

Report No.: 18270BC20140701

APPLICATION FOR UL TEST REPORT

Client Name : Shenzhen Run Sen Sheng Trading CO.,Ltd.

Address Room 2304, Tower B, Galaxy World, Bantian Yabao

Road, Longgang District of Shenzhen, China

Product Name : Lithium Battery Pack

Date : Jun. 09, 2022





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TEST REPORT

ANSI/CAN/UL1973: 2018

Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications

Report

Reference No. 18270BC20140701

Compiled by (+ signature).....: Eason Zhou/ Project Engineer

Approved by (+ signature) Dely Yang / Project Engineer

Date of issue...... Jun. 09, 2022

Testing laboratory

Name Shenzhen Anbotek Compliance Laboratory Limited

Address . Zone South,1/F.,Building2,Hengchangrong High-Tech Industrial

Park, Huangtian Hangcheng Street, Bao'an District, Shenzhen,

Guangdong, China

Testing location: Shenzhen Anbotek Compliance Laboratory Limited

Client

Name Shenzhen Run Sen Sheng Trading CO.,Ltd.

Address...... Room 2304, Tower B, Galaxy World, Bantian Yabao Road, Longgang

District of Shenzhen, China

Test specification

Standard ANSI/CAN/UL1973: 2018

Test procedure Compliance with ANSI/CAN/UL1973: 2018

Non-standard test method: N.A.

Test item

Description....: Lithium Battery Pack

Trademark: W=174=

Model and/or type reference...... TPLI-12100AH

Manufacturer: TOPAK POWER TECHNOLOGY CO.,LTD.

Address....... Topak Industrial Park, NO.26, Yingfeng RD 1, Dalang Town,

Dongguan, China

Factory.....: Same as manufacturer

Address...: Same as manufacturer

Rating(s)...: 12.8V, 100Ah, 1280Wh



Code: AB-BAT-127-a

Tel:(86) 755-26066440 Fax: (86) 755-26014772 Email: service@anbotek.com



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Possible test case verdicts:

Testing:

Date of receipt of test item...... Dec. 25, 2021

General remarks:

This report shall not be reproduced, except in full, without the written approval of the testing laboratory.

The test results presented in this report are only relevant to the test sample.

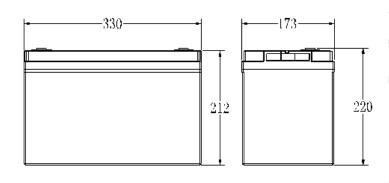
"(see remark #)" refers to a remark appended to the report.

"(see appended table)" refers to a table appended to the report.

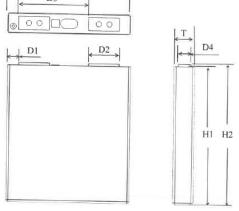
Throughout this report a point is used as the decimal separator.

As specified by the client, all the results in this report were quoted from report 18270BC10448501, test sample: Lithium Battery Pack, test model: TC12100.

Construction:



Battery(unit: mm)



Item	Parameter
[√] o _f W ^{√√} p _o	140.2 ± 0.5
H1	160.2 ± 0.5
H2	163.0 ± 0.5
-boteT	24.0 ± 0.5
D1	12.3 ± 0.5
D2	35 ± 0.5
D3	80 ± 0.5
D4	15 ± 0.5
1997	

Cell (unit: mm)

Shenzhen Anbotek Compliance Laboratory Limited

Hotline 400-003-0500 www.anbotek.com



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General product information and other remarks:

This battery is constructed with eight lithium-ion cells (4S2P), and has overcharge, over-discharge, over current and short-circuits proof circuit.

The main features of the battery are shown as below:

Model	Nominal capacity	Nominal voltage	Nominal Charge Current	Nominal Discharge Current	Maximum Charge Current	Maximum Discharge Current	Maximum Charge Voltage	Final Voltage
TPLI-12100AH	100Ah	12.8V	20A	50A	100A	100A	14.6V	10.5V

The main features of the cell in the battery are shown as below:

Model	Nominal capacity	Nominal voltage	Nominal Charge Current	Nominal Discharge Current	Maximum Charge Current	Maximum Discharge Current	Maximum Charge Voltage	Final Voltage
IFP23140160- 50Ah	50Ah	3.2V	25A	25A	50A	50A	3.65V	2.0V

The main features of the cell in the battery are shown as below:

Model	Upper limit charge voltage	Taper-off current	Lower charge temperature	Upper charge temperature
IFP23140160- 50Ah	3.65V	2.5A	0°C	45°C



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A -70	otek Anboren Anb	ANSI/CAN/UL1973: 2018	An-	K Anb
Clause	Requirement + Test	Resu	ult - Remark	Verdict
- 10	NV U	O's	- 07	

	CONSTRUCTION	nbole P
7	General	AND POR
7.1	Non-metallic materials	Post
7.1.1 habou	Polymeric materials employed for enclosures shall comply with the requirements as outlined in Table 6.1 Path III of UL 746C except as modified by this standard.	P And
botek Anbotek	Exception No. 1: Polymeric materials utilized for light electric rail (LER) enclosures for motive applications shall have a minimum flammability of V-1 or better, in accordance with UL 94 if intended for building into an enclosure or compartment within the train.	Anbotek
Anbore.	Exception No. 2: LER enclosure parts for motive applications may alternatively be evaluated to the 20 mm end-product flame tests in accordance with UL 746C.	PAni
7.1.2	The factors taken into consideration when an enclosure is being judged are as follows. For a Non-metallic enclosure, all of these factors shall be considered with respect to thermal aging.	Anbotek
	Dimensional stability of a polymeric enclosure is addressed by compliance to the mold stress relief distortion test. a) Resistance to impact; b) Crush resistance;	Anbo.
orek Ant	c) Abnormal operations; d) Severe conditions; and e) Mold-stress relief distortion.	npotek -tek
7.1.3	The polymeric materials employed as enclosures and insulation shall be suitable for anticipated temperatures encountered in the intended application.	Ambore
7.1.4	Pack enclosures shall have a Relative Thermal Index (RTI) with impact suitable for temperatures encountered in the application but no less than 80°C (176°F), as determined in accordance with UL 746B.	Pant
7.1.5	The pack enclosure materials intended to be exposed to sunlight in the end use application shall comply with the UV Resistance and the Water Exposure and Immersion tests in accordance with UL 746C.	Anbotek
Anbotek Anbotel	Polymeric materials used as direct support for live parts other than those circuits determined non-hazardous (i.e. limited power circuits) shall comply with the insulation requirements of UL 746C.	AP Anb
otek Aup	Exception: Insulation materials that meet the criteria outlined in UL 60950-1/CAN/CSA-C22.2 No. 60950-1, Clause 4.7.3.3 "Materials for components and parts	yotek P
	outside of fire enclosures" or Clause 4.7.3.4 "Materials for components and parts inside of fire enclosures" are considered acceptable.	Anbotel
7.1.6	Gaskets and Seals relied upon for safety shall be determined suitable for the temperatures they are exposed to and other conditions of use. Compliance is determined by the applicable tests of UL 157.	Panto



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Report No.	10270BC20004201	ANSI/CAN/UL1973:	2018	Vupo.	Page 6 01 73
Clause	Requirement + Test	and projek	Result -	- Remark	Verdict
7.2	Metallic parts resistance to	corrosion	Vupore,	V Pup	N Pupology
7.2.1	Metal pack enclosures sha suitable plating or coating corrosion resistance. Addi to achieve corrosion prote 50E/C22.2 No. 94.2.	process can achieve tional guidance on me ction can be found in	ethods	Aupotek Aup	otek AnbNek Anbote
7.2.2	Conductive parts in contact connections shall not be selectrochemical action. Coin Table D.1 of Appendix I	ubject to corrosion due mbinations above the		Anbotek Anbotek	k Anbolek N
7.3	Enclosures	Anbo Lok abot	ek Anbo	Vie Vie	rek Aup Pek
7.3.1	The enclosure of a battery strength and rigidity requir physical abuses that it will intended use, in order to re injury to persons. Complia tests of this standard.	ed to resist the possible be exposed to during educe the risk of fire once is determined by	ole its or the	Anbotek Anbotek	Anbotek Anbotek
7.3.2	A tool providing the mechascrewdriver, hacksaw, or s		pliers,		Arbotek P
Anbotek	be the minimum mechanic open the enclosure.	al capability required	to		stek Anbore
7.3.3	Openings in the enclosure prevent inadvertent access Compliance is determined Against Access to Hazarde	s to hazardous parts. by the Tests for Prote		Anbotek A	Anbotek Anb
ek Ant	First Characteristic Numer or CAN/CSA-C22.2 No. 60	al, Clause 12 of IEC 6	0529		Ann
Anbotek Anbotek	rating of IP2X or IPXXB, a Selection Table for Nonha 65. (Evaluation per IEC 60 No. 60529, Clause 12, cor	zardous Locations, Ta 1529 or CAN/CSA-C22 nsists of the use of the	able 2.2 EIEC		habotek Anbotek
Anbore	articulate probe applied wi Exception: For battery sys	tems intended for loca		Anbotek	Ambotek Panbe
atok Anb	probe, but shall be located	ontacted with the artic I or guarded to preven			Anbotek Anbotek Anbotek
Anbotek	unintended contact by ser personnel. Such equipmer installation instructions in a marked in accordance with	nt shall be provided wi accordance with 42.3			ek Anbotek



