U.S. Department
of Transportation

Pipeline and Hazardous Materials
Safety Administration

1200 New Jersey Ave., SE
Washington, DC 20590

MAR 30 2010

Mr. Kyle Pitsor
Vice President, Government Relations
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1752
Rosslyn, VA 22209

Ref. No.: 09-0160

Dear Mr. Pitsor:

This responds to your July 13, 2009 letter requesting clarification of the applicability of the Hazardous Materials Regulations (HMR; 49 CFR Parts 171-180) to the transport of used dry cell batteries and used lithium metal batteries. You reference a letter issued by this Office to Kinsbursky Brothers Inc. (09-0090) pertaining to the transport of used alkaline batteries transported for recycling or disposal. You provide additional test data illustrating different short circuit scenarios involving alkaline batteries, carbon zinc cylindrical and lantern batteries and lithium coin and lithium cylindrical cells.

In letter Ref. No. 09-0090, we stated that based on the test data provided, spent 1.5 volt alkaline dry cell batteries are not subject to regulation under the HMR when transported by highway or rail because they are not likely to generate a dangerous quantity of heat nor are they likely to short circuit or create sparks when they are transported in a packaging with no other battery types or chemistries present. You request confirmation that used or spent non-lithium batteries utilizing dry chemistries (i.e., alkaline and carbon zinc) that are combined in the same package without terminal protection do not pose an unreasonable risk in transportation and, thus are not subject to the HMR.

Your understanding is correct. After further consideration and analysis of the battery chemistries and sizes in question, and based on information available to us, it is the opinion of this Office that used or spent dry, sealed batteries of both non-rechargeable and rechargeable designs, described as "Batteries, dry, sealed, n.o.s." in the Hazardous Materials Table in § 172.101 of the HMR and not specifically covered by another proper shipping name, with a marked rating of 9-volt or less that are combined in the same package and transported by highway or rail for recycling, reconditioning, or disposal are not subject to the HMR. Note that batteries utilizing different chemistries (i.e., those battery chemistries specifically covered by another proper shipping name) as well as dry, sealed batteries with a marked rating greater than 9-volt may not be combined with used or spent batteries of the type "Batteries, dry, sealed, n.o.s." in the same package. Note also, that the clarification provided in this letter does not apply to batteries that have been reconditioned for reuse.

You also provided test data on lithium metal coin cells and cylindrical lithium metal cells representing various states of discharge. Lithium metal cells were placed randomly in a rigid plastic container. Temperatures were measured in various locations inside the container. Even in a partially discharged state, the lithium cells were capable of producing higher temperatures than the comparable alkaline and carbon zinc batteries. Further, most lithium batteries are comprised of a sealed metal can and contain a flammable electrolyte not found in other dry battery chemistries. We have concerns that the observed elevated temperatures and many unprotected lithium cells in close proximity to each other in an enclosed space could lead to increased pressure inside individual lithium cells, leaking of the flammable electrolyte and possibly a thermal runaway situation characterized by rapidly increasing temperatures and exothermic side reactions. We have observed various transportation and non-transportation incidents involving lithium batteries not properly protected from short circuits. While these incidents likely resulted from a lack of compliance, they serve to illustrate the point that even while partially discharged, lithium batteries pose a risk of evolving a dangerous quantity of heat while in transportation. Therefore, spent or used lithium batteries must be offered for transportation in a manner that protects against short circuits, damage and the evolution of a dangerous quantity of heat in accordance with all applicable requirements of the HMR.

I trust this satisfies your inquiry. If we can be of further assistance, please contact us.

Sincerely,

Charles E. Betts
Chief, Standards Development
Office of Hazardous Materials Standards

NEMA
Setting Standards for Excellence

KYLE PITSOR
Vice President, Government Relations

Leary
§172.102 SP 130
§173.21.
§173.185
Batteries
09-0160

July 13, 2009

Mr. Charles Betts
Office of Hazardous Materials Standards
Pipeline and Hazardous Materials Safety Administration
U.S. Department of Transportation
East Building
1200 New Jersey Ave. SE
Washington, DC 20590-0001

RE: 49 CFR §172.102, Special Provision 130, and §173.21

Dear Mr. Betts,

I am writing on behalf of the Dry Battery Section of the National Electrical Manufacturers Association (NEMA) to request the Department's interpretation of the applicability of 49 CFR §172.102 Special Provision 130 and §173.21 on primary (non-rechargeable) spent or scrap dry cell batteries being shipped for recycling or disposal. The information provided below and in the attachment supplements the April 16, 2009 letter from Kinsbursky Brothers (KBI), Inc and Toxco Inc. regarding the applicability of 49 CFR §172.102 Special Provision 130 and, §173.21 on spent alkaline dry cell batteries being shipped for recycling or disposal. Data generation and this letter were all drafted and completed prior to the 23 June 2009 response from DOT/PHMSA to KBI, but we include all our data below for reference.

The difference in this letter from the KBI letter is the inclusion of scrap batteries (varying states of charge) and all non-rechargeable dry cell batteries (alkaline and carbon zinc, as opposed to just alkaline). While they are also technically primary dry cell batteries, lithium metal batteries are covered separately below.

As mentioned in the KBI letter, it appears the Hazardous Materials Regulations (HMR) do not account for the low risk associated with the transport of non-lithium primary dry cell batteries. The requirement in Special Provision 130 to insulate the terminals of each and every dry cell battery in transportation presents numerous technical and financial problems for spent and scrap types and is unnecessary for these chemistries of batteries, as outlined in the KBI letter.

To further support our joint request, the NEMA Dry Battery Section has completed short circuit testing of a number of different scenarios representing reasonable and worst case conditions for spent or scrap batteries in transportation. Testing was conducted for alkaline and carbon zinc cylindrical and lantern batteries as well as lithium coin cells and lithium cylindrical cells.

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Unlabeled and undischarged samples were used in many of the test scenarios to represent an absolute worst case condition. Unlabeled and undischarged samples maximize the short circuit and heat generation potential. However, this condition would be rarely found in the field since in most, if not all collection scenarios the batteries collected would be discharged and labeled.

In NEMA's testing, in no case was there a dangerous evolution of heat generated, even during the worst case scenarios. More realistic scenarios showed maximum temperatures in the 25 – 35°C range.

