Lithium Battery Information Sheet

Section 1: Identification

Products Name: Primary (non-rechargeable) Lithium metal Sulfuryl Chloride (Li/SO2Cl2) cells and batteries. Cells include the 3.9V cells series and the batteries assembled from them.

This Battery Information Sheet covers the the above Cells sizes: TL-6902, TL-6903, TL-6955, TL-6920, TL-6930, and TL-6937 with all their finishing versions and batteries assembled from them, denoted by "/" followed by letters or digits.

Manufacturer Name: Tadiran, US office address- 2001 Marcus Avenue, Suite 125E, Lake Success, NY 11040.

US office address: 2001 Marcus Avenue, Suite 125E, Lake Success, NY 11040

Emergency Telephone No: CHEMTREC: 1-800-424-9300

Tel. for information: 1-516-621-4980

Section 2: Hazards Identification

The Lithium Sulfuryl chloride batteries described in this Battery Information Sheet are hermetically sealed units, which are not hazardous when used according to the recommendations of the manufacturer.

Under normal condition of use of the batteries, the electrode materials and the liquid electrolyte they contained are non-reactive provided the battery integrity is maintained. Risk of exposure exists only in case of mechanical, electrical or thermal abuse. Thus the batteries should not short circuit, recharge, puncture, incinerate, crush, immerse in water, force discharge, or expose to temperatures above the temperature range of the cell or battery. In these cases there is risk of fire or explosion.

Protection from charging:

Whenever lithium batteries are not the single power source in a circuit, Whenever lithium batteries are not the single power source in a circuit, the measures recommended by Underwriters Laboratories are relevant. The relevant protection means should be recommended/approved by TADIRAN.

Section 3: Composition/Information on Ingredients

Ingredient Name	CAS #	%	ACGIH (TLV) *	OHSA (PEL)
Lithium Metal (Li)	7439-93-2	4-6%	Not Established	None
Sulfuryl Chloride (SO2Cl2)	7791-25-5	35-45%	N/A	N/A
Thionyl Chloride (SOCl2)	7719-09-7	3-5%	1 ppm (5 mg/M3)	5 mg/m3
Carbon (C)	1333-86-4	3-6%	3.5 mg/m3	3.5 mg/m3
Aluminum Chloride (AlCl3)	7446-70-0	4-6%	2 mg/m3 (Al salt, soluble)	
Lithium Chloride (LiCl)	7447-41-8	1-2%	Not Established	
Glass		<1%	Not Established	
PVC	9002-86-2	<1%	Not Established	
PTFE	9002-84-0	<1%	Not Established	

** TLV- Threshold Limit Value is personal exposure limits determined by ACGIH (American Council of Governmental Industrial Hygienists).*

IMPORTANT NOTE: The above levels are not anticipated under normal use conditions.

Section 4: First aid measures

In case of battery rupture, explosion, or major leakage, evacuate personnel from contaminated area and provide good ventilation to clear out corrosive fumes, gases or the pungent odor. Seek immediate medical attention.

Eyes - First rinse with plenty of water for 15 minutes (remove contact lenses if easily possible), and then seek medical attention.

Skin - Remove contaminated clothes and rinse skin with plenty of water or shower for 15 min. Refer to medical attention.

Inhalation - Remove to fresh air, rest, and half-upright position, use artificial respiration if needed, and refer to medical attention.

Ingestion - rinse mouth, DO NOT induce vomiting, give plenty of water to drink, and refer to

Section 5: Fire - fighting measures

FLASH POINT:	NA	LOWER (LEL):	NA
FLAMMABLE LIMIT IN AIR:	NA	UPPER (LEL):	NA

EXTINGUISHING MEDIA:

1. Lith- X (Class D extinguishing media) is the **only** effective on fires involving a few lithium batteries. If the cells are directly involved in a fire **DO NOT USE:** WATER, SAND, CO_2, HALON, and DRY POWDER OR SODA ASH EXTINGUISHERS.

2. If the fire is in adjacent area and the cells that are either packed in their original containers or unpacked, the fire can be fought based on fueling material, e.g., paper and plastic products. In these cases the use of copious amounts of **cold** water is effective extinguishing media. Storage area may also employ sprinkler system with cold water.