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	ANS	I/CAN/UL1973: 20	18		
Clause	Requirement + Test	photek	Result - Remark	anb ^c	Verdic
7.3.4	Openings in the enclosure shall be	oe constructed to	Pupoter Pupo	No.	bolek P
ofell	prevent accumulation of flammak	ole gases that	sotek Anbo	b.	Vo.
	could lead to a hazardous conditi	ion from	And	4010	anbore
	concentrations of hydrogen gas of	due to electrolysis	of aboten Ar	100	
	aqueous electrolytes for applicab	ole battery	bu.	potek	Aupe
	technologies, such as vented or	valve regulated lea	ad all	Ville OK	
	acid and nickel batteries and app		loo stek	Anbore	Þ
	electrochemical capacitor techno	logies, greater tha	an belek Anbo	h	10,
	25% of the LFL of hydrogen (equ	ivalent to 1%	View Polek	Anbo	
	concentration in a volume of air).		ngs	.V.	Motok
	shall have a minimum opening	Anbo	rek anbol	P.	10
	area of:		Aupo	400	"pote"
	$A = 0.005NC_5 (cm_2)$		K solek an	po,	Der.
	Where:		Anb	Noton	anbo
	A = Total cross sectional area of	ventilation holes	tell spolen	Vup.	
	required (cm ₂)		DO. VIII	bolon	P.
	N = Number of cells in battery		olek oupour	bu.	1/0
	C ₅ = Capacity of battery at the 5-	h rate (Ah)	And	npo	
Dr.	Exception: The area of ventilation		Poles Vuo		ale/P
	reduced if it can be demonstrated		And You	OF AT	00
	sufficient ventilation within the ba		Vupote Vu	No.	hotek
	hydrogen accumulations above 2		was you	DOLO	Vier
	hydrogen.		Aupo, W.	401	000
7.3.5	Packs intended for installation when	here they may be	ok hotek	Vupo,	Р
7.5.5	exposed to moisture either through		Jose Vur	worek.	63
	splashing water or immersion sha	- 700	r dek saboles	AMO	Mr.
	their intended resistance to ingre		Aupo, W.	lode	81
	accordance with IEC 60529 or Ca		otek Anbor	bu.	400
	60529, or as outlined in NFPA 70		Ario	No No	00,0
	Section 2 of C22.1 for enclosure		and sabotes And		Horon
	UL 50E/C22.2 No. 94.2, or NEM/		and his	20181	Aupo
	Section 36.	A 200. Occ also	K Vupore Vii.	Nos	-100
- abotek	PUD SOF	ntoter And	Noton No.	Pupose	Vu
7.4	Wiring and terminals	potek Anb	Oye. Wun	, bolok	P
7.4.1	General		spotsk Aupo.	by.	» P
7.4.1.1	Wiring shall be insulated and acc	ceptable for the	W. Poler	VUD	P
7.11.11.1	purpose, when considered with re		Andore And	M- 1	olek.
	temperature, voltage, and the co		to	VU	2/4
	which the wiring is likely to be su		Anbo. A.	401	"pole"
	equipment.	View Ville	k hotek and	0,	by.
7.4.1.2	A wiring splice or connection sha	II be mechanically	Plen.	~010h	P.B.
Anbo	secure and shall provide electrica			And	
	strain on connections and termin		Pr. FOK	abolen	PL
Vier	Wiring shall be secured and route		rp of	par.	⊮ P
	edges or parts exceeding insulati		The Mark	anbore	F F
POA	Openings in compartments throu		d abover Arise		olek P
	wiring is routed shall be smooth a			Ank	- P
	provided with protective insulatin		Vupole Vun	40.	hotek
	grommet to prevent abrasion.	g 24011111g0 01	riek ab	0/0.	ALLE
(C)	Wiring connections between varie	Ous parts of a batt	erv	101	- NOW
	module/pack and accessories sh		.ory	Yupo,	₽0P
	secured to prevent the potential f		And And	4010	100



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100	ek Anbores Anbo	ANSI/CAN/UL1973: 201	18	Anbotek Ant
Clause	Requirement + Test	potek potek	Result - Remark	Verdict
7.4.1.3	secured to its supporting than friction between sur	including a terminal, shall to surface by a method other faces so that it will be shifting in position, or creati	Anbotek Anbor	potek Anbotek
7.4.1.4		ting. An external terminal vent inadvertent misalignme	ent	Anbotek P Anb
7.4.1.5	External non-detachable accessible in the end use provided with strain relies internal conductors unde conditions.	f that prevents strain to	Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotek Anbotek
7.4.1.6	Plugs and receptacles sh	nall be rated for the intende ature, and if applicable, for anditions.	ed	K Arbotek
7.4.1.7	Battery system cables sh anticipated service include temperature and environ hazardous voltage circuit	nall be rated for their ding voltage, current, ment. External cords for ts shall be jacketed to conductors and rated and	Anbotek Anbotek	otek Anti Par Antiotek Antiotek Antiotek Anti
7.4.1.8	In multiway plugs and so could otherwise occur, m		ng	Anbotek
Anbotek Anbote	Compliance is checked to measurement and, where test. A force of 10 N (2.2 conductor near its terminal conductor n	by inspection, by e necessary, by the followir	otak anbote.	Anbotek Anbo
otek I	extent that spacings are specified in 7.5.	reduced below the values	Anbotek Anbotek	Anbotek
7.4.1.9	for connection of the batt circuits shall be construc	ted as outlined below:	Anbotek Anbo	hootek Anbotek
Anbotel		ade shall be located so be accessible for inspection		Anbotek Panbo
Anbotek Anb	secured and shall be rem deformation of the enclose	metal enclosure shall be	110	tek Ankotek
Anbotek	of a conduit bushing or lo		tek Anbotek Ar	aboten Anburabot



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	ANSI/CAN/UL1973: 2	2018	
Clause	Requirement + Test	Result - Remark	Verdict
ootek Anbotek	c) An outlet box, terminal box, wiring compartmer which field connections are made shall be free from any sharp edges including screw threads, a burr, or moving part of the like that may abrade the insulation on conductor or otherwise damage wiri	om a fin	Abot P Ambotek
Anbore Anbor	d) A field wiring terminal or lead shall be rated for connection of a conductor or conductors having a minimum ampacity rating of 125% of the rating of unit.	the a	nbotek P Ani
Anbotek Anbotek	e) The distance between the end of the connection point of a field installed wire and the wall of the enclosure toward which the wire is to be directed shall be in accordance with Table 312.6 (A) or (B NFPA 70.	k Anborek Anbore	Anborek
7.4.2	Beads and ceramic insulators	hotek Anboron Anbo	N N
7.4.2.1	Beads and similar ceramic insulators on conductors shall:	Anbolo	N N
	a) Be so fixed or supported that they cannot char their position in such a way that a hazard would be created; andb) Not rest on sharp edges or sharp corners.	nge	Arbotek
7.4.2.2	If beads are located inside flexible metal conduits they shall be contained within an insulating sleev unless the conduit is mounted or secured in such way that movement in normal use would not crea hazard. Compliance is checked by inspection and where necessary, by the following test. A force of	e, a ate a d,	botek Anb
otek V.	N (2.25 lbf) is applied to the insulators or to the conduit. The resulting movement, if any, shall not create a hazard in the meaning of this standard.	Arbo. Arek	Anbotek Anbotek
7.5	Spacings and separation of circuits	tek Anbore Ans	ek Note
7.5.1	Electrical circuits within the pack at opposite pola shall be provided with reliable physical spacing to prevent inadvertent short circuits (i.e. electrical	Dag William William	botek N
	spacings on printed wiring boards, physical secur of un-insulated leads and parts, etc.). Insulation suitable for the anticipated temperatures and maximum voltages shall be used where spacings	Anbotek Anbo	Anbotek
7.5.2	cannot be controlled by reliable physical separati Electrical spacings in circuits shall be based upor grade of insulation required as outlined in the	on.	N
	Grade of Insulation section of UL 60950-1/CAN/CC22.2 No. 60950-1, and shall comply with the creepage and clearance requirements of the	CSA-	potek Anb
	Clearances, Creepage Distances and Distances Through Insulation section of UL 60950-1/CAN/C	SA-	Autotok
	C22.2 No. 60950-1 for the appropriate pollution degree of the intended environment (see the Poll Degrees section of UL 60950-1/CAN/CSA-C22.2		Anbored



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100%	ANSI/C	CAN/UL1973: 201	8 Total	Aupo,
lause	Requirement + Test	a botek	Result - Remark	Verdic
No.	Exception No. 1: As an alternative		hupoto hup	ek hooteN
	requirements, the spacing requiren		abotek Anbo	1010
	may be used. For determination of		VII.	ootek Anbo
	source such as a battery does not		k Aupore An	No.
	overvoltage category as outlined in		W.	Anb.
	Components of UL 840 unless cha		ac	br.
	mains connected rectifier, then the	overvoltage	N Olek	Auport P
	category should be the same as th	at required for the	Papeler Anbe	dek
	rectifier unless the rectifier uses ga	Ivanic isolation. If	f" ak aboten	Anbo
	galvanic isolation is employed, the	n the overvoltage	Auport Am	ok notok
	category can be reduced to the nex	kt lower	otek anbor	N. V.
	overvoltage category. The anticipa	ted pollution	Anbo	tek abole
	degree is determined by the design		of seek and	D.,
	the electrical energy storage system			niek anbi
	under evaluation.	Do. by.	tel aboter	AUDO
.18	Exception No. 2: As an alternative	to the clearance	Par.	nbotek NA
	values outlined in UL 60950-1/CAN		lek Anbore	Ans
	60950-1, the clause for Clearances		"upo	20010
	Distances and Distances Through		wotek Anbor	All.
	alternative method for determining		AND STORY	W. W. Dog
	clearances in the Annex for Alterna		Poley Vupo	rel
	Determining Minimum Clearances,		Du.	ofek Anbo.
			Ant Ant	M. sel
	60950-1/CAN/CSA-C22.2 No. 6099	ou- i may be	br.	Poles Vun
PUD.	applied.		tok Supor	Mr.
	Exception No. 3: As an alternative		No.	Vupose. No
	requirements, the spacing requiren		Polen Vupo	No.
	may be applied instead. When usir		un K Potek	Anbo
	maximum working voltages of circu		And And	Note N
	determined through the test of Sec		rek abote	V. Villa
	note in Table 7.1 regarding adjustn		Vupo, Vi	tek spoten
0181	where double or reinforced insulati		das Vos	Die Vier
5.3	Conductors of circuits operating at		ls Marie	No No
upole.	shall be reliably separated from ea		ok hotek	Tupo,
	they are each provided with insulat	ion acceptable fo	I And	notek A
anbore	the highest potential involved.	Aupo.	sek spoter	And
5.4	An insulated conductor shall be rel	iably retained so	Jpo. W.	Anbotat N
Vup.	that it cannot contact an uninsulate	d live part of a	otek anbore	Pr.
	circuit operating at a different poter		And Stell	anboro
	examples include clamping or routi		-botek Anbo	Nor
	use of separating barriers of insula		Die.	HOK Anbo.
	other means that provides perman		Anbore. And	-V- 200
	the parts.	otek Anbo.	b. selv	aboles Ano
YUD'S	There are no minimum spacings ap	onlicable to parts	lok Vubor b	N No.
5.5	where insulating compound complete	_4.0	N/.	Anbotek Na
	of a compound or subassembly if the		POLITICE AMPONE	108
	through the insulation, at voltages		le lok wotek	Vupo.
	is a minimum of 0.4-mm (0.02-in) t		Anbore Ano	Mela
			hek aboter	Anka
	supplementary or reinforced insula		Pupo, Vu	ok hotek
	the Dielectric Voltage Withstand Te		dek abo	Vice.
	minimum insulation thickness requ		Vupo. Vi	1000
	insulation of circuits at or below SE		IC Notek	upo, VIII
	or functional insulation. Some exar		OL VUDO	Not Not
apole.	potting, encapsulation, and vacuun		18/00	Anbo. An
Part .	Insulation levels and protective gro	unding and	VOL.	10 F
6	incalation lovolo and protoctivo gro	arianing aria	Marie Control of the	works. B