The scenarios tested and the results are shown in the attached annex in two sections:

1. Alkaline and carbon zinc batteries
2. Lithium batteries

Based on the additional data presented in the attached annex, NEMA makes the following requests.

Non-lithium primary dry cell batteries

NEMA is requests the Department's agreement that based on the additional testing provided:

1. Non-lithium dry cell batteries (Batteries, Dry Sealed n.o.s.) are incapable of producing a dangerous evolution of heat during transportation.

2. Non-lithium dry cell batteries (Batteries, Dry Sealed n.o.s.), based on their chemistry and design, meet the requirements of SP 130 without the need to insulate the terminals of these batteries when scrap or discharged. While technically, even new batteries, as tested, would not evolve dangerous levels of heat, the battery industry has no intention of shipping new batteries, intended for retail or other customers, in a manner that does not protect from short circuit.

Lithium primary dry cell batteries

NEMA is requesting the Department's agreement that based on the additional testing of spent lithium primary batteries:

1. Spent (and only spent) lithium primary batteries, when mixed with consumer spent other battery types, are incapable of producing a dangerous evolution of heat during transportation.

2. Spent (and only spent) lithium primary batteries, when mixed with consumer spent other battery types, meet the requirements of SP 130 without the need to insulate the terminals of these batteries.

Thank you for your consideration of the attached data and of the above requests. I look forward to your reply. Please contact Craig Updyke or my staff at 703 841 3294 or cra_updyke@nema.org with any questions, concerns or comments.

Respectfully,

Kyle Pitsor

Kyle Pitsor
Vice President, Government Relations

Attachment: Technical annex

REF: INTERPRETATION LETTER TO MR. KYLE PITSOR AT NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (1-7-2010)

This reviewer (Steve Hwang) has some concerns about the wording in the letter drafted for response for the following reasons:

1. Non-lithium dry cell batteries

The summary for the test data under the heading of "Alkaline and carbon zinc batteries" shows that "lantern cells" were "Not tested" in the "Discharged" states. Hence, I would be cautious about the wording in the last sentence of the first paragraph of the response letter. I would recommend changing " and lantern batteries" to "except for lantern batteries." Also the summary table indicates "Not yet tested" in the "Discharges states" for the alkaline and carbon zinc batteries although the draft response letter seems to indicate that the test data are inclusive of these conditions. No profile of battery energy content or the range of voltages used in the experiments was not provided. It would be appropriate to raise a question regarding how NEMA made conclusion that "Non-lithium dry cell batteries are incapable of producing a dangerous evolution of heat" despite the NEMA data that "Undischarged," "Unlabeled" alkaline and carbon zinc batteries showed a significant rise in the maximum temperature (over 100 °C versus about 30 °C) compared to "Undischarged," "Labeled" batteries and regarding what the definitions for "Undischarged," "Discharged," "Labeled," and "Unlabeled" are.

2. Lithium batteries

Measured temperatures are shown at various locations of the experimental set-up before and after stirring. Six temperature measurements are reported on the table in terms of "Maximum temperature." Out of these six, three data points were shown to be "Not yet tested." Rather than indicating incompleteness of the tests results, the draft letter states that "Even in a partially discharged state,... higher temperatures than the comparable alkaline and carbon zinc batteries." There is no "partially discharged state" included in the summary. Also this statement regarding the temperature rise is not consistent with the NEMA's data. It would be inappropriate to compare the temperature rises between the lithium batteries and dry cell batteries because of different chemistry, electrolytes, and the designs used. We would just note that we can not make any conclusions based on the "Not yet tested" data base and the temperature rise exceeding 100 °C. In addition to the past histories of incidents and the flammability of electrolyte we indicate hazards associated with lithium batteries especially with the primary lithium batteries because of possibility of external and internal short-circuiting unless terminals are protected. I would indicate that the NEMA's data are insufficient to make any conclusions regarding the issues that NEMA is addressing because of the "Not yet tested" data base and the consequences associated with the rise in maximum temperature up to 104 °C in an experiment.

Technical Annex to NEMA Letter

Alkaline and carbon zinc batteries

Battery Type	State of Charge	Labeled / Unlabeled	Maximum Temperature (°C)
Alkaline AA/AAA	Undischarged	Labeled	28.5
	Undischarged	Unlabeled	104
	Discharged	Labeled	Not yet tested
	Discharged	Unlabeled	Not yet tested
	Discharged	Mixed	32
Carbon zinc AA/AAA	Undischarged	Labeled	26.2
	Undischarged	Unlabeled	105
	Discharged	Labeled	Not yet tested
	Discharged	Unlabeled	Not yet tested
Carbon zinc Lantern	Undischarged	--	137.8
	Discharged	Less severe; Not tested	
Alkaline Lantern	Undischarged	--	151.2
	Discharged	Less severe; Not tested	