AUTO-IGNITION: NA

SPECIAL FIRE FIGHTING PROCEDURES: Wear self-contained breathing apparatus to avoid breathing of irritant fumes (NIOSH approved SCBA & full protective equipment). Wear protective clothing and equipment to prevent body contact with electrolyte solution.

Fire may be fought, but only from safe fire-fighting distance. Evacuate all persons from immediate area of fire.

UNUSUAL EXPLOSION AND FIRE EXPLOSION: Battery may explode when subject to: excessive heat (above 150^{o}C), recharged, over-discharged (discharge below 0V), punctured and crushed. During thermal decomposition generation of chlorine (Cl_2), hydrogen chloride (HCl), and sulfur dioxide (SO_2) can be formed.

Section 6: Accidental release measures

PROCEDURES TO CONTAIN AND CLEAN UP LEAKS OR SPILLS: The material contained within the battery would only be released under abusive conditions.

In the event of battery rapture and leakage: contain the spill while wearing proper protective clothing and ventilate the area. Then, cover with sodium carbonate (Na_2CO_3) or 1:1 mixture of soda ash and slaked lime. Keep away from water, rain, and snow. Placed in approved container (after cooling if necessary) and disposed according to the local regulations.

NEUTRALIZING AGENTS: Sodium carbonate (Na_2CO_3) or 1:1 mixture of soda ash and slaked lime.

WASTE DISPOSAL METHOD: Product decomposed by water must be neutralized. if sufficiently diluted, it may be added to waste water if it is sufficiently diluted.

PRECAUTIONS IN HANDLING AND STORAGE: avoid short-circuiting, over-charging and heating to high temperatures. Store the batteries in dry and cool area and keep container dry and tightly closed in well-ventilated area. Store cells away from food and drink.

OTHER PRECAUTIONS; Never attempt to disassemble, machine, or otherwise modify batteries or injury may result.

Section 7: Handling and Storage

The batteries should not be opened, destroyed or incinerate, since they may leak or rupture and release to the environment the ingredients that they normally contained in the hermetically sealed container.

HANDLING- Do not short circuit terminals, or expose to temperatures above the temperature rating of the battery, over charge the battery, forced over-discharge (voltage below 0.0V), throw to fire.

Do not crush or puncture the battery, or immerse in liquids.

STORAGE- is preferably done in cool (below 30^{o}C), dry and ventilated area, which is subject to little temperature change.

Do not place the battery near heating equipment, nor expose to direct sunlight for long periods. Elevated temperatures can result in shortened battery life and degrade performance.

Keep batteries in original packaging until use and do not jumble them.

Do not store batteries in high humidity environment for long periods.

OTHER- cells and batteries are not rechargeable batteries and should not be charged.

Applying pressure and deforming the battery may lead to disassembly followed by eye skin and throat irritation.

Follow manufacturer recommendations regarding maximum recommended current and operating temperature range.

Section 8: Exposure controls / personal protection

GENERAL- The following safety measures are not necessary in normal use. They need only be applied if there is a risk that, in use or handling, the recommendations, as outlined in Section 3, have not been followed.

RESPIRATORY PROTECTION: In case of abuse or leak of liquid or fumes, use NIOSH approved Acid Gas Filter Mask or Self-Contained Breathing Apparatus.

VENTILATION: In case of abuse, use adequate mechanical ventilation (local exhaust) for battery that vents gas or fumes.

PROTECTIVE GLOVES: In case of spill use PVC or Nitrile gloves of 15 mils (0.015 inch) or thicker.

EYE PROTECTION: Use ANSI approved chemical worker safety goggles or face shield.

OTHER PROTECTIVE EQUIPMENT: In case needed, chemical resistance clothing is recommended along with eye wash station and safety shower should be available meeting ANSI design criteria.

WORK HYGIENIC PRACTICES: Use good hygiene practice. Wash hands after use and before drinking, eating or smoking. Launder contaminated cloth before reuse.

SUPPLEMENTARY SAFETY AND HEALTH DATA: If the battery is broken or leaked the main hazard is the electrolyte. The electrolyte is mainly solution of Lithium chloride (LiCl), and aluminum chloride ($AlCl_3$) in Thionyl chloride ($SOCl_2$).

Fires may be fought but only from safe firefighting distance, evacuate all persons from immediate area of fire. Prevent heating of the battery, charging the battery, discharge to predetermined limit, do not crush, disassemble, incinerate or short circuit.

