable liquid containing and nonDG containing) in one entry
- Limited quantity amount should be based on the quantity of flammable liquid contained in the device (1 litre for PG II flammable liquid) – equates to a 2.5 kg ultracapacitor
- Certain tests/requirements should be applicable to all ultracapacitors to ensure integrity in all stages of transport (new, in equipment, waste), including: drop, pressure differential (air transport), safe retention of pressure build up in use and safe venting

New ultracapacitors (under atmospheric pressure) transported individually or in a module

- May only be transported in uncharged state
- Discharged state to be ensured by connection of opposing terminals on individual units and modules – except for small ultracapacitors caps where impracticable/less warranted due to low energy levels.
- Ultracapacitors containing no dangerous goods, ship discharged, fitted with a shorting device (except small units) should not otherwise be subject to the regulations
- Ultracapacitors containing a flammable liquid excepted from the regulations up to a certain size limit based on amount of free liquid (**Fact**: A 10 kF ultracapacitor unit has 5.5gm free flammable liquid inside and a total of approximately 450g of flammable liquid total with the bulk absorbed into the carbon matrix of the electrode like a sponge)

Ultracapacitors in equipment (e.g., vehicles, computers, wind turbines, Airbus door)

- To be subject to all of the above general requirements
- Impractical to require ultracapacitors to be discharged (e.g. computer where ultracapacitor is used in place of clock battery)
- Equipment should be protected against short circuiting (to be included)

Spent ultracpacitors (potential for pressure buildup in ultracapacitor)

- Expect to be forbidden from air transport
- Must be transported in discharged state
- Shorting device connecting opposing terminals(except small units) to ensure no charge
- **Fact**: Pressure buildup stops as soon as charge is removed, pressure only increases when the device is under charge and the rate is proportional to the charge level. Low/no voltage evolves negligible to no gas.

Marking requirements to facilitate compliance

- marking to indicate absence of dangerous goods
- marking of capacitance to generally indicate the amount of liquid inside

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Consolidated Comments and Issues Listing Including KFI Response

1. Proper shipping name should be changed from Ultracapacitor to Electric Double Layer Capacitors due to a trademark existing for the term Ultracapacitor - **<Japan>**

   KFI Response – Legal investigation has revealed that while a trademark for the term ultracapacitor does exist, the requirements for trademarks under the US and Madrid systems requires that the trademark be referenced to some specific class of goods. In this case the term ultracapacitor and the trademark of the term is related to the class of goods described as *Custom manufacture of interconnects for others, namely dense interconnects integrated directly onto the substrate surface.* Since this has no relation to the manner in which the term ultracapacitor is being used in this proposal there is no restriction on its use as a term to describe the devices. While ultracapacitor is preferred, KFI is not opposed to changing the proper shipping name to the technically correct term Electric Double Layer Capacitor to describe the covered devices. It is up to the subcommittee to choose which is more appealing in the context of the proposal.

2. Section 3a – 10 meter drop appears too stringent **<Japan>**

   KFI Response – The 10 meter drop test proposed is a slightly modified industry standard test that exists for ultracapacitors today. It was intended to demonstrate the high integrity of the packaging of such devices. It is a severe test relative to transport conditions, KFI could support a less severe test. The 1.2m drop test (unpackaged) already applies to fuel cell cartridges and could be used. Recommend adopting the 1.2m drop test.

3. Section 3b – The pressure differential test is not clear, recommend using a mechanical vibration and alternate pressure differential test that already exists **<Japan>**

   KFI Response – the pressure differential test is commonly used in the regulations to demonstrate suitability for air transport. The purpose is to ensure that contents will not be released in air transport. Vibration and pressure tests (SP238) would pose no difficulty but do not seem relevant. All manufacturers of devices are typically executing vibration testing for use purposes.

4. Section 3 General – The 100F lower limit for cell size to relieve the requirement for a shorting strap seems too low **<Japan>**

   KFI Response – the value of this capacitor was picked by the members of KiloFarad International as an appropriate lower limit of capacitance for relieving the requirements for a shorting strap. It is low enough in capacitance that the energy contained in the device is small so if there is a device that does not get discharged for some reason before shipping the impact is of no consequence. Further the requirement to package so as to prevent shorting is required to again offset impacts of the manufacturer who does not discharge the device. It is an added level of security against short circuit arcing and the related effects. KFI recommends keeping the level where it is as defined in the existing proposal. We would welcome a detailed analysis by Japan.

5. General – If a device does not contain any Dangerous Goods and it is uncharged then it should not be regulated. **<Japan>**

   KFI Response – the purpose of calling those devices that do not contain regulated materials into the proposal is to ensure that they are discharged and this is important for transportation safety. Such ultracapacitors are only subject to limited requirements – see second subpara (c), page 5.