9/13 not tested

151.6

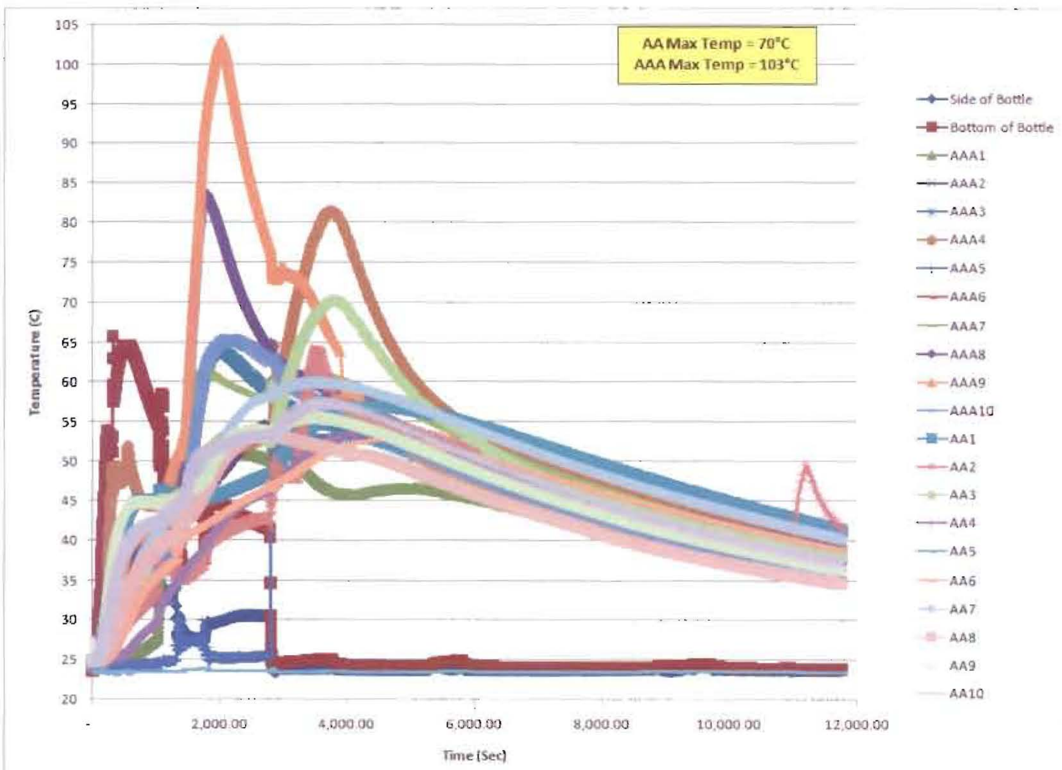
Except for the lantern batteries, AA and AAA cells were used to maximize the potential for short circuit and heat generation. It is important to note that the maximum temperature listed above was the highest observed temperature found at a single point and not the temperature of the container or every single battery in the container as is shown in the infrared images. This maximum temperature is the highest recorded value from either the thermocouples or the infrared image. Infrared was used to show the profile of temperatures seen inside the containers.

Each set of tests below was conducted in a lexan box with no air circulation as pictured below.

Alkaline - Unlabeled, Undischarged AA and AA

		
Top of Container Approximately 100 AA and 100 AAA Batteries	Side of Container	Infrared Picture of Side Maximum Temp = 104°C

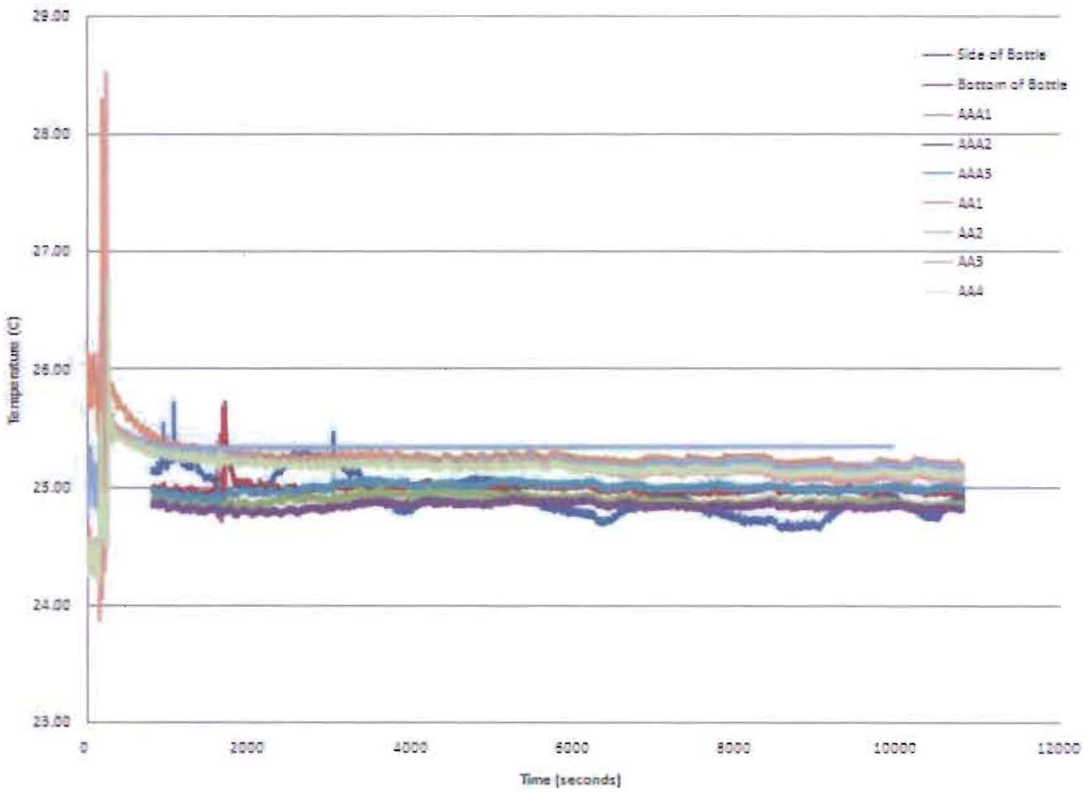
Profile of temperature of cells with thermocouples



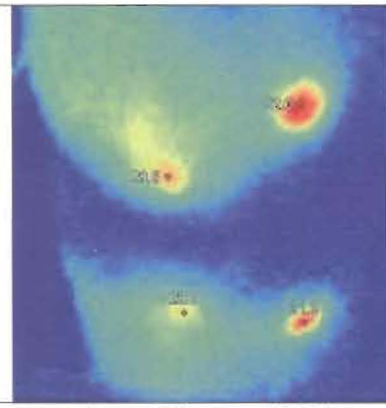
Alkaline - Labeled, Undischarged AA and AAA

	No infrared image available
Side of Container Approximately 100 AA and 100 AAA Batteries	Maximum Temperature = 28.5°C