Section 9: Physical and chemical properties

TASTE	NA, unless individual components exposed
SPECIFIC GRAVITY (GR/CC)	> 1 gr/cc
BOILING POINT (760 mm Hg)	NA, unless individual components exposed
MELTING POINT	NA, unless individual components exposed
VAPOR PRESSURE (mm Hg, 20ºC)	NA, unless individual components exposed
VAPOR DENSITY	NA, unless individual components exposed
VOLATILE BY VOLUME (%)	NA, unless individual components exposed
EVAPORATION RATE (butyl acetate=1)	NA, unless individual components exposed
PHYSICAL STATE	Solid
SOLUBILITY IN WATER (% by weight)	NA, unless individual components exposed
PH (1% solution in water)	NA, unless individual components exposed
Appearance	Geometric Solid Object.
ODOR	If leaking, gives off pungent corrosive odor

Section 10: Stability and reactivity

STABLE OR NOT STABLE — Stable

INCOMPATIBILITY (MATERIAL TO AVOID) — Strong mineral acids, water and alkali solutions.

HAZARDOUS DECOMPOSITION PRODUCTS

1. Reaction of lithium with water: Hydrogen (H_2), Lithium hydroxide (LiOH).
2. Thermal decomposition over 150ºC: Sulfur oxides, (SO_2, SO_3), Sulfur chlorides (SCl_2, S_2Cl_2), Chlorine (Cl_2), Lithium oxide (Li_2O).
3. Electrolyte with water: Hydrogen Chloride (HCl), Sulfuric acid (H2SO4), Chlorine (Cl_2) and SO_2

DECOMPOSITION TEMPERATURE (ºF) — NA

HAZARDOUS POLYMERIZATION: May Occur____ Will Not Occur __X__

CONDITIONS TO AVOID — Avoid mechanical abuse and electrical abuse such as short-circuiting, overcharge, over-discharge, (voltage reversal) and heating.

Section 11: Toxicological information

THRESHOLD LIMIT VALUE (TLV) AND SOURCE: NA

ACUTE TOXICITY OF INTERNAL COMPONENTS:

Sulfuryl Chloride	LC50 inhalation, rat, 1 hour- 131-242 ppm	LD50- N/A
Thionyl Chloride	LC50 inhalation, rat, 1 hour- 500 ppm	LD50- N/A

HEALTH HAZARD ACUTE AND CHRONIC: Inhalation, skin contact, eye contact and ingestion are not likely by exposure to sealed battery.

Inhalation, skin contact and eye contact are possible when the battery is opened. Exposure to internal contents, the corrosive fumes will be very irritating to skin, eyes and mucous membranes. Overexposure can cause symptoms of non-fibrotic lung injury and membrane irritation.

Carcinogenicity- NTP: No

Carcinogenicity- IARC: No

Carcinogenicity- OSHA: No

Risk Phrases for Sulfuryl Chloride are: R14, R23, R24, R25, R34 and R37

Safety Phrases for Sulfuryl Chloride are: S26, S36, S37, S39 and S45.

SIGNS AND SYMPTOMS OF OVEREXPOSURE: Exposure to leaking electrolyte from ruptured or leaking battery can cause:

Inhalation- Burns and irritation of the respiratory system, coughing, wheezing, and shortness of breath.

Eyes- Redness, tearing, burns. The electrolyte is corrosive to all ocular tissues.

Skin- The electrolyte is corrosive and causes skin irritation and burns.

Ingestion- The electrolyte solution causes tissue damage to throat and gastro/ respiratory track.

MEDICAL CONDITION AGGRAVATED BY EXPOSURE: Preexisting skin, asthma and respiratory diseases are generally aggravated by exposure to liquid electrolyte vapors or liquid.

For further information refer to section 4.

Section 12: Ecological information

1. When properly used or disposed the battery does not present environmental hazard.
2. Cells do not contain mercury, cadmium, lead or other heavy metals.
3. Do not let internal components enter marine environment. Avoid release to waterways, wastewater or ground water.

Section 13: Disposal Considerations

1. Dispose in accordance with the applicable regulations in country and state.
2. Disposal should be performed by permitted, professional disposal firms knowledgeable in Federal, State or Local requirements of hazardous waste treatment and hazardous waste transportation.
3. Incineration should never be performed by battery users, but eventually by trained professional in authorized facility with proper gas and fume treatment.
4. Battery recycling should be done in authorized facility.