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W 200	18270BC20064201 ANSI/CA	N/UL1973: 2018	10 020	ge 11 01 73
Clause	Requirement + Test	abotek l	Result - Remark	Verdict
7.6.1	Hazardous voltage circuits shall be in accessible conductive parts and circulation outlined in 7.6.2 through the following a) Basic insulation and provided with grounding system for protection in the of a fault of the basic insulation; or b) A system of double or reinforced in c) A combination of (a) and (b).	uits as g: a protective e event	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Anbotek Anbotek Anbote Anbote Anbote
7.6.2	Safety extra low voltage (SELV) circu 6.44 that are insulated from accessible parts through functional insulation or accessible.	le conductive	And hotek	Anbotek Anbotek
7.6.3	Article 250, Section VIII of NFPA 70 C22.1 outline dc system grounding reincluding identifying types of dc circu that must be grounded. Batteries that protective grounding, shall comply w 7.6.9.	equirements its and systems t rely upon ith 7.6.4 through	tek Anbotek Anbote	ek Anbr
7.6.4	Accessible non-current carrying meta- battery system with hazardous voltage could become live in the event of an shall be bonded to the equipment gro	ge circuits, that insulation fault,	Anbotek Anbotek	Anbotek
7.6.5	Parts of the protective grounding sys reliably secured in accordance with 7 provided with good metal-to-metal connections shall be secured agains	7.4.1.2 and ontact. All	ek Anbotek Anbote	Anbo
nbotek Ani	loosening and shall ensure a thoroug connection. The resistance between conductive terminal of 7.6.8 and the	phly good the protective accessible non-	Arbotek Anbotek Anb	Anbotek
7.6.6	current carrying conductive parts out shall not exceed 0.1 Ω. With reference to 7.6.5, when connections	A. sek	Ambotek Anbotek	Anbo
Anbote	parts to be bonded, paint or coatings contact shall be removed or paint pie washers shall be used with securem	ercing lock	boyek Aupotek Aupote	otak Anbo
tek Ant	screws to provide good metal to met Thread-locking sealants, epoxies, glu similar compounds, and solder alone	ues, or other	Anbotek Anbotek	unbotek
Anbotek Anbotek	used as a securement means as the considered reliable. In addition, rivets metal-to-metal piano type hinges), as be removed as a result of servicing s	se are not s, hinges (unless nd parts that ma shall not be relied	y Ann Hotel	Anbotek Anbotek
Anbote	upon as connections for ensuring co protective grounding and bonding sy		otok Anbotok Anbors	PI.



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100	ek Anborer Anbo	ANSI/CAN/UL1973: 201	18	anbotek Ant
Clause	Requirement + Test	tek spotek	Result - Remark	Verdict
7.6.7	contact can consist of the a) Terminal blocks; b) Pressure connectors, grounding and bonding e c) Exothermic welding prod) Machine screw-type fathan two threads or are s	ensuring good metal-to-me e following methods: grounding lugs and similar equipment connectors; ocesses; esteners that engage not le ecured with a nut; and	ess de la	Jotek Anborek Anborek Anborek Anborek Anborek Anborek
botek	less than two threads in t	by. F.C.	abotek Anbor	k Who,
7.6.8	system shall be identified following: a) A green-colored, not re	eadily removable terminal	ak Aupon Pur	Anbotek Anbotel
ek Anto	screw with a hexagonal hb) A green-colored, hexa terminal nut; c) A green colored pressi	gonal, not readily removab	ple hotek Anbotek	Anbolek Anbolek
Anbotek Anbotek	d) The word "Ground" or grounding symbol (IEC 6	the letters "G" or "GR" or t	Ans sek	otek Anbotek
7.6.9	Conductors, relied upon to and bonding system, sha intended fault currents ar shall be green or green a Grounding conductors sh	for the protective groundinal be sized to handle and if insulated, the insulation yellow striped in color. In all be sized in accordance FPA 70 or Rule 10-810 of	on botek Ambotek	Anbotek Anbotek Anbotek
7.7	System safety analysis		Anbo	Potek Woter
7.7.1	shall be conducted on the determine that events that	nazards (including an FME. e device under test to at could lead to a hazardou utified and addressed throu	18 of six	Anbotek Nanbo
7.7.2	Documents that can be usafety analysis include: a) IEC 60812; b) IEC 61025;	sed as guidance for the	Anbotek Anbotek	tek Anbotek
Ans Antotel	c) MIL-STD-1629A; and d) IEC 61508, all parts.	tilized to identify anticipate	ad at the andorok	Anbolek Anbo
7.7.3	faults in the system which condition and the types a provided to mitigate the a analysis shall consider si	n could lead to a hazardou and levels of protection anticipated faults. The ngle fault conditions in the	Anbotek Anbotek	Anbotek N Ar
Anbotek	protection circuit/scheme faults and/or identify the similar safety classification		Anbotek Anbo	ipotek Aupotek



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		ANSI/CAN/UL19	73: 2018		
Clause	Requirement + Test	po pote	Resul	t - Remark	Verdict
7.7.4 hootek Anbotek	When conducting the analytic protective devices shall result as fety unless they completed (c). Refer to 6.39 and 6.4 passive protective device a) They are provided with protective device; or b) They are provided with	not be relied upon for y with the following to for definitions of a ses. In a redundant passion redundant active process.	or critical in (a) – active and ive	potek Anbotek Anbotek Anbotek Anbotek Anbotek	hbotek Anbotek Anbotek
	that remains functional a upon loss of power/failur protection; or c) They are determined t to the active circuit; or d) Meet the identified saf 61508 or similar safety c	e of the first level ac o fail safe upon loss ety integrity level pe	s of power		tek Anbotek
7.7.5	Devices relied upon for control shall be tested for functional sandle appropriate functional sandle adversariated through standard.	onality in accordanc fety requirements u	e with Inless	k Anbotek	Anbotek N
7.7.6	The safety system analyst that are identified as small compatible or smart grid of UL 2744, shall include as a result of integration smart environment.	art grid enabled, sm interactive as define analysis of impact	art grid ed in 1.1 to safety	Anbotek Anbot Anbotek An	N N
7.8	Protective circuit and cor	ntrols	ok note	k Anbore	Amb
7.8.1	General	abotek Anbo	by.	otek anbotek	Andon P.

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lo _{de-}	ANSI/CAN/UL19	73: 2018	Yofok	Anbore. A
Clause	Requirement + Test	k. 102	Result - Remark	Verdic
7.8.1.1	Battery systems shall be protected against	otek	Vupose, Vup	k poleh
	overcharge and overdischarge, resulting from		botek Anbo.	10 N
	anticipated use and abuse conditions includ		Vila P	otek Vupo.
	component faults in control systems, short of		Anbore Ani	. V
	conditions and power surges as applicable t		rek	Anbore. And
	intended battery system application and inst		Anbo	n dek
	determined by the manufacturer. If relied up		ok bojek	Anbo. A
	maintaining the cells within their safe operat	-	ipolo Aria	notek
	region, the battery management system (BM		otek anbore	Dur
	maintain cells within the specified cell voltag		Ando	k Whole
	from over-charge and over-discharge of the		abotek Anbo	North
	voltage, and it shall maintain cells within the		Yu.	otek Aupo
	cell temperature region providing protection		Vupole Vun	, W
	overheating and under temperature operation		Note:	upole Aug
	Additionally, it shall maintain batteries within		Vupo.	101
abole	specified battery current region from over ch		o ok bojek	Aupo. N.
	current and prevent high rate discharge exc		G to View	nolek
	cell specifications. When reviewing safety ci		stek Anbote.	Anto
	determine that cell operating region limits ar	e	Mipo. N.	r pole
	maintained, tolerances of the protective circuit/component shall be considered in the		Potek Vupo,	No.
			VUr.	otek Aupor
	evaluation. Components such as fuses, circle breakers or other devices and parts determined by the components of the components such as fuses, circle breakers or other devices and parts determined by the components such as fuses, circle breakers or other devices and parts determined by the components such as fuses, circle breakers or other devices and parts determined by the components such as fuses, circle breakers or other devices and parts determined by the components such as fuses, circle breakers or other devices and parts determined by the components such as fuses, circle breakers or other devices and parts determined by the components of the components such as fuses, circle breakers or other devices and parts determined by the components of the compon		Antores Anto	V 100
	necessary for safe operation of the battery s		br.	apoles Aupa
	that are required to be provided in the end u		sk Vupo, b	Nos
	installation, shall be identified in the installat		Worley W	Anbor
r 511.	instructions.	IOII Anl	Doles And	abolek
7.8.1.2	If the specified operating limits are exceeded	d, the	polek Anbo	w. Alek
	protective circuit shall limit or shut down the	charging	Are notel	Pubo.
	or discharging to prevent excursions beyond		Anbore Ans	ak hotek
	operating limits if an unsafe condition is crea		e wak	View. Wille
	battery system will be damaged. If safety lim		Anbo. A.	tek nbot
abole	determined per 7.7 are exceeded, the protect		k hotek A	upo.
	circuit shall shut down the charging or disch	arging to	And	hotek an'
	prevent excursions beyond safety limits.		Ask subole.	VULL
	Compliance is determined through a review	of the	o, b,	aboter
	pack and cell or electrochemical capacitor d		Potek Vupo,	by.
	through the testing of this standard.		VL. K POLOK	Anbor
7.8.1.3	Solid state circuits and software controls, rel	ied upon	Pupote, Mun	ek spop
.8.1.3	as the primary safety protection, shall be evo			AUD
	UL 991 or C22.2 No. 0.8, UL 1998, UL 6073		Aupo, by	Your Yes
	CAN/CSA-E60730-1, or EN/IEC 61508 serie		k notek at	po, bu
	applicable based upon the design and comp		AUD	worek and
	the controls. The required severity level, per		and ofter	AUD
	level, or the class of control function shall be		o. W.	aboten
	determined by the manufacturer and the cor		notek anbore	NI.
	designed in accordance with one of the above		An stek	antore
	functional safety standards.	Nos	aboten Anbo	-tek
101	Exception: Solid state circuits and software	need not	Mr. No.	lay Vupo,
	comply if it can be demonstrated that the so		Anboro Anu	-ote
	circuits and software are not relied upon as		, dek	Pur
	Tonound and continued are not relied apoil as		F PO. Br.	