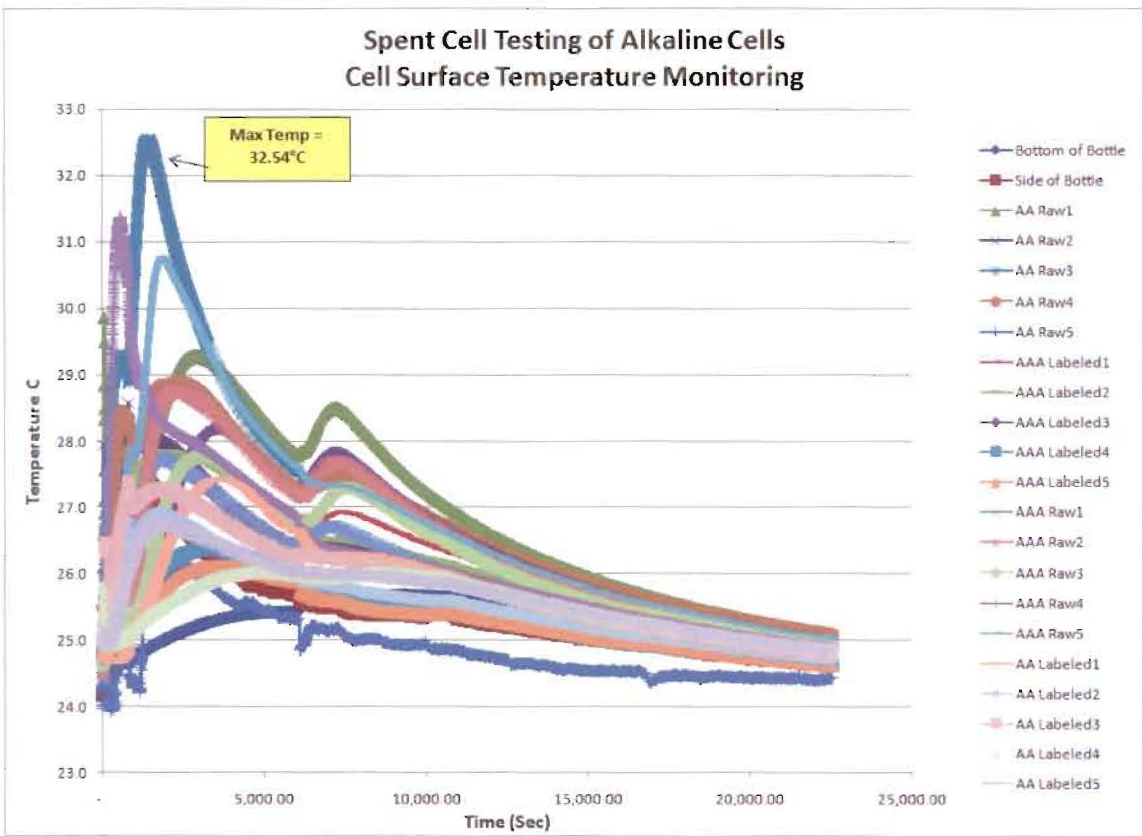
Profile of temperature of cells with thermocouples



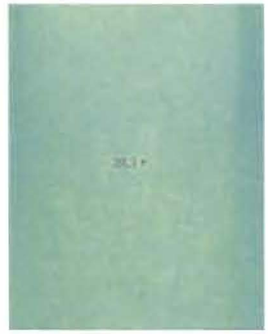
Alkaline - Mix of Labeled and Unlabeled, Discharged AA and AAA

	
Top of Container Approximately 100 AA and 100 AAA Batteries	Infrared Picture of Side Maximum Temperature = 32°C

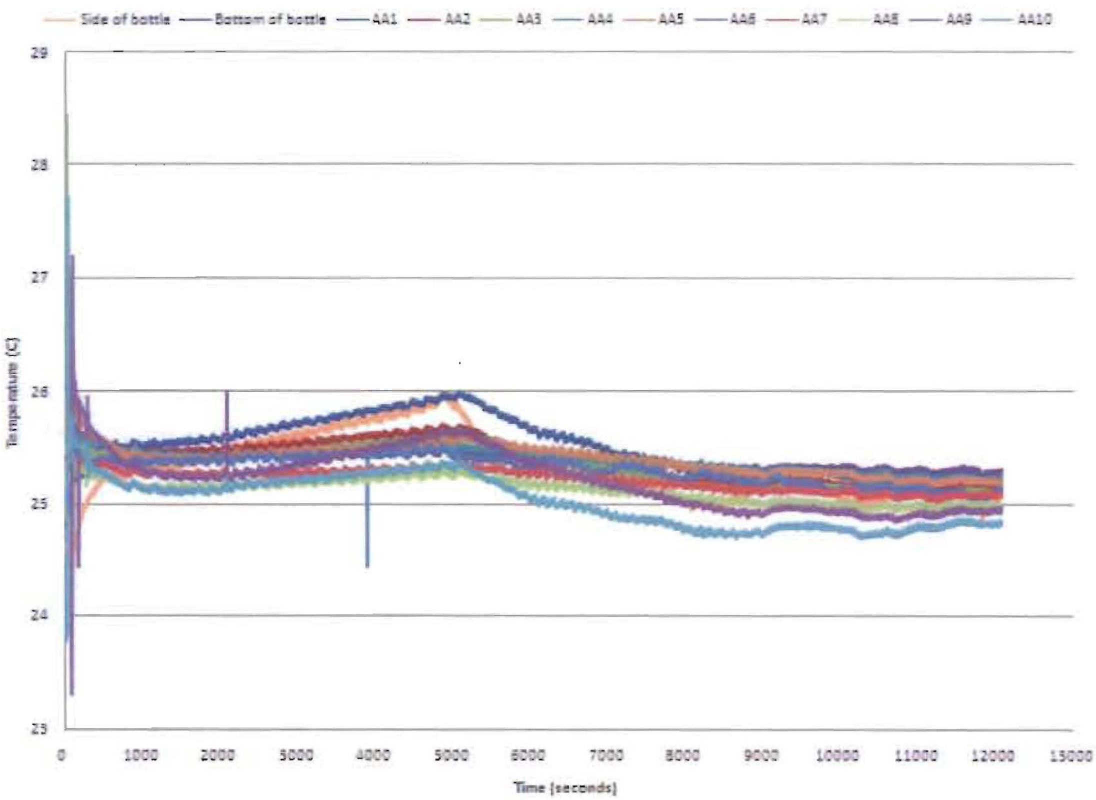
Profile of temperature of cells with thermocouples