Section 14: Transport information

Shipping Name:

UN 3090: Lithium Metal Batteries

UN 3091: Lithium Metal Batteries contained in equipment, or
Lithium Metal Batteries packed with equipment

Hazard Classification: Class 9

Packing Group: N/A

Special provisions and packing instructions:

The cells and batteries are manufactured under a quality management program in an ISO9001 certified factory and meet all the requirements of a UN manual of tests and criteria, Part III, sub-section 38.3. The cells and batteries must be packed in accordance with Packing Instructions / Special Provisions (SP) of the applicable code:

IATA (59th revised edition)/ICAO (Packing Instructions: PI968, PI969 and PI970)

IMDG Code (SP188)

ADR (SP188).

Transportation within, to and from the US: are governed by the US DOT CFR 49, Parts 171, 172, 173 and 175. They details the required packaging and labels and transportation mode of cells transported separately or in equipment. The battery cannot be shipped, within, to, and from the US by passenger aircraft. Air shipments of cells can be done only by cargo aircraft.

Air transport: Lithium Metal cells and Batteries are forbidden for transport on passenger aircraft worldwide.

Section 15: Regulatory information

1. All the cells and batteries are defined as “articles” and thus are exempt from the requirements of the Hazard Communication Standard”.
2. The internal component (Thionyl chloride) is hazardous under the criteria of the Federal OHSA Hazard Communication Standard 29 CFR 1920.1200.
3. NFPA rating- Lithium batteries are not included in the NFPA material list. Below is the NFPA rating for lithium metal. Lithium metal is an internal component, enclosed by hermetically sealed metallic can. Under normal application is not exposed.

Section 16: Other information

The information and the recommendations set forth are made in good faith and believed to be accurate at the date of preparation. The present file refers to normal use of the product in question. Tadiran Batteries makes no warranty expressed or implied.

Assembly of battery packs:

The design and assembly of battery packs require special skills, expertise and experience. Therefore it is not recommended that the end user will attempt to self-assemble battey packs. It is preferable that any battery using lithium cells will be assembled by TADIRAN to ensure proper battery design and construction. A full assembly service is available from TADIRAN who can be contact for further information. If for any reason, this is not possible, TADIRAN can review the pack design in confidential to ensure that the design is safe and capable of meeting the stated performance requirements.

VERIFICATION OF COMPLIANCE

Product	Primary Lithium Sulphur Dioxide Battery Pack
Model/ Type Ref.	3200730-XXX / LP CR Plus
Ratings and Principal Characteristics	12 V, 1.5 Ah
Tested According to	UN Manual of Tests and Criteria, Part III, sub-section 38.3
Verification Report No.	4058616BAT-001
Date of Issued	2017.02.01
Applicant	Physio-Control Inc.
Address of Applicant	11811 Willows Road NE, Redmond, WA 98052, USA
As shown in the Test Report No. which forms Part of this Verification	4058616BAT-001

Conclusion

Based upon a review of the Test Report(s), the apparatus mentioned above is deemed to comply with the below requirements of:

UN Manual of Tests and Criteria, Fifth Revised Edition, Amendment 2, Part III, sub-section 38.3

Test 1: Altitude Simulation
Test 2: Thermal Test
Test 3: Vibration
Test 4: Shock
Test 5: External Short Circuit
Test 6: Crush (component cell)
Test 8: Forced Discharge (component cell)

Note : This verification is only valid for the product and configuration described and in conjunction with the technical data detailed above.

Reviewed by

Rodney Grimes
Sr. Battery Engineer

UN 38.3 TRANSPORT TESTING REPORT

4058616

Physio-Control Inc.
Primary Lithium Sulphur Dioxide Battery Pack
(3200730-XXX / LP CR Plus)

The product has been tested to the procedures contained herein and the statements and data in this report are accurate and true to the best of our knowledge and belief. The test data contained within this report is confidential property of the client.