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· foot	ak Aupo, M. Me	NSI/CAN/UL1973: 20	18 motel	Anboro Ar
Clause	Requirement + Test	ak abotek	Result - Remark	Verdict
7.8.1.4	Battery systems with hazardo including outputs of 50V or gr		hupore was apole	+ Pupotek
	provided with a manual discor		Anbore Ans	rek abotek
	provided with installation instr		ok botek Anb	0, 0,
	disconnect device to be provide		n of	-botek Anbo
	the system. The disconnect d	evice shall be located	l as	'u.
	near as possible to the batter			Aupor Ai
	shall be rated for the applicati			POLOK
	under load if applicable. The disconnect both poles of the disconnect both		all hotek Anbore	DUL
	disconnect shall not require the		of photos	PUPOL
	or equipment to be operated.	ic asc of a special tot	Anbore Amo	yelou ye.
7.8.2	Smart Grid Applications	Auporan Aug	ok spokek bup.	N
7.8.2.1	Those battery systems that ar	e identified as smart	VIII	upotek N
.0.2.1	grid enabled, smart grid comp		otek Anbo, P	N N
	interactive as outlined in 1.1 c		ok bolek	Vupo.
	evaluated for functional safety			"polek
	the environmental criteria that			Pr.
	grid communication system of		All token	AGOO.
7.9	there is impact to battery syst	V07	bupon bu	Jek Anborek
Map .	Cooling/thermal management	477	Anboren Anbe	vd
7.9.1	Battery systems that rely upor management systems to prev		has solek A	hotel M
	designed to shutdown upon fa		Jole Amb	hotek Ar
	management system unless is		ed, a elt anbore	Anu
	that the thermal management		not	Anboy
	result in a hazardous situation		arbote. Ann	notek
	determined by the Failure of t		worlek Ambore	View OK
	Stability System Test of Section Piping, hose, and tubing used		II ok no	iok Autoria
7.9.2	be resistant to chemical degra			N N
	contains, as well as other liqu			ipole Ville
	contact such parts during exp		ofer And	hotek An'
	equipment. It shall have the s		Motore Anbore	Ville
	characteristics necessary to w			Anboy
	mechanical and environmenta		ce	polek
700	is determined as outlined in 7 With reference to 7.9.2, piping		holek Ausole	PU.
7.9.3	accordance with the scope of		Anti-	ek AnboN ^k
	comply with the applicable red		de.	Your Yes
	ASME B31.3 applies to piping	that contains toxic	ok wotek Ar	Pur
	fluids, flammable fluids, fluids	0.00	the state of the s	hotek An
	tissue, and nonhazardous flui			Ann
	than 15 psi (105 kPa) or temp		"up "otek	Anbor
7.0.4	−29°C (−20°F) or greater than Piping, hose, and tubing contains		a bus ole bus	Yotok
7.9.4	routed and secured to preven		hotek Anbore	Muse N
	result in a fire, explosion or sh		Ann ak 50th	anbore Anbore
7.9.5	Fans or blowers utilized for ai	r-cooling systems sha		otek Mise
No ford	comply with the applicable red			DOJ. VILLE
	Exception: Fans located in SE need not be evaluated if show		Ano Ano	work Nab



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-V wolf	ANSI/CAN/UL1973: 2	018	Aupo, Liek	rage 10 01 73
Clause	Requirement + Test	Result	- Remark	Verdict
7.9.6	Battery systems that rely on integral heaters to	Bupose	Pur Felt	, botel
10000	maintain operating temperatures of the battery			Pr.
Dr.	system, shall be designed to shutdown upon failu	re of		Anboro
Anbotek	the heaters unless is can be demonstrated through		Anbores Anb	4
Note	fault analysis and if necessary an abnormal opera	ation		Anba
Anb	test, that the heater failure does not result in a	2018/		do. No.
910d. W	hazardous situation.	Tur.	Noton A	upo, Vi
7.9.7	Temperature controls for heaters used to maintain	n the	Ann	"olek N "
olek Anb	operating temperature range of a battery system	40		Ann
	during cold ambient conditions shall be positioned			""pole"
"pole"	such that they monitor the system temperature an			10K
Note	are minimally affected by the outside ambient. Fo			Anbo
Anbo	example, temperature controls or regulators shou	IQ/r		ok botel
	normally be located away from outside vents.	\ <u>\</u>	odul Nation	No. William
7.10	Electrolyte containment parts and parts subject to pressure	nbote.		notek Nambe
7.10.4	Parts that contain electrolyte, such as piping, hose	Α	Vupoje. V	AL NI
7.10.1	and tubing shall be resistant to chemical degradat			Pupolek N V
O. VUL	from the electrolyte. Electrolyte containing parts s			No.
NoV.	have the strength and material characteristics	Par		ATO
Mapo	necessary to withstand the anticipated mechanica	al anb		botek
poter	and environmental stresses.			Pu.
Dir	Compliance is determined through review of mate	erial		lok Vupore
Anboro	datasheets and where determined necessary, an	2014		V
wore!	immersion test (using the electrolyte as the test lice			boten And
Anba	in accordance with the Volume Change Test after			You
de Yar	Immersion of UL 157 for elastomeric materials or	the		Anbo, A
O. br.	Test for Resistance of Polymeric Materials to	00000		notek.
polek b	Chemical Reagents in UL 746A for other than	4		Arre
The Ok	elastomeric materials, (same as ASMT D543, Tes Method	Anb		aupore
Anboy	I), as applicable to the material and part being tes	ted		v -otek
FOROK	Elastomeric parts in contact with electrolyte shall			Anb
Anb	subjected to the volume change and extraction te			sek abo
, abote	after 70-h immersion in the electrolyte in accordar			100,
br.	with UL 157. The volume change shall be minus 1			MOTER AT
stak Aupo	plus 25% and extraction (change in weight) no gre			And
40.	than 10%. Plastics other than elastomeric parts in			anboro
nboro A	contact with electrolyte shall be subjected to an	200		Nek
WOLOK.	immersion for 168 h at room temperature followed			Anbo
Ant	a check for volume and weight change in accorda	ince		ak aboten
anbole	with ASTM D543, Procedure I method. The	None		Pro-
10 N	percentage of change of volume shall not be greather 20% of the critical and the sharper in weight			otek Aupo,
Anbo	than 2% of the original and the change in weight s			- 4
000 400	be no not increase more than 25% or decrease methan 10% of the original value.	Ole		Anbor An
D. 871.	Exception No. 1: See Appendix C for material	Motor	Man	uo'et NI
Hotek M	requirements for flowing electrolyte systems.	Apr.		Anto N
, ak	Exception No. 2: Not applicable to individual cell of	or Ambo	v Nok	Anibotati N
Anboro	capacitor casings and materials that have been	No.		k atek
work.	evaluated to appropriate component requirements	s per		Anbo
VUCA	7.11.	016h	Vupo, br.	You You
7.10.2	Piping, hose, and tubing containing electrolyte, sh			N
la de	be routed and secured to prevent leakage that co	uld		thores Ani
ier vupo	result in a fire, explosion or shock hazard.	491	anboro	D11.



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lode	ANSI/CAN/U	L1973: 2018	8 Manbote Anbote	P.U.
Clause	Requirement + Test	otek p	Result - Remark	Verdict
7.10.3	Parts under pressure shall be acceptable	for the	hupager Prup	potek N
boter	maximum anticipated pressure as detern tests of Section 33.	nined by the	Anbotek Anbo	anbotek.
Aupo, siek	Exception: See Appendix C for material r for flowing electrolyte systems.	equirement	S Anbote And	Noore
7.10.4	Relief valves or rupture members relied used relieve overpressure conditions in a batter shall operate in accordance with their specific process.	ery system ecifications	nbitek Anbotek Anbote	o lek N Ant
	for start to discharge (i.e. pressure at wh valve or rupture membrane starts to relie	ve pressure	e). 10010	Motek
	Compliance is determined by the tests of This requirement does not apply to relief rupture members integral to a cell or more battery such as a VRLA type battery.	valves or	Anbotek Anbotek	Anbotek
Anbore	Exception: Relief valves and ruptures me stamped with the ASME approval mark for		tek Aupotes Aupote	K N _{Anb}
	particular device in accordance with the and Pressure Vessel Code need not be the tests of Section 34.			olek
7.10.5	A pressure-relief device shall have its dis opening located and directed so that ope	ration of	Aupotek Aupotek	N.k
Anbore	the device will not deposit moisture on ba or on insulation or components that could detrimentally affected by the discharge. I	d be	And ok work	Anbotel
	start to discharge (i.e. pressure at which valve or rupture membrane starts to relie rating adequate to relieve the pressure.	the relief	Ar. sek apote	Pup,
7.10.6	The fill port of the electrolyte containmen		Arbotek Anbors An	note ^N N
potek	monobloc system shall be designed to prand spillage of electrolyte during the electrolyte d	trolyte filling	g. Anbore And	-botek
7.10.7	Flow batteries shall be provided with a m control such as a spill containment syste electrolyte spills. The spill containment significant spills are spill containment significant spills.	m to preven hall be	ek Anbotek Anbotek	Anbotek
	sufficient to handle electrolyte spills for the system. See Spill Containment Systems, means to determine compliance.		Polsk Anbotek Anbote	Mak Vun
7.11	Cells (battery and electrochemical capac	itor)	Anborek Anbo	notel*P
7.11.1	Sealed nickel metal hydride cells shall co the cell tests of the Testing Required for UL 2054 in addition to the requirements	Cells table	of Manager Annual St.	Aupo Br
Vupotek	standard. Exception No. 1: The overall dimensions	Anboro	William William William	Anboro
	projectile test aluminum test screen may from those outlined in UL 2054 to accom	be increase modate larg	ge Maria	P _{Anbo}
	cells intended for stationary and LER app the flat panels of the test screen shall no distance of 305 mm (12 in) from the cell	t exceed a	Antotek Anbore Andrew Ar	ipotek
Anborek	direction. Exception No. 2: The overall external res	istance for	Anbotek Anbotek	Prek
	the short circuit test shall be less than or $m\Omega$.	equal to 20	ak abotek Anbotek	Anbo



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ho'	Anbores And	ANSI/CAN/UL1973: 20	18	Anbotek An
Clause	Requirement + Test	ak abotek	Result - Remark	Verdict
Anbotek Anbotek	Exception No. 3: The crustest rather than a flat plate 15-cm (5.9-in) diameter if UL 2054 is insufficient to the cell as determined by	e crush using a bar with a the flat plate crush test pe create a crush condition in (a) – (c) below. The force	er Anbotek Anbo	Botek Anborek
	shall be applied until one a) A voltage (OCV) drop of cell voltage occurs;		bote Anbotek	Anbotek Ant
	b) A deformation of 15% of dimension occurs; or c) A force of 1,000 times to		And Anbotek Anbotek	ek Anbolek
Anbotek	Exception No. 4: Nickel m cadmium cells that are se monobloc battery, need o	netal hydride or nickel ealed and formed as part only eally comply with the	Vilo.	botek AntiP
	requirements of this stand assembled battery. If prov release vent or flame arre comply with the requirement	vided with a pressure ester, the nickel battery sh	potek Anbotek	Ambotek Anbotek
potek And	Exception No. 5: Sample based upon UL 2054 test from 5 samples tested to	numbers tested for each to program may be reduced	10.7	ak Ar bote P
Anbotek	Exception No. 6: During the are held for 30 min at the rather than 10 min.	he heating test, the sampl	les	Anbotek Anbote
7.11.2	Secondary lithium cells sh requirements of UL 1642 requirements of this stand	in addition to the	nall Anbotek	Anbotek PAnt
potek And	be conducted on fresh ce Exception No. 1: The ove	Ils only for lithium ion cells rall dimensions of the	S. potek Anbote	Ar Datek
	projectile test aluminum to from those outlined in UL cells intended for stationa the flat panels of the test	1642 to accommodate lar iry and LER applications, screen shall not exceed a	rge but	Anbotek Anbotel
Anbote	distance of 305 mm (12 in direction. Exception No. 2: The ove	lek Aupo	Upotek tupotek	Aupoten P V
Potok Vup	the short circuit test shall $m\Omega$.	be less than or equal to 2	20 Arbotek Anber	k Anbotek
	Exception No. 3: The crustest rather than a flat plate 15-cm (5.9-in) diameter if UL 1642 is insufficient to	e crush using a bar with a the flat plate crush test of	f Anbotek Anb	otek Anbotek
	the cell as determined by shall be to be applied untifirst:	(a) - (c) below. The force	Non Wupa	Anbotek Anbr
	a) A voltage (OCV) drop of cell voltage occurs; or b) A deformation of 15% of the control of the cell voltage.	otek subotek	Anbotek Anbotek	Antotek
Anbotek	dimension occurs; or c) A force of 1000 times the	he weight of cell is reache		otek supotek
	Exception No. 4: During the are held for 30 min at the rather than 10 min.		les	Anbotek Anbo