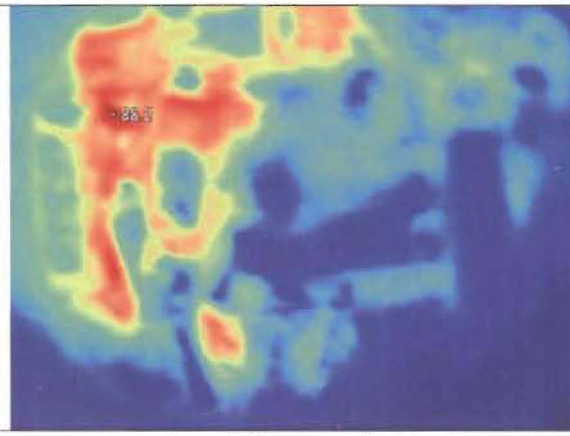
Carbon Zinc – Labeled, Undischarged AA

	
Test Setup Approximately 100 AA Batteries	Infrared Picture of Sides Maximum Temperature = 26.2°C

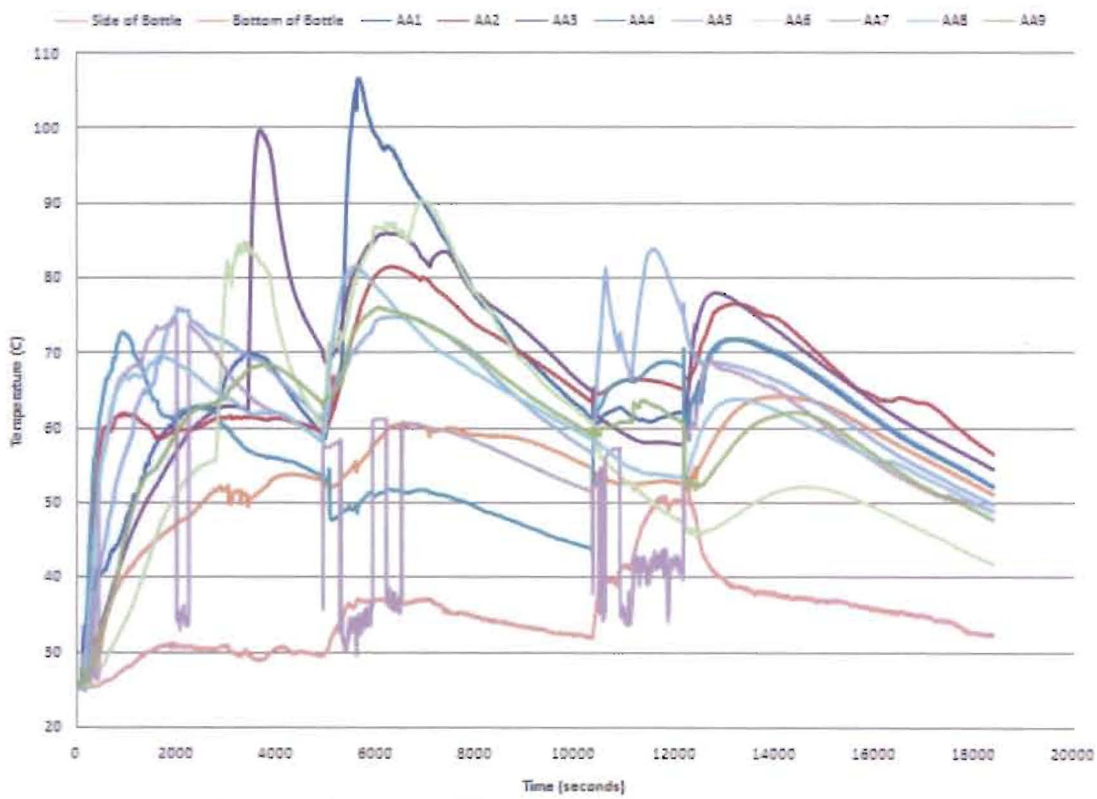
Profile of temperature of cells with thermocouples



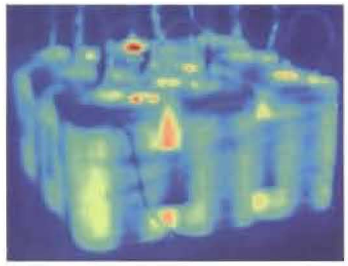
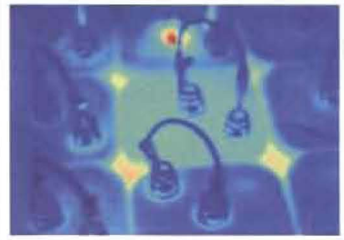
Carbon Zinc – Unlabeled, Undischarged AA

	
Test Setup Approximately 100 AA Batteries	Infrared Picture of Sides Maximum Temperature = 105°C

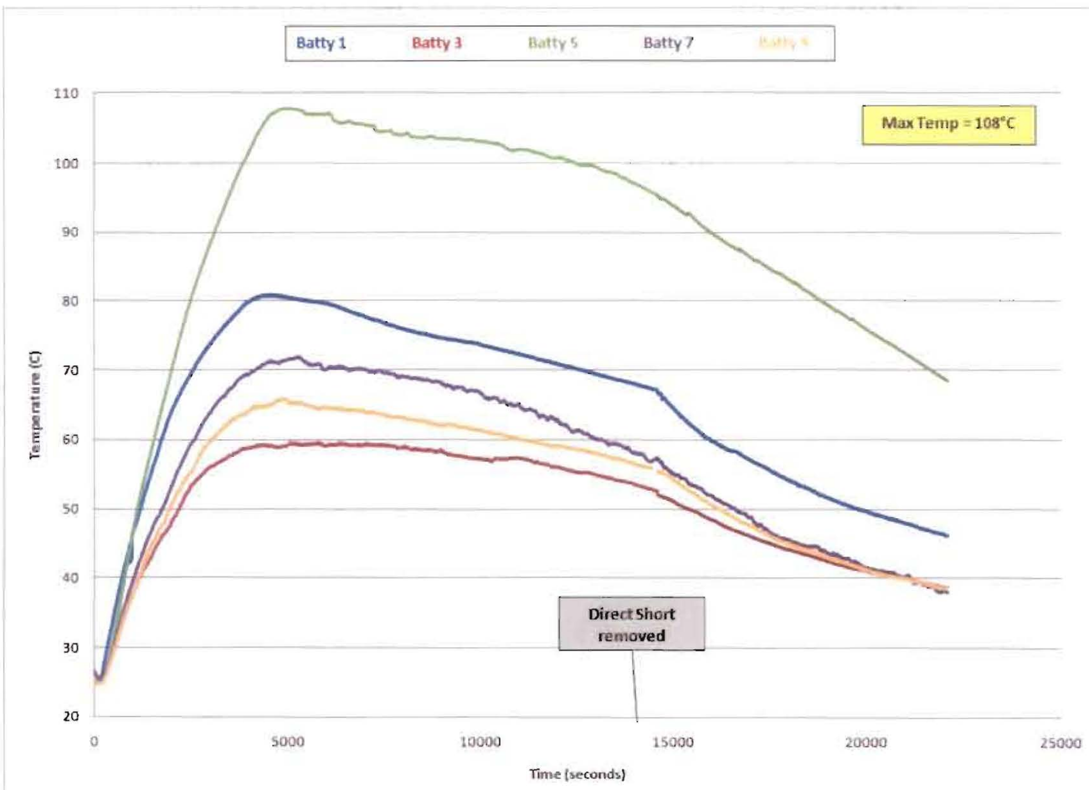
Profile of temperature of cells with thermocouples