SGS North America
620 Old Peachtree Road, Suite 100
Suwanee, GA 30024
USA

Issue Date: February 1, 2017
Revision Date: none

Tested by:

Penny George

E&E Lab Technician

Reviewed by:

Rodney Grimes

Sr. Battery Engineer

REVISION HISTORY

Revision	Date	Justification
0	02.01.2017	Original Issue

Name and address of Client:

Physio-Control Inc.
11811 Willows Road NE
Redmond, WA 98052, USA

Sample Receipt Date: 11.23.2016
Date(s) of Tests and Measurements: 12.02.2016 – 01-10-2017

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GENERAL INFORMATION

Product Description

The Equipment Under Test (EUT) is a 12 V, 1.5 Ah Primary Lithium Sulphur Dioxide Battery Pack, Part Number: 3200730-XXX / LP CR Plus.

TESTS AND MEASUREMENTS

Method

Test requirements were performed in accordance with the Recommendations on the TRANSPORT OF DANGEROUS GOODS Manual of Tests and Criteria, 5th Revised Edition, Amendment 2. The following tests were performed.

T1: Altitude Simulation
T2: Thermal Test
T3: Vibration
T4: Mechanical Shock
T5: External Short Circuit
T6: Crush
T8: Forced Discharge

Test Equipment

All instrumentation is calibrated annually to NIST traceable standards. Test equipment used to evaluate the product is itemized in Table 8.

Test Results

Testing completed with no failures observed.

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FIGURE 1
TEST SAMPLES

Altitude Simulation

Method

Batteries were subjected to Altitude Simulation Testing. Samples were stored at a pressure of 11.6 kPa or less for at least six hours at ambient temperature (20±5°C).

Requirement

No mass loss beyond allowable limits, no leakage, no venting, no disassembly, no rupture, no fire and the open circuit voltage of each battery after testing is not less than 90% of its voltage immediately prior to the test procedure.

Results

Results for Altitude Simulation testing are given in Table 1. OCV is not considered for pass/fail criteria for samples D1 – D4 as samples are in fully discharged state.

TABLE 1
ALTITUDE SIMULATION RESULTS

Sample#	Initial		Final		Result (Pass/Fail)	Comment
	OCV (V)	Mass (g)	OCV (V)	Mass (g)		
U1	11.680	70.731	11.440	70.739	Pass	Tested under mpts#157
U2	11.700	70.691	11.690	70.701	Pass	Tested under mpts#157
U3	11.700	70.858	11.700	70.868	Pass	Tested under mpts#157
U4	11.710	70.673	11.650	70.683	Pass	Tested under mpts#157
D1		70.878		70.897	Pass	Tested under mpts#157
D2		71.129		71.139	Pass	Tested under mpts#157
D3		71.038		71.048	Pass	Tested under mpts#157
D4		70.750		70.760	Pass	Tested under mpts#157

Thermal Test

Method

Upon successful completion of Altitude Simulation Testing, the batteries were subjected to the Thermal Test. Samples were stored for at least six hours at a test temperature equal to 72±2°C, followed by storage for at least six hours at a test temperature equal to -40±2°C. The maximum time interval between test temperature extremes is 30 minutes. Procedure is repeated a total of 10 times, after which all samples are stored for 24 hours at ambient temperature (20±5°C).

Requirement

No mass loss beyond allowable limits, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each battery after testing is not less than 90% of its voltage immediately prior to the test procedure.

Results

Results for Thermal Test are given in Table 2. OCV is not considered for pass/fail criteria for samples D1 – D4 as samples are in fully discharged state.

TABLE 2
THERMAL TEST RESULTS

Sample#	Initial		Final		Result (Pass/Fail)	Comment
	OCV (V)	Mass (g)	OCV (V)	Mass (g)		
U1	11.440	70.739	11.670	70.726	Pass	Tested under mpts#157
U2	11.690	70.701	11.700	70.701	Pass	Tested under mpts#157
U3	11.700	70.868	11.690	70.868	Pass	Tested under mpts#157
U4	11.650	70.683	11.680	70.683	Pass	Tested under mpts#157
D1		70.897		70.885	Pass	Tested under mpts#157
D2		71.139		71.126	Pass	Tested under mpts#157
D3		71.048		71.036	Pass	Tested under mpts#157
D4		70.760		70.749	Pass	Tested under mpts#157

Vibration

Method

Upon successful completion of Thermal Testing, the batteries were subjected to Vibration Testing. Samples are firmly secured to the platform of the vibration machine. Samples were then subjected to a sinusoidal waveform with a logarithmic sweep between 7Hz and 200Hz and back to 7Hz traversed in 15 minutes. The cycle was repeated 12 times for a total of 3 hours for each of three mutually perpendicular axes. One of the directions of vibration must be perpendicular to the terminal face.