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100		ANSI/CAN/UL197	'3: 2018		
Clause	Requirement + Test	ak abotek	Result - F	Remark	Verdict
ipotok	Exception No. 5: Sample based upon the UL 1642 reduced from 5 samples to	test program may be	o _{took} o	ak Anbotak	Anbotek
Anbor Anborek	Exception No. 6: Secondar tested using the test progression Secondary lithium cells of subjected to the cycling prof UL 1642 prior to condu	ram outlined in Appo ther than lithium ion re-conditioning requ	endix E. shall be irements	Anbotek Anh	Anbotek Anb
7.11.3	Sodium-beta cells and ba cell tests outlined in Appe	tteries shall comply		Aupoten	And
7.11.4	Flowing electrolyte cells a comply with the requirement	and battery systems		k Aupore	N Pek
7.11.5	Batteries employing press arrestors shall comply with or the flame arrester test of requirements of this stand	h the pressure relea of UL 1989 in addition	se test	Anbotek Anb	otek Photel
7.11.6	Electrochemical capacitor comply with the requirement addition to the requirement	ents outlined in UL 8	310A in	Anbotek Anbotek	Anbolek P p

	PERFORMANCE	Aup P
8	General	A Rooter
8.1	Unless indicated otherwise the device under test (DUT) shall be at the maximum operational state of charge (MOSOC), in accordance with the	P _{Anb} o
e _k	manufacturer's specifications, for conducting the tests in this standard. After charging and prior to testing,	notek r
porek	the samples shall be allowed to rest for a maximum period of 8 h at room ambient.	nbotek
8.2	Unless otherwise indicated, fresh samples (i.e. not more than 6 months old) representative of production shall be used for the system level tests described in	Anbotek Anbotek
ak An'	Sections 15 – 39. The test program and number of samples to be used in each test is shown in Table 8.1.	lak bi
orek	Exception: At the agreement of the manufacturer, DUT samples may be re-used for more than one test if not damaged in a manner that would affect test	ote ^k P
Anbore	results. Minor repairs can be made to samples such as replacement of fuses, etc. in order to reuse samples for multiple tests.	Anbotek
8.3	All tests, unless noted otherwise, are conducted in a room ambient 25 ±5°C (77 ±9°F). Tests shall be	Punbo
N.	conducted with the DUTs heated to normal operating temperatures unless indicated otherwise in the test.	otek bi
otek	For those tests that require the DUT to reach thermal equilibrium, thermal equilibrium is considered to be	abolek
Amboten	achieved if after three consecutive temperature measurements taken at intervals of 10% of the	Anborek
Anbore	previously elapsed duration of the test but not less than 15 min, indicate no change in temperature greater than ±2°C (3.6°F).	Anbot



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And the state of t	Report NC	D.: 18270BC20064201 ANSI	/CAN/UL1973: 201	8 Ambore	Page 20 of 73
component cell or module during the system level tests in Sections 15 – 39. Temperatures shall also be measured on any components affected by temperature in the control circuit during the tests of 9.1 and 9.2. Temperature shall be measured using thermocouples consisting of wires not larger than 24 AWG (0.21 mm2) and not smaller than 30 AWG (0.05mm2) connected to a potentiometer-type instrument. Temperature measurements shall be made with the measuring junction of the thermocouple held tightly against the component/location being measured. 8.5 Unless noted otherwise in the individual test methods, the tests shall be followed by a 1-h observation time prior to concluding the test and temperatures shall be monitored in accordance with 10.2. 9 Determination of Potential for Fire Hazard P 9.1 In addition to visible signs of fire, non-compliant test results for fire shall also include an evaluation for combustible vapor concentrations during testing if there is the potential for combustible vapor concentrations during testing if there is the potential for combustible vapor concentrations of potential combustible vapor concentrations of potential combustible vapor concentrations of potential combustible vapor concentrations of the battery system. For detection of potential combustible vapor concentrations may occur such as at vent openings or vent ducts shall be used for taking measurements. Exception: As an alternative to using gas detection measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct.	Clause	h. " " " " " " " " " " " " " " " " " " "	Andahotek	10/2	Verdict
thermocouples consisting of wires not larger than 24 AWG (0.21 mm2) and not smaller than 30 AWG (0.05mm2) connected to a potentiometer-type instrument. Temperature measurements shall be made with the measuring junction of the thermocouple held tightly against the component/location being measured. 8.5 Unless noted otherwise in the individual test methods, the tests shall be followed by a 1-h observation time prior to concluding the test and temperatures shall be monitored in accordance with 10.2. 9 Determination of Potential for Fire Hazard P. 9.1 In addition to visible signs of fire, non-compliant test results for fire shall also include an evaluation for combustible vapor concentrations during testing if there is the potential for combustible vapor concentrations based upon the technology and design of the battery system. For detection of potential combustible vapor concentrations that may be emitted during testing, a gas monitor suitable for detecting 25% of the lower flammability limit (LFL) of the evolved gases being measured. A minimum of two sampling locations where concentrations may occur such as at vent openings or vent ducts shall be used for taking measurements. Exception: As an alternative to using gas detection measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	8.4	component cell or module during tests in Sections 15 – 39. Temper measured on any components aff temperature in the control circuit	the system level ratures shall also b fected by during the tests of	De Ambolek Anbol	ek Albotek Anbotek Anbotek
instrument. Temperature measurements shall be made with the measuring junction of the thermocouple held tightly against the component/location being measured. 8.5 Unless noted otherwise in the individual test methods, the tests shall be followed by a 1-h observation time prior to concluding the test and temperatures shall be monitored in accordance with 10.2. 9 Determination of Potential for Fire Hazard P 9.1 In addition to visible signs of fire, non-compliant test results for fire shall also include an evaluation for combustible vapor concentrations during testing if there is the potential for combustible vapor concentrations during testing if there is the potential for combustible vapor concentrations that may be emitted during testing, a gas monitor suitable for detecting 25% of the lower flammability limit (LFL) of the evolved gases being measured. A minimum of two sampling locations where concentrations may occur such as at vent openings or vent ducts shall be used for taking measurements. Exception: As an alternative to using gas detection measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	Anbo	thermocouples consisting of wires AWG (0.21 mm2) and not smaller	s not larger than 24 r than 30 AWG	ote 4 Inbriek Anbotek	Anbotek Anb
B.5 Unless noted otherwise in the individual test methods, the tests shall be followed by a 1-h observation time prior to concluding the test and temperatures shall be monitored in accordance with 10.2. 9 Determination of Potential for Fire Hazard P 9.1 In addition to visible signs of fire, non-compliant test results for fire shall also include an evaluation for combustible vapor concentrations during testing if there is the potential for combustible vapor concentrations based upon the technology and design of the battery system. For detection of potential combustible vapor concentrations that may be emitted during testing, a gas monitor suitable for detecting 25% of the lower flammability limit (LFL) of the evolved gases being measured. A minimum of two sampling locations where concentrations may occur such as at vent openings or vent ducts shall be used for taking measurements. Exception: As an alternative to using gas detection measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	upotek Potek	instrument. Temperature measure made with the measuring junction thermocouple held tightly against	ements shall be n of the the	Anbotek Anbotek Anbotek Anbot	ootek Anbotek
9.1 In addition to visible signs of fire, non-compliant test results for fire shall also include an evaluation for combustible vapor concentrations during testing if there is the potential for combustible vapor concentrations based upon the technology and design of the battery system. For detection of potential combustible vapor concentrations that may be emitted during testing, a gas monitor suitable for detecting 25% of the lower flammability limit (LFL) of the evolved gases being measured. A minimum of two sampling locations where concentrations may occur such as at vent openings or vent ducts shall be used for taking measurements. Exception: As an alternative to using gas detection measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	8.5	Unless noted otherwise in the ind the tests shall be followed by a 1-prior to concluding the test and te	lividual test method h observation time emperatures shall b	tek anboten	Anbotek Anb
results for fire shall also include an evaluation for combustible vapor concentrations during testing if there is the potential for combustible vapor concentrations based upon the technology and design of the battery system. For detection of potential combustible vapor concentrations that may be emitted during testing, a gas monitor suitable for detecting 25% of the lower flammability limit (LFL) of the evolved gases being measured. A minimum of two sampling locations where concentrations may occur such as at vent openings or vent ducts shall be used for taking measurements. Exception: As an alternative to using gas detection measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	9	Determination of Potential for Fire	e Hazard	arek anbotek	Anbo P
concentrations based upon the technology and design of the battery system. For detection of potential combustible vapor concentrations that may be emitted during testing, a gas monitor suitable for detecting 25% of the lower flammability limit (LFL) of the evolved gases being measured. A minimum of two sampling locations where concentrations may occur such as at vent openings or vent ducts shall be used for taking measurements. Exception: As an alternative to using gas detection measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	9.1	results for fire shall also include a combustible vapor concentrations	n evaluation for during testing if	t Albotek Anbot	ortek Arbotek
the evolved gases being measured. A minimum of two sampling locations where concentrations may occur such as at vent openings or vent ducts shall be used for taking measurements. Exception: As an alternative to using gas detection measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	Anbotek Anbotek	concentrations based upon the te design of the battery system. For potential combustible vapor conce be emitted during testing, a gas n	chnology and detection of entrations that may nonitor suitable for	upo, e. Aug	Anbotek Anbotek Anbotek
measurement to determine if there are combustible vapor concentrations, non-compliant tests results for fire may include an evaluation for potential combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	nbotek Anbotek	the evolved gases being measure two sampling locations where cor occur such as at vent openings o used for taking measurements.	ed. A minimum of ncentrations may r vent ducts shall b	Arbotek Arbote	otek Anbotek
combustible vapor concentrations with the use of a minimum of two continuous spark sources. The continuous spark sources shall provide at least two sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	Anbotek Anbot	measurement to determine if ther vapor concentrations, non-compli	e are combustible ant tests results fo	or Anbotek	Anbotek Anbo
sparks per second with sufficient energy to ignite natural gas and shall be located near anticipated sources of vapor such as vent openings or at the vent duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	sek an	combustible vapor concentrations minimum of two continuous spark	with the use of a sources. The	Arbotek Anbotek	k Anborek Ar
duct. 9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	hotek	sparks per second with sufficient	energy to ignite	Anbotek Anbote	otek Anbotek
9.2 Additional precautions shall be taken during tests requiring this analysis due to the potential for combustible vapor concentrations that may occur within the test room or chamber.	anbotek.	sources of vapor such as vent op		ent Andrew	Anborek Anbor
combustible vapor concentrations that may occur within the test room or chamber.	9.2	Additional precautions shall be ta		N. Społek	Anbores Pinto
10 Important Test Considerations P	rok An'	combustible vapor concentrations within the test room or chamber.		Popotek Vipotek	Anbotek Ar
	10	Important Test Considerations	Anv	Anborek Anbore	W. Br