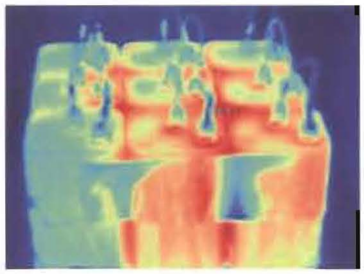
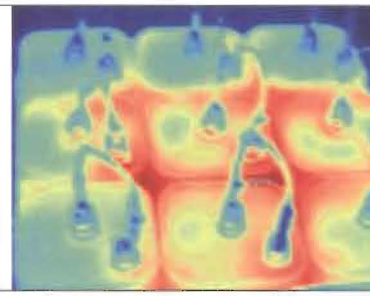
Carbon Zinc Lantern Batteries – Undischarged

		
Test Setup	Infrared Picture of Sides Maximum Temperature = 67.8°C	Infrared Picture of Tops Maximum Temperature = 137.8°C

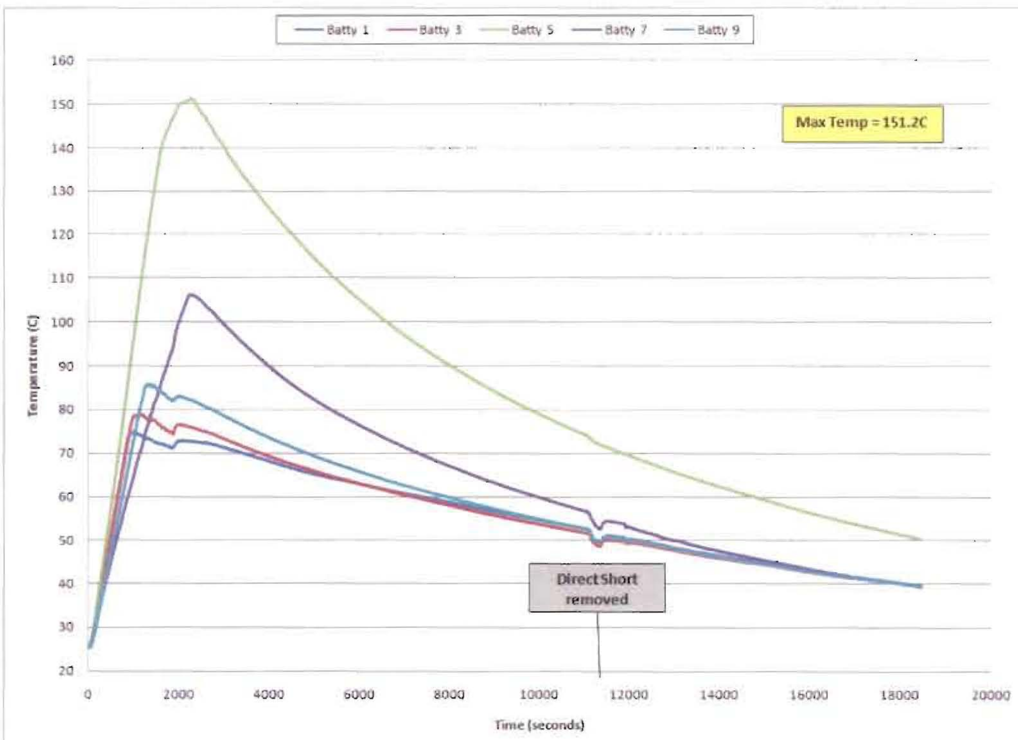
Profile of temperature of cells with thermocouples



Alkaline Lantern Batteries – Undischarged

		
Test Setup	Infrared Picture of Sides Maximum Temperature = 110.1°C	Infrared Picture of Tops Maximum Temperature = 121.6°C

Profile of temperature of cells with thermocouples



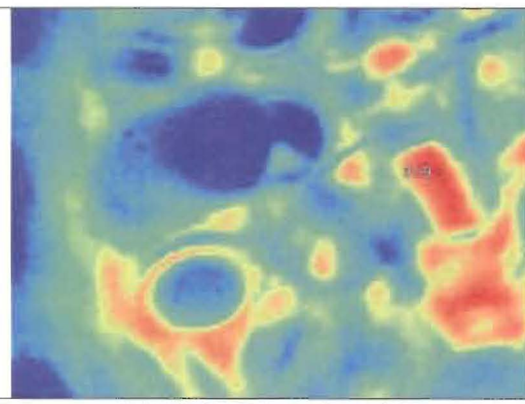
Lithium batteries

In addition to the carbon zinc and alkaline dry cell batteries, several sets of lithium batteries were also tested. The types tested were:

Battery Type	State of Charge	Labeled / Unlabeled	Maximum Temperature (°C)
Lithium Coin	Undischarged	Coin cells are never labeled	Not yet tested
	Discharged		34.1
Lithium 1.5V AA/AAA	Undischarged	Labeled	Not yet tested
	Undischarged	Unlabeled	104
	Discharged	Labeled	Not yet tested
	Discharged	Unlabeled	27.6