Requirement

No mass loss beyond allowable limits, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each battery after testing is not less than 90% of its voltage immediately prior to the test procedure.

Results

Results for Vibration Test are given in Table 3. OCV is not considered for pass/fail criteria for samples D1 – D4 as samples are in fully discharged state.

TABLE 3
VIBRATION RESULTS

Sample#	Initial		Final		Result (Pass/Fail)	Comment
	OCV (V)	Mass (g)	OCV (V)	Mass (g)		
U1	11.670	70.726	11.670	70.726	Pass	Tested under mpts#157
U2	11.700	70.701	11.640	70.689	Pass	Tested under mpts#157
U3	11.690	70.868	11.690	70.855	Pass	Tested under mpts#157
U4	11.680	70.683	11.700	70.670	Pass	Tested under mpts#157
D1		70.885		70.885	Pass	Tested under mpts#157
D2		71.126		71.126	Pass	Tested under mpts#157
D3		71.036		71.035	Pass	Tested under mpts#157
D4		70.749		70.748	Pass	Tested under mpts#157

Shock

Method

Upon successful completion of Vibration Testing, the batteries were subjected to Shock Testing. Samples were secured to by a means of a rigid mount which will support all mounting surfaces. Each sample subjected to a half-sine shock of peak acceleration of 150 g_n and pulse duration of 6 milliseconds. Each sample subjected to three shocks in the positive direction followed by three shocks in the negative direction of three mutually perpendicular mounting positions for a total of 18 shocks.

Requirement

No mass loss beyond allowable limits, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each battery after testing is not less than 90% of its voltage immediately prior to the test procedure.

Results

Results for Vibration Test are given in Table 4. OCV is not considered for pass/fail criteria for samples D1 – D4 as samples are in fully discharged state.

TABLE 4
SHOCK RESULTS

Sample#	Initial		Final		Result (Pass/Fail)	Comment
	OCV (V)	Mass (g)	OCV (V)	Mass (g)		
U1	11.670	70.726	11.680	70.725	Pass	Tested under mpts#157
U2	11.640	70.689	11.680	70.687	Pass	Tested under mpts#157
U3	11.690	70.855	11.730	70.855	Pass	Tested under mpts#157
U4	11.700	70.670	11.700	70.669	Pass	Tested under mpts#157
D1		70.885		70.883	Pass	Tested under mpts#157
D2		71.126		71.125	Pass	Tested under mpts#157
D3		71.035		71.034	Pass	Tested under mpts#157
D4		70.748		70.747	Pass	Tested under mpts#157

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External Short Circuit

Method

Upon successful completion of Shock Testing, the batteries were subjected to External Short Circuit Testing. Samples were stabilized to where the external case temperature reaches 55 ± 2°C and then the sample is subjected to a short circuit condition with a total external resistance of less than 80mΩ ± 20 mΩ at 55 ± 2°C. The short condition is continued for a minimum of one hour after the external case temperature has returned to 55 ± 2°C. The sample is then observed for an additional six hours.

Requirement

External temperature does not exceed 170°C and there is no disassembly, no rupture and no fire within six hours of testing.

Results

Results for External Short Circuit Test are given in Table 5.

TABLE 5
EXTERNAL SHORT CIRCUIT RESULTS

Sample#	Disassembly or fire within 6 hrs of testing	Result (Pass/Fail)	Comment
U1	No	Pass	Tested under mpts#157
U2	No	Pass	Tested under mpts#157
U3	No	Pass	Tested under mpts#157
U4	No	Pass	Tested under mpts#157
D1	No	Pass	Tested under mpts#157
D2	No	Pass	Tested under mpts#157
D3	No	Pass	Tested under mpts#157
D4	No	Pass	Tested under mpts#157

T.6 Crush

Method

Ten (10) previously untested component cells were subjected to crush testing. The cells were crushed between two flat surfaces. The crushing was gradual in speed of approximately 1.5cm/s at the first point of contact. The crushing continued until the first of the three options below was reached.

1. The applied force reaches 13 kN ±0.78kN, or
2. The voltage of the cell drops by at least 100mV, or
3. The cell is deformed by 50% or more of its original thickness.