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-100	rek Anbor An	NSI/CAN/UL1973: 201	8 Lotek	Anboten Ani
Clause	Requirement + Test	ok abotek l	Result - Remark	Verdict
10.1	The tests contained in this state explosions, fire and emissions and/or toxic vapors, leakage as well as electric shock. It is use extreme caution when contacts and that they be protected.	s of combustible of hazardous chemicals important that personneducting any of these	nel Anbores Anb	k Anbotek
	tests and that they be protect leaked electrolyte, explosive the chemicals and sudden releas could result from testing. To p	force, toxic vapors and e of heat and noise tha prevent injury, protectiv	atodek Anborek	Anbotek Ant
	equipment and clothing shoul handling batteries and when a Short-circuiting can lead to ve and large format batteries ma	conducting testing. ery hazardous currents, ly still be hazardous	Anbotek Anbotek	k Anbotek
	even in an uncharged condition be well ventilated to protect put harmful vapors or gases and prevent exposure to leaked e	ersonnel from possible care should be taken to	0 100	otek Anbo.
	shall be equipped to contain, toxic vapors and particulate n and other hazardous substan generated during the tests of	natter, leaked electrolyt ces that may be	All tok	Anbo botek
Anbotek	the External Fire Exposure To See also 9.2.	est of Section 38.	Anbotek Anbote	tok Pupole
10.2	As an additional precaution, t surfaces of the DUT shall be tests per 8.5. All personnel in battery systems shall be instructed the DUT until temperatures a levels.	monitored during the volved in the testing of ucted to never approac	ch l	Anbotek P Anb
11	Single Fault Conditions	eek abolek	Anbore An otek	, anboPik
11.1 Anbotek	Where there is a specific refe condition in the individual test fault shall consist of a single fother failure means) of any coelectrical energy storage syst	t methods, the single failure (i.e. open, short component in the	y stok	hek Anbotek
ik Ant	identified in the system safety could affect the results of the		at Anbotek	Anbo
12	Test Results		abotek Anbore	Arr Pk
12.1	Tests that result in one or mo conditions as noted in Table Section 6, shall be considered the test. Additional details of are provided in the individual	12.1 and as defined in d as non-compliant for passing results criteria	ek Anbotek Anbotek	ek Anbotek Anbotek



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Clause	Requirement + Test	botek	Result - Remark	Verdict
le. Vi	IE W (II) (II) (II)	Pro-	Pupp.	184
12.2	For the following tests, if the DUT		nal Indian	Pupo, B
	after the test (a user replaceable		k anbote. And	V Joseph
	replaced or user resettable device		P. Apol	VIDE VIDE
	accessible circuit breaker, etc. re		otek Aupo, W.	1000
	subjected to a minimum single ch			Pilo
	in accordance with the manufact			Note N
	No non-compliant results as outli			Anbe
	shall occur during the charge/disc	cnarge cycle of a	a Still	100 les
	operational DUT.		rotek anbore	Pur.
	a) Overcharge;		And	Mpore
	b) Short Circuit;		Anboten Anbo	Yel
	c) Overdischarge Protection;		All both both	W. Vupo
	d) Imbalanced Charging;e) Failure of Cooling/Thermal Sta	hility Cyatam:	otek aupore Am	You you
	f) Vibration;	ibility System,	y stek on	Pole Vier
	g) Shock;		abotek Anbo	alek out
	h) Impact or Drop Impact;		ok botek	Aupo
	i) Static Force;	otek	anbore Ann	notek.
	j) Thermal Cycling;		otek anbore	And
	k) Salt Fog; and		Albo Liek	Vapole
	I) Resistance to Moisture.		spoter Aupo	Note
13.01ex	Determination of Toxic Emissions	Diek Anton	tok vopo,	N
D1.	10 TO		tek hupo, by	100%
13.1	For those systems for which vent			N
	capacitors could result in the emi		ses	bolek Anb
	as determined by an analysis of t		na alek Ambole	Ann
	substances, the concentration of			Vupo,
	the destructive testing noted in T			10K
	monitored using one of the samp		ted Market	Anbo.
	below and as outlined in 13.2. Ar		Anbore Ans	k worek
	outgassed substances can be ob review of MSDS sheets and/or ar		w. sek subote	And
	outgassed substances. If it can b		Lek Vupo, Vi	tek abole
	through examination of the cells		though world Ant	, b.,
				work and
	did not vent as a result of the test compliance with these criteria.	i, ine system is i	tek aboles	Ano
	a) ASTM D4490;		Aupo, W.	aboles.
	b) ASTM D4490, b) ASTM D4599;	VUD	Lotek Anbore	bu.
	c) OSHA Evaluation Guidelines f	or Air Sampling	Vis K Step	Anboro
	Methods Utilizing Spectroscopic		anboie Anbo	v otek
	d) NIOSH Manual of Analytic Me		by.	Vupe



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Clause	Requirement + Test	Result - Remark	Verdict
13.2	To determine the concentration of toxic emissions, testing shall be conducted in a closed test chamber known volume large enough to contain the DUT. Results obtained from continuous sampling the emissions during testing shall be scaled to estimate	Anbotek Anbotek	Anbotek Anbotek
Anbote Anbote	the anticipated exposure and concentration of toxic materials within either the passenger compartment a light electric rail (LER) or the anticipated smallest room in which the system can be installed. For walk units, continuous monitoring shall also be conducted	of c-in	olek Vup
Anbotek Anbotek	in the interior of the system enclosure. The results f stationary applications shall be further scaled to consider a 0.5 air changes per hour (ACH) ventilation rate. The 0.5 ACH represents allowable low ventilation rated for construction.	or Anbotek Anbotes	Anbotek Anbotek
k Anbotel	Exception: Stationary systems intended for installatioutdoors only and that are not walk-in units are exempted from this monitoring. Stationary systems and systems for LER applications are also exempte	Anbolek Anboro An	N And
Anbotek A	from these requirements if provided with a ventilation system or otherwise designed to prevent exposure toxic vapor releases and vents vapors to a safe location.	on tek species p	Anbotek
14 Anbores	Measurement Equipment Accuracy	otek anbotek Anbot	P
14.1 Anbore	Unless noted otherwise in the test methods, the overall accuracy of measured values of test specifications or results when conducting testing in accordance with this standard, shall be within the following values of the measurement range: a) ±1% for voltage;	Arbotek Anbotek Anbotek Anbotek Anbotek Anbotek	neotek Ar
Anbotek Anbotek	b) ±3% for current; c) ±4% for watts; d) ±2°C (±3.6°F) for temperatures at or below 200°C (392°F), and ±3% for temperatures above 200°C (392°F);	Cek Anbotek Anbotek	Anbotak Anbotak
nbotok Anbo	e) ±0.1% for time; f) ±1% for dimension; g) ±3% for Ah; h) ±4% for Wh.	Anbotek Anbotek Anbo	hbotek Ai
15	Overcharge Test	Anbotek Anbot	Potek
15.1	The purpose of this test is to evaluate a battery system's ability to withstand an overcharge conditio	K wołek Anbors	P
15.2	A fully discharged DUT (i.e. discharged to the manufacturer's specified EODV) shall be subjected an overcharge resulting from a single fault condition		ek P Ani
hotek Ar	the charging protection/control circuit of the system that could lead to an overcharge condition. See Section 11 for a description of a single fault condition	Anbotek Anbotek Ar	rupotek Poter

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20010	ANSI/C	CAN/UL1973: 20 ⁻	18 Martiel Anbore	
Clause	Requirement + Test	p	Result - Remark	Verdict
Anbotek Anbotek	Single fault conditions can be appli and active protective devices. The equipment used for charging the D sufficient to create an overcharge of least 110% of the maximum specific voltage. The charging rate used sh manufacturer's specified maximum	test supply UT shall be of the DUT to at ied charging all be the	Anbotek Anbor A	nbotek Anbotek Anbote Anbote
lek Pup	Exception No. 1: Overcharge testin subassembly may be conducted in complete battery system if determine representative of the battery system.	stead of the ned to be	Anbotek Anbotek Anbo	lpotek lek N
Anbotek Anbotek	Exception No. 2: Components in ci reliability (i.e. evaluated for function considering single fault conditions 7.8.1.3) need not be subjected to s conditions.	nal safety criteria in accordance w ingle fault	k spolek Anbo	Anborel Anborel
15.3	The test shall continue until ultimat followed by an observation period pultimate results are considered to when one of the following occurs:	oer 8.5.	Anbotek Anbotek Anbo	ok P p
Anbotek Anbotek	a) The sample charging is terminat protective circuitry whether it is due temperature controls or if the DUT its maximum specified charging vo Exceeding the manufacturer's specis considered a non-compliant resu	e to voltage or reaches 110% o ltage limit. cified charging lir	stek anboten Anb	Anbotek Anbotek
oglek bup	The DUT is monitored per 8.5 and b) Battery system failure occurs as explosion, fire or other identifiable results per Table 12.1.	10.2; or evidenced by	Ar Dotek Anbotek Anbotek	ootel P
15.4	During the test, detection methods Section 9 shall be used to detect the combustible vapor concentrations in	ne presence of	Anbotek Anbotek	Anborek Anborek
ak Anbotel	If required based upon system des venting of toxic releases shall be comonitored during the testing per Se	ontinuously	notek Anbotek Anbot	ak P at
15.5	If the DUT is operational after the control shall be subjected to a discharge a in accordance with the manufacture. See 12.2 for details regarding user	nd charging cycler's specification resettable device	e s.	Anbotek Anbotek
15.6	An observation period per 8.5 is the At the conclusion of the observation samples shall be subjected to an "a dielectric voltage withstand test in a second	n period, the as received" accordance with		P _i mbo
And And	Section 20. The DUT shall be example rupture and evidence of leakage.	nined for signs o	Anbotek Anbo. An	otek