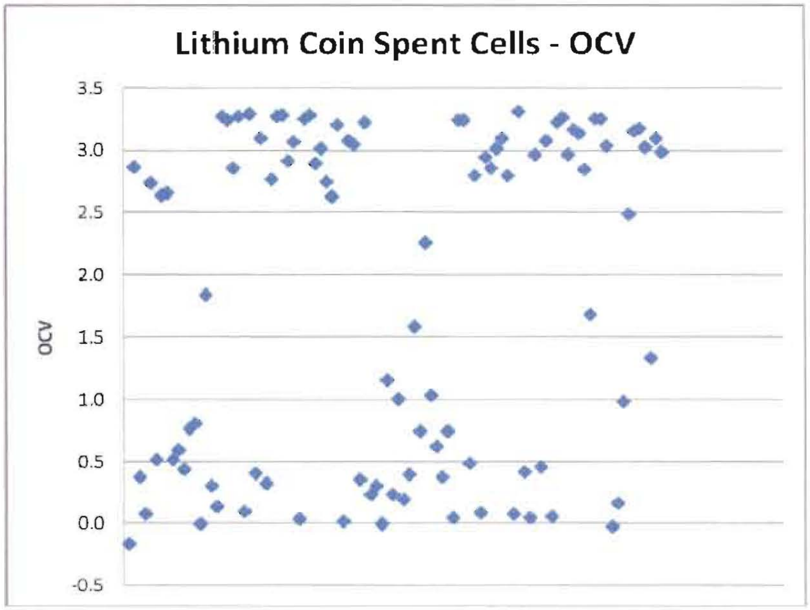
Unlabeled, Discharged Lithium Coin Cells (All Coin Cells are Unlabeled)

Side of Container
Approximately 165 Batteries

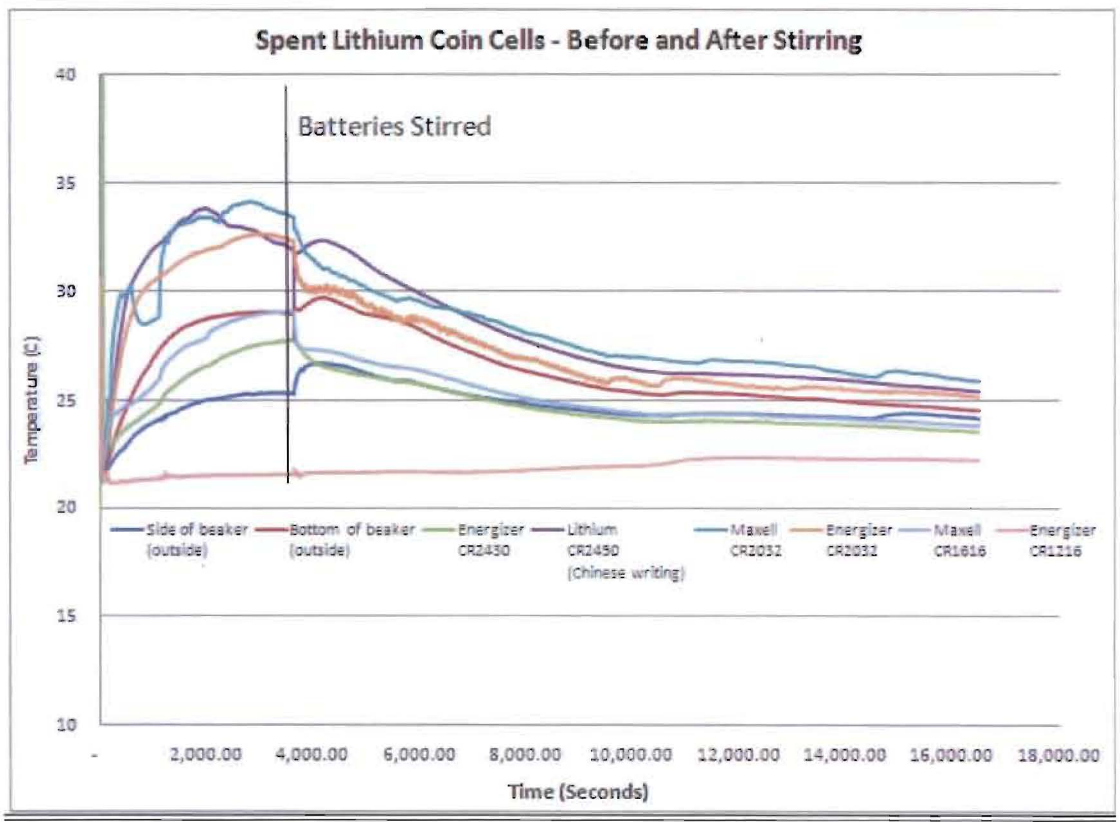


Infrared Picture from Top
Maximum Temperature = 34.1°C

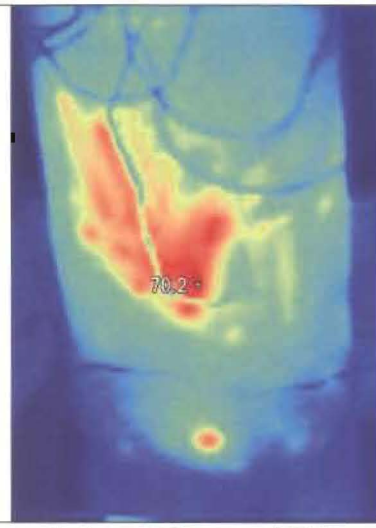
The cells tested represented varying states of discharge. A profile of the open circuit voltages of these batteries is shown below. Undischarged lithium coin cells are nominally about 3.0 volts but their typical new open circuit voltage is 3.2 – 3.3 volts.



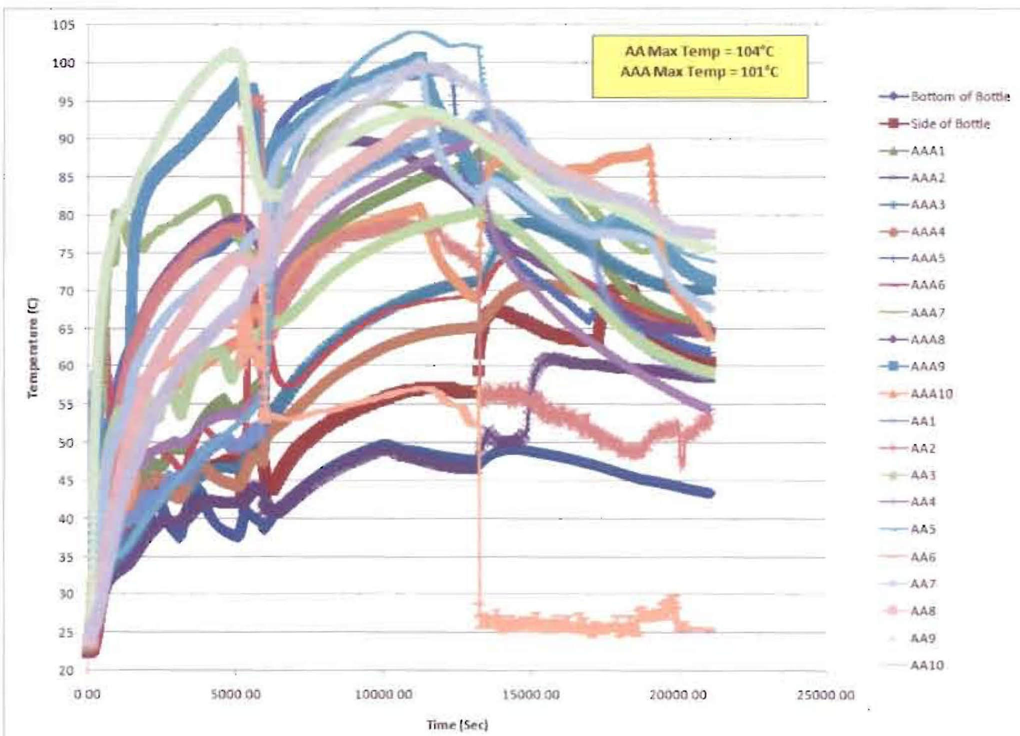
Profile of temperature of cells with thermocouples



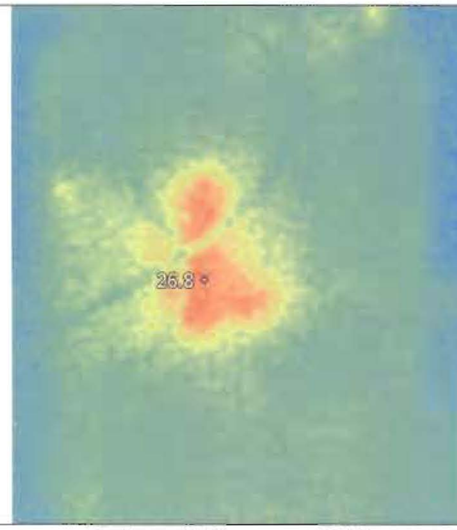
Unlabeled, Undischarged Lithium (1.5V) AA and AAA

	
Side of Container Approximately 100 AA and 100 AAA Batteries	Infrared Picture of Side Maximum Temperature = 104°C

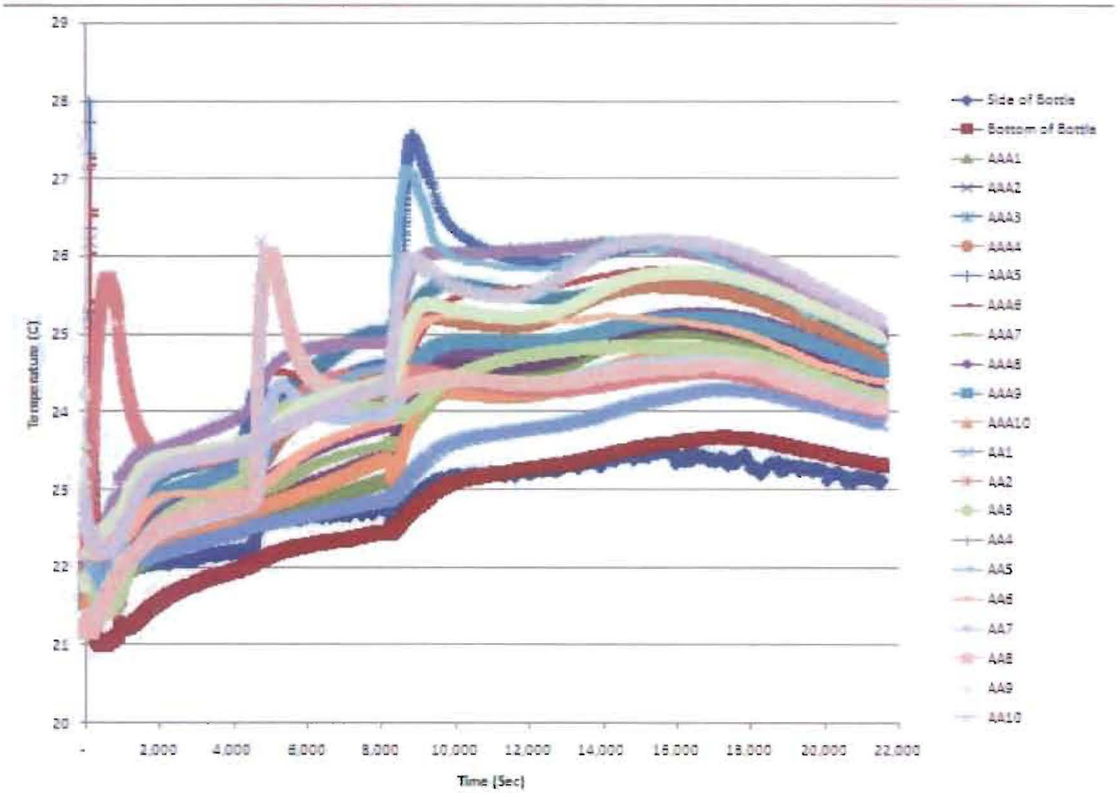
Profile of temperature of cells with thermocouples



Unlabeled, Discharged Lithium (1.5V) AA and AAA

	
Side of Container Approximately 125 AA and 60 AAA Batteries	Infrared Picture of Side Maximum Temperature = 27.6°C

Profile of temperature of cells with thermocouples



END OF TECHNICAL ANNEX