Once the maximum pressure has been obtained, the voltage drops by 100mV or more, or the cell is deformed by at least 50% of its original thickness, the pressure shall be released.

Requirement

External temperature does not exceed 170°C and there is no disassembly and no fire during the test and within six hours after the test.

Results

Results for Crush Test are given in Table 6. Samples U11 to U15 (un-discharged samples) leaked electrolyte.

TABLE 6
CRUSH RESULTS

Sample	Initial Voltage (V)	Minimum Voltage (V)	Voltage Drop (V)	Cell Thickness (mm)		Deformation (% Crush)	Limiting factor	Peak Temp (°C)	Result (Pass/Fail)
				Initial	Final				
U11	3.992	0.085	3.907	14.09	6.82	51.6	Voltage/Thickness	50.2	Pass
U12	3.921	0.021	3.900	14.09	9.79	30.5	Voltage	49.9	Pass
U13	3.923	0.004	3.919	14.11	9.06	35.8	Voltage	35.6	Pass
U14	3.921	3.700	0.221	14.09	9.93	29.5	Voltage	20.7	Pass
U15	3.924	0.002	3.922	14.09	8.97	36.3	Voltage	57.0	Pass
D11	3.609	2.911	0.698	14.10	13.40	5.0	Voltage	20.8	Pass
D12	3.305	3.200	0.105	14.08	12.79	9.2	Voltage	20.0	Pass
D13	3.473	0.029	3.444	14.12	9.69	31.4	Voltage	19.5	Pass
D14	3.461	0.023	3.438	14.10	9.19	34.8	Voltage	24.6	Pass
D15	3.635	0.052	3.583	14.13	9.48	32.9	Voltage	23.0	Pass

T.8 Forced Discharge

Method

Ten (10) previously untested, fully discharged component cells were subjected to the forced discharge test. Each cell shall be forced discharged at ambient temperature by connecting it in series with a 12V D.C. power supply at an initial current equal to the maximum discharge current specified by the manufacturer (50mA). Each cell shall be forced discharged for a time interval (in hours) equal to its rated capacity divided by the initial test current (in Ampere).

Requirement

No disassembly and no fire during the test and within seven days after the test.

Results

Results for Forced Discharge Test are given in Table 7.

TABLE 7
FORCED DISCHARGE RESULTS

Sample#	Test Time (hrs)	Maximum Temperature (°C)	Disassembly or fire within 7 days of testing	Result (Pass/Fail)	Comment
D16	27	44.9	No	Pass	Sleeving melted spots observed
D17	27	66.1	No	Pass	Split and shrinkage of sleeving
D18	27	46.2	No	Pass	Sleeving melted spots observed
D19	27	29.6	No	Pass	--
D20	27	27.6	No	Pass	Sleeving melted spots observed
D21	27	27.7	No	Pass	--
D22	27	29.0	No	Pass	--
D23	27	58.0	No	Pass	Split and shrinkage of sleeving
D24	27	37.9	No	Pass	Sleeving melted spots observed
D25	27	42.3	No	Pass	Sleeving melted spots observed

TABLE 8
TEST INSTRUMENTS

Test	Equipment	Manufacturer	Model	Control #	Calibration Due Date
Crush	Pressure Gauge	Enerpac	GP-10P	B091436	10-25-2017
Crush	Caliper	Mitutoyo	500-196-30	L246	12-09-2017
Crush	Digital Multi Meter	Fluke	87 V	B079673	06-30-2017
Crush	Thermometer	Tektronix	DTM920	40-67	06-30-2017
Forced Discharge	Electronic Load	Kikusui	PLZ334W	BAT-ELD-01	10-13-2017
Forced Discharge	Electronic Load	Kikusui	PLZ334W	BAT-ELD-02	10-14-2017
Forced Discharge	DC Power Supply	TDK Lambda	ZUP20-10	BAT-DCS-09	04-05-2017
Forced Discharge	DC Power Supply	TDK Lambda	ZUP20-10	BAT-DCS-10	04-05-2017
Forced Discharge	Data Acquisition System	Fluke	Hydra Series II	BAT-DLG-01	10-14-2017
Forced Discharge	Current Shunt	Crompton	50mV / 1A	BAT-CST-11 BAT-CST-12	12-09-2018