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loof.	ANSI/CAN/UL1973: 2018					
Clause	Requirement + Test	R	Result - Remark	Verdict		
15.7	As a result of the overcharge test, the followi – (h) are considered non-compliant results. For additional information on non-complying refer to Table 12.1. a) E – Explosion; b) F – Fire;	No.	(See Table 15)	ek Anbotek Anbotek		
lek Anboth	 c) C – Combustible vapor concentrations; d) V – Toxic vapor release; e) S – Electric shock hazard (dielectric break 		otek Anbotek	Anbotek Ant		
lbotek nbotek	 f) L– Leakage (external to enclosure of DUT) g) R – Rupture (of DUT enclosure exposing hazardous parts as determined by 7.3.3); h) P – Loss of protection controls. 	hotek	Anbotek Anbotek	Anbotek Anbotek		
16	Short Circuit Test	Anboro	Ans tek	olek Ibpo.		
16.1	This test shall be conducted on a fully charge (MOSOC per 8.1) with parallel connected ce modules to determine its ability to withstand	lls or	ek Anbotek	Anbotek Panb		
notek Ant	external short circuit. DUTs with only series connections (i.e. no parallel connections of c modules) are tested at the cell level if determ	ells or	botek Anbotek	Anbotek		
Anbatek	be equivalent to testing at the system level. Exception: Short circuit testing on a subasse	pore	Anborok Anborok	Aupore.		
Anbotek	be conducted instead of the complete battery if determined to be representative of the batt system.	y system	Anbotek Anb	Anbotek Anb		
16.2	The sample shall be short-circuited by conner positive and negative terminals of the sample shorting device having resistance as low as	e with a	potek Anbotek	Ambotek P A		
Anbotek	practicable. In all cases the resistive circuit to have a maximum total resistance of 20 m Ω , measured from the DUT terminals. For batte	as ry	Anbotek Anbote	k Anbotek		
Anboten	systems, the short circuit discharge profile at terminals for current and time shall be record compared with the manufacturer's specified 41.3.	led and	Anbotek Anb	anbotek Anbo		
16.3	Testing is repeated at a load that draws a ma		rek potek	Aupolia, h		
ootek I	current between 85% and 100% of the proterrating. For the purposes of this test, the proterrating for a fuse is defined as 2.0×10^{-2} km where	ector trip	Anbotek Anbotek	Anbotek		
16.4	fuse current rating per UL 248-1. Tests shall be conducted at room ambient. T samples shall reach thermal equilibrium temporary.		Anhores Anb	AP AP		
, nbotel	as outlined in 8.3 before the terminals are co	nnected.	We Polok b	abotek Anbo		
16.5	The sample shall be completely discharged (discharged until near zero state of charge/its is depleted), or protection in the circuit has o	energy perated	Potek Aupotek	Anbotik P Ar		
otek p	and the temperature on the center module had peaked or reached a steady state condition a has elapsed, or a fire or explosion has occur	and 7 h	Anbotek Anbotek	Anbotek		



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10	Report No	ANSI/CAN/UL1973: 20	018
87	Clause	Requirement + Test	Result - Remark Verdict
DO A'	16.6	During the test, samples supplied with protective devices shall be subjected to a single component fault using any single fault condition that may be determined to occur during discharge conditions. Section 11 for details regarding single fault conditi Single fault conditions can be applied to both pass and active protective devices.	See ions.
200	Polek Vupe	Exception: Components in circuits evaluated for reliability (i.e. evaluated for functional safety critericonsidering single fault conditions in accordance v 7.8.1.3) need not be subjected to single fault conditions.	
0,00	16.7	During the test, a detection method as outlined in Section 9 shall be used to detect the presence of combustible vapor concentrations if determined necessary. If required based upon system design installation, venting of toxic releases shall be continuously monitored during the testing per Sec 13.	potek Aupo, W. ek
200	16.8	If the DUT is operational after the short circuit test shall be subjected to a charge and discharge cycle accordance with the manufacturer's specifications See 12.2 for details regarding user resettable devian observation period per 8.5 is then conducted.	e in Andrew Andrew Andrew
00	16.9	At the conclusion of the observation period, the samples shall be subjected to the "as received" dielectric voltage withstand test in accordance witl Section 20. The DUT shall be examined for signs rupture and evidence of leakage.	
Ar	16.10	As a result of the short circuit test, the following in – (h) are considered non-compliant results. For additional information on non-complying result refer to Table 12.1. a) E – Explosion; b) F – Fire;	(ess rable 19)
0	ar Anbo	 c) C – Combustible vapor concentrations; d) V – Toxic vapor release; e) S – Electric shock hazard (dielectric breakdown) 	anbotek Anbotek Anbotek Ar
in'	Aupotek Pose, Vi	 f) L – Leakage (external to enclosure of DUT); g) R – Rupture (of DUT enclosure exposing hazardous parts as determined by 7.3.3); h) P – Loss of protection controls. 	Anbotek Anbotek Anbotek
	16.11	For battery systems, the measured maximum sho circuit current and duration at that maximum value shall not be greater than the specified value of 41.	half abotek Anbo
386	17 Amb	Over-discharge Protection Test	Andrew Antron Antrophe P



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N.	hotel	ANSI/CAN/UL1973: 2018	1 ₀ V _{U₁} , v _A	27 UI 73
	Clause	Requirement + Test	Result - Remark	Verdict
D.C.	17.1 hootak	This test shall be conducted on a fully charged sample (MOSOC per 8.1) to determine the DUTs ability to withstand an over-discharge condition and is conducted with all discharge protection circuitry for both temperature and minimum voltage connected to	Anboron Anbo	nbotek Anbotek
lk.	Anborel	prevent irreparable cell damage. During the test, active protective devices shall be subjected to single fault conditions, unless the protection circuit has bee tested for functionality in accordance with 7.8.1.3.		lek Vup.
P. C.	ootek b	Exception: Over-discharge protection testing on a subassembly may be conducted instead of the complete battery system if determined to be	Anbotek Anbotek A	potek Ambotek
le.	17.2	representative of the battery system. The DUT shall be subjected to a constant discharging current/power that will discharge a battery at the manufacturer's specified maximum discharge rate.	g	IP ^{botol}
01/2	otek Vupo	The test will continue until the passive protection device(s) are activated, or the minimum cell voltage/maximum temperature protection is activated or the DUT has been discharged for an additional 30 min after it has reached its specified normal discharge	stek anbote. Ar	ok P k
	17.3	limit, whichever comes first. During the test, a detection method as outlined in Section 9 shall be used to detect the presence of combustible vapor concentrations as determined	ek Anbotek Anbotek	P ^{i otok}
016	k Anbo	necessary. If required based upon system design or installation, venting of toxic releases shall be continuously monitored during the testing per Section 13.	Arbotek Anbotek Anbot	ootek Ar
100	17.4 Anbolek	If the DUT is operational after the overdischarge protection test it shall be subjected to a charge and discharge cycle in accordance with the manufacturer's specifications. See 12.2 for details	Anbotek Anbotek	Anbotek Anbotek
	Anbotek	regarding user resettable devices. An observation period per 8.5 is then conducted.	notek Anbotek Anbotek	k Anbo
100	17.5	At the conclusion of the observation period, the samples shall be subjected to the "as received" dielectric voltage withstand test in accordance with	Anbotek Anbotek Anbot	P A
100	17.6	Section 20. The DUT shall be examined for signs of rupture and evidence of leakage. As a result of the overdischarge protection test, the	(See Table 17)	Anboren Ar Porek
	Anborek	following in (a) – (h) are considered non-compliant results. For additional information on non-complying results refer to Table 12.1.	or ik Anbotek Anbotek	k Anbol
10	otek anbot	 a) E – Explosion; b) F – Fire; c) C – Combustible vapor concentrations; d) V – Toyic vapor release; 	Antiotek Anbotek Anbot	otek bu
0	Anbotek Anbotek	 d) V – Toxic vapor release; e) S – Electric shock hazard (dielectric breakdown); f) L – Leakage (external to enclosure of DUT); g) R – Rupture (of DUT enclosure exposing hazardous parts as determined by 7.3.3); h) P – Loss of protection controls. 	Anbotek Anbotek Anbotek Anbotek Anbotek	Anbotek Anbotek Anbot
-34	18	Temperature and Operating Limits Check Test	o, W. Olek Vupoje	P An



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loo's	ANSI/CAN/UL1973:	2018	W. Polek	Anboten	PU
Clause	Requirement + Test	R	esult - Remark	V	erdict
18.1	This test is conducted to determine whether or n		Upose Pup	100	P
	cells/modules of the DUT are being maintained v	within	Polek Pupo,	p.	
	their specified operating limits (including voltage	and	Ans K wol	ek or	
	current at specified temperature) during maximu	m. «	aboles And		
	charge and discharge conditions. During this tes	t, it	All.	poter	
	shall also be determined as to whether or not		Anbor An	10.	
	temperature sensitive safety critical components	are	V GOV	Aupore	
	being maintained within their temperature ratings	3 00	Ver Vupe	rek	
	based upon the maximum operating temperature		ok work	VUPO	
	specifications of the DUT as well as a determina	tion	upore Am	1001	
	that temperatures on accessible surfaces are no	t	otek anbore	Villa	
100	exceeding safe limits.	P. C.	Anbo	100	pole.
abote	Exception: Temperature and operating limits che	ck	Polek Vupo.	ga.	P
W.	test on a subassembly may be conducted instea	d of a	Vun.	Notok	
Aupo,	complete battery system if determined to be		Vupoje, Vu		
	representative of the battery system.		h.	abole	
18.2	A fully discharged DUT (i.e. discharged to EODV	/)	lek Vupo	W.	Р
e/c = 1/9	shall be conditioned within a chamber set to the	upper	k cotek	Anbo	
bu.	limit charging temperature specifications of the D	DÚT.	pole. Vup	200	
- Nok	After being stabilized at that temperature (refer to	0	rek abolen	AFD	
100	8.3), the DUT shall be connected to a charging of	circuit	Anbor Am	to the	
bolek	input representative of anticipated maximum cha	arging	notek anbore	bu	
Villa	parameters. The DUT shall then be subjected to	0,00	Amb	Note	
anbore	maximum normal charging while monitoring volta	ages	bolek Ant	,0	
100	and currents on modules until it reaches the	upore	VI.	hotek	
Anbo.	manufacturer's specified fully charged condition.		ek anbore	Arra	
. V.	Temperatures shall be monitored on temperature	e Anbe	Note .	Upolo	
V.	sensitive components including cells.		potek Anbo	24.5	1/6
101	Exception No. 1: If the DUT is unable to be teste	d in a	Notek Notek	Ando	P
bo.	chamber, it can be tested at an ambient tempera	iture	Anbore And		otek
"Olek	of 25 ±5°C (77 ±9°F). If tested at ambient		rek subote	Vu.	
VUL.	temperatures during the test, the temperature		Aupo.	401	
apole	measurement T shall not exceed:		hotek Anb	0.	
br.	T ≤ Tmax − (Tma − Tamb)		Ann	mojek.	
Anboro	Where:		ek aboten	And	
v	T is the temperature of the given part measured	under	be.	aboten	
PUP.	the prescribed test.		otek Anboy	br.	
400	Tmax is the maximum temperature specified for		k work	anbore	
0070	compliance with the test.		aboren Anbe		
Note	Tamb is the ambient temperature during the test		Ar. Potel	Anb	
Anbo	Tma is the maximum ambient temperature perm	itted	Anboro Ans	1/2.	
Polek	by the manufacturer's specified or 25°C		stek anb	1	
An	(77°F), whichever is greater.	boyer	Anbo	401	dna
nbole	Exception No. 2: If the design of the DUT and its	307	ok spoten	upo	Р
	controls result in worse case normal charging		Vien	POLEK	
	conditions when testing at ambient (i.e. due to		atek anbote.	Ann	
	thermostats or other controls lowering the charge	e po	Pa. br.	" pote	
	levels at elevated ambient), the test shall be		polek anboy	Der.	
100	conducted at ambient temperature of 25 ±5°C (7	7	Ville K Viel	day	
	±9°F). Temperatures on temperature sensitive		abover Anbo		
	components shall not exceed Tmax.		by.	100	

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.V	report No.	ANSI/CAI	N/UL1973: 2018	VI. VI	29 01 73
0.	Clause	Requirement + Test	anbotek l	Result - Remark	Verdict
000	18.3	While still in the conditioning chambe temperature shall be set to the upper temperature specifications of the DUT	limit dischargin		nbotek P
	Anbotek Anbotek	the charging temperature. The fully cl (MOSOC per 6.1) shall then be disch- accordance with the manufacturer's n	narged DUT arged in	Anbotek Anbotek	Anbotel
N.	Anborel	discharge down to the manufacturer's discharge condition while monitoring	specified end		lek And
0	iek Anbr	current on modules. Temperatures sh on temperature sensitive safety critical including cells. Temperatures on acce	al components	Anbore And	ipolek
72	por p	are also monitored. Exception No. 1: If the DUT is unable	potek	Aupo, W.	Aupotek
	Anbotek	chamber, it can be tested at an ambie of 25 ±5°C (77 ±9°F). If tested at amb	ent temperature ient		Anbotek
1/4	Anboren	temperatures during the test, the tem measurement T shall not exceed: T ≤ Tmax − (Tma − Tamb)	perature	upolek Aupolek Aupol	lok by
0	tek And	Where: T is the temperature of the given part	measured und	ler Note to the least of the le	(botek
24	po, bolek	the prescribed test. Tmax is the maximum temperature sp	notek	Anbotek Anbotek	Anbotek
	Anbotek	compliance with the test. Tamb is the ambient temperature dur Tma is the maximum ambient temper		ek Anbotek Anbotek	Anbo
7	Aupore No	by the manufacturer's specified or 25 (77°F), whichever is greater.	°C	polsk Aupoten Aupo	lok bi
0	ootek An	Exception No. 2: If the design of the Econtrols result in worse case normal conditions when testing at ambient (i	discharging	Arbotek Anbotek Ar	pote ^V P
71	Anbotek	conditions when testing at ambient (i. thermostats or other controls lowering rate at elevated ambient), the test sha	the discharge all be conducted	6/1/	Anborek
7	Anborek	at ambient temperature of 25 ±5°C (7 Temperatures on temperature sensiting shall not exceed Tmax.		ek Anbotek Anbotek	Anbol
07	18.4	The charge and discharge cycles are for a minimum of two complete cycles	of charge and		P M
'U	otek Pr	discharge. The DUT is then subjected observation period per 8.5.	br.	Anbotek Anboten An	abotek.
	18.5	At the conclusion of the observation p samples shall be subjected to the "as dielectric voltage withstand test in acc	received" cordance with	Anbotek Anbotek	Anbotek
	Anbotek	Section 20 if it anticipated that there had deterioration of the insulation during to test. The DUT shall be examined for states.	he temperature		Anbot
35	ik Anbol	and evidence of leakage.	signs of rupture	stek Anbotek Anboli	Pr.



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Or bugo.	- ok	SI/CAN/UL1973: 20	100	- No
Clause	Requirement + Test	. aboter	Result - Remark	Verdict
18.6	The manufacturer's specified or	perating limits for	(See Table 18)	, botek
10.0	cells/modules (voltage, current		(See Table 10)	Plus
	temperatures) shall not be exce		Aupo. W.	k spoien
	charging and discharging cycles		K wolek Anboy	D11.
	measured on components shall		Yes. Vup	otek pupor
			sible! Hotel And	D. Br.
	specifications. Temperatures m			work an
	surfaces shall not exceed allow		e sk	AND
	18.1 and Table 18.2 for tempera		Anber All	HOIGH
	Additional non-compliant results		stek anbore	Ville
	temperature test are as noted b			polo
	additional information on non-co	omplying results ref	ter know know	b.
	to Table 12.1.		Anbor Air	v vipolo
	a) E – Explosion;		ek botek Anbe	
	b) F – Fire;		bu.	Jiek Wipo.
	c) S – Electric shock hazard (die	electric breakdown); tek	
	d) L - Leakage (external to enc	losure of DUT);	100. Br.	Poles Vu
	e) R – Rupture (of DUT enclosu	V 11/2	Nek Nupore	"Line
	hazardous parts as determined		Aupo	nbo
V. VI	nazardous parts as determined	by 7.5.5),	Bolek Vupo.	h. Ash
19	Imbalanced Charging Test	ek Anbore	All tek abotek	Moo. B
19.1	This test is to determine whether	er or not a battery	Anbo. A.	- App
poter	system with series connected c	ells/modules can	olek oupole	bu.
	maintain the cells/modules with		Anbo	tok supor
	operating parameters if it become		ok hotek Anbi	by.
P21	Exception No. 1: Testing may b		Posts. Prop	abotek PAn
	subassembly level if that is repr		ak aboten A	up.
	battery system.	Cochiative of the	Anbo All	POSSI
ak Buk	Exception No. 2: Testing may b	o conducted on an	olek vidosle	VUL
			Aroc	PoterP
	alternate configuration if it can be		potek Aupo,	b.,
40.	representative for the battery sy		anb.	Nupo10
19.2	A fully charged DUT (MOSOC p		all	P
	of its modules/cells with the exc		Vun K MO	tek Anbote
Aupo,	discharged to its specified fully			4
010	The undischarged module/cell s			pole, Vup
	approximately 50% of its specifi	ied state of charge	Visk Vupore V	. V
	(SOC) to create an imbalanced	condition prior to	Anbo	"pot
	charging.	Vien	Lotek Anbo	Pr.
19.3	The sample shall then be charg	ed in accordance v	with	Pupper B
30.0	the manufacturer's maximum no		Thorem And	Nek
	specifications. Charging shall co		VII.	Anbo
	charge conditions and the DUT			V 2010
	equilibrium. The voltage of the		P. 184 200	And
	module/cell shall be monitored		n to	d. 40.
	determine if its voltage limits are		J-10	pole Vue
AUL			Pot It Bupo. N.	104
	During the test, active protective		Ann	Anbor P
	subjected to single fault condition		Anbo	Yel
	protective circuit has been teste	ed for functionality i	n Pr	MURO
0,	accordance with 7.8.1.3.	Non	abore And	York
19.4	During the test, a detection met	hod as outlined in	Pr. Poler	Anbe P .
ANDO	Section 9 shall be used to detec		k vupose vur	ak morel
	combustible vapor concentratio		toda 40°	And
	necessary. If required based up		or	no No.
	installation, venting of toxic rele		atek an	DOLD VUI
	continuously monitored during t		tion	201
	13.	no teating per sect	Non-	Pupo,
	13.	po-	48.	- 16



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000	ANSI/CAN/UL197	'3: 2018	stek Anbore An
Clause	Requirement + Test	Result - Remark	Verdict
19.5	If the DUT is operational after the test it shall subjected to a discharge and charging cycle accordance with the manufacturer's specifica See 12.2 for details regarding user resettable	n tions.	Anbotek Anbotek
notek	An observation period per 8.5 is then conduc		. Aupolen Aupo
19.6	At the conclusion of the observation period, the shall be subjected to an "as received" dielections with the same state of the same state.	ric Marie Land	tek Anbotek P Anh
lek bu	voltage withstand test in accordance with Sec The DUT shall be examined for signs of ruptuevidence of leakage.		hootek Anboles
19.7	The maximum voltage limit of the module/cel not be exceeded when charging an imbalanc DUT.		Anbotek Anborek
Anbotek.	Also, the following in (a) – (h) are considered compliant results. For additional information of		9) P
Anboi	complying results refer to Table 12.1. a) E – Explosion;	Anboro Anbor	ek Anbotek Anb
ek Mu	b) F – Fire;c) C – Combustible vapor concentrations;d) V – Toxic vapor release;	ok Wipolek Wi	botek Anbotek
Anbotek bo.	e) S – Electric shock hazard (dielectric break f) L – Leakage (external to enclosure of DUT g) R – Rupture (of DUT enclosure exposing		Anbotek Anbotek
Anbotek	hazardous parts as determined by 7.3.3); h) P – Loss of protection controls.	Anbotek Anbotek	ek abotek Anb
20	Dielectric Voltage Withstand Test	apolek Anbo	N Name of the N
20.1	This test is an evaluation of the electrical spa and insulation at hazardous voltage circuits w battery system.		Anbotek AnbotekN
20.2	Circuits exceeding 42.4 V peak or 60 Vdc sha subjected to an electric strength test in accor- with UL 60950-1/CAN/CSA-C22.2 No. 60950 Clause 5.2.	dance -1,	Anbotek Anbotek
Anbor	In Canada, the dc limits are 42.4 Vdc as defir CAN/CSA-C22.2 No. 0.	ned in	ok Anbo otsk
otek An	Exception: Semiconductors or similar electron components liable to be damaged by application the test voltage may be bypassed or disconnection.	ion of	anbotek AnbotekN
20.3	The test voltage shall be applied between the hazardous voltage circuits of the DUT and no current carrying conductive parts that may be accessible.	n- nbotek Anbotek	Anbotek Anbotek
20.4	The test voltage is also to be applied between hazardous voltage charging circuit and the	abotal Anbo	Pupos Num
on Anh	enclosure/accessible non-current carrying co parts of the DUT.	Anyore Any	Jose Aug
20.5	If the accessible parts of the DUT are covere insulating material that may become live in the of an insulation fault, then the test voltages a applied between each of the live parts and m	e event re	Anbotek Anbotek
anbore	in contact with the accessible parts.	rek hoter	AUD



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lode	ANSI/0	CAN/UL1973: 201	18 Anbore	Visi
Clause	Requirement + Test	n botek	Result - Remark	Verdict
20.6	The test voltages shall be applied in min with the cells/modules disconn	ected to prevent		nbotek N
	charging during application of the value of	be at an elevated be active, such as	An tek abotek	Anbote
All not	sodium-beta chemistries, shall be to disconnection and applying the		Otte. Vup