6. Section 3 bullet 3 – Limited quantity exemption and the specification of a 5kg mass limit will ensure that no device shipped today will be regulated. This seems excessively lenient. **<France>**

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KFI Response – KFI proposed to reduce the LQ mass limit to 2.5kg. This corresponds to a one liter volumetric limit used for PGII Class 3 liquids. A mass limit is proposed to aid in verifying compliance. This equates to a 20 kF unit. It is true that 10 kF units are at the current upper limit however ultracapacitors with several orders of magnitude more capacitance are being developed. The one liter limit is conservative considering how the flammable liquid is absorbed by the activated carbon.

7. Section 3 bullet 5 – Selecting a 10kF cell limit for unregulated devices is a waiver to all manufacturers due to the fact that no manufacturer makes a device larger than that and it covers all devices currently being manufactured as unregulated. **<France, Belgium>**

   KFI Response – the device size was selected based on a rational consideration of how much free liquid will be in the device. In a device of this size/capacitance, there is approximately 5.5 gm free liquid (compared to 30ml for excepted quantities in less robust inner packagings). The capacitance was specified in place of the amount of free liquid to aid in compliance verification. If a lower capacitance value is selected it means less free liquid in the cell. KFI is open to discussing a different capacitance level. Free liquid varies with capacitance. In a 5000F device there will be approximately 3.5g of free acetonitrile which is about 4g of electrolyte solution.

8. Section 3 bullet 11 – It is suggested that industrial standard tests be adopted for the testing that will take place on the devices **<France>**

   KFI Response – the tests in place now are based on industrial standard tests or UN tests with the exception of the vent test. There is no single applicable industry standard at present for this test.

9. Proper shipping name of ULTRACAPACITORS UNCHARGED is confusing as it relates to ultracapacitors in equipment which are allowed to be charged per the current proposal. **<USA,Germany>**

   KFI Response – the term was introduced based on comments at the 35th session. We agree to delete the term uncharged.

10. General consideration of describing a power device by the amount of energy contained inside. Is this a rational way to relate the two characteristics? **<USA>**

    KFI Response – The comparison of a 10 kF ultracapacitor with a lithium ion cell was done to provide a general comparison of energy density. It is not included in the proposal.

11. The 4.1 flammable solid test may yield a positive result in ultracapacitors **<Austria>**

    KFI Response – We consider this test irrelevant to an ultracapacitor. How would the material be tested? It could not to take into account the safety provided by the casing and the manner in which the carbon is fixed to the electrode membrane.

12. Proposal Section 3b, page 4 – Unclear relationship between the pressure test of 95kpa and the venting pressure **<Austria, Spain>**

    KFI Response – The 95kpa pressure differential test is a transport requirement for aircraft transportation. The vent pressures requirements are intended to ensure safety as pressure builds up during the life of the ultracapacitor.

13. Proposal Section 3, page 4,General consideration of where test conditions have been derived from **<Germany>**

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KFI Response – 10m drop test – test applicable to ultracapacitors installed in vehicles; 95 kPa – air transport; vent tests are good industry practice agreed by KFI members.

14. Proposal Section 3b Page 5, General consideration describe as issues with the terms "conveyance and completed conveyance components". **<Germany, Switzerland>**

    KFI Response – KFI's original proposal used the term vehicles. Based on comments from the 35th session and consistent with the terminology of fuel cell systems the term conveyance was adopted. We are in the hands of the Subcommittee.

15. Proposal Section 3d, Page 4, General consideration that the vent is obligatory **<Spain>**

    KFI Response – The proposal does require that venting occur in such a way that the device does not rocket or fragment. This is explicit reference to the existence of a venting scheme and directly makes a venting scheme obligatory.

16. Proposal Section 3c, Page 5, consideration of a mark on the device which doesn't seem to be in the proposal **<Belgium>**

    KFI Response – The proposal does contain the requirement for marking the cells to indicate the absence of dangerous goods over 10k F when no dangerous goods are present. Marking of cell capacitance is also required when it is over 100F.

17. General consideration of pressure build up in aged capacitors, what test is appropriate to gauge their safety, Fire engulfment test is not appropriate, what about the puncture test? **<United Kingdom>**

    KFI Response – The vent test is to be carried out by applying an internal pressure until the device fails. Venting is considered safe if the device does not rocket or fragment.

18. General consideration of Class 9 categorization as not appropriate **<Switzerland, France (rebut), Canada>**

    KFI Response – Class 9 permits regulation of both types of hydrocarbon liquids used (flammable and nonflammable) in ultracapacitors designs in use.

19. Proposal Section 3c Page 4, It is not clear **<Switzerland>**

    KFI Response –An attempt is made to clarify as follows:

    WAS - (c) the device can retain a pressure build up in the casing equivalent to 1.5 times the pressure buildup at the point of venting; or

    NEW - (c) the device shall be designed and tested to demonstrate that it can retain a pressure build up in the casing equivalent to 1.5 times the pressure buildup at the point that the installed vent will actuate thereby relieving the pressure safely.

    KFI recommends adopting the NEW description in place of the WAS for clarity of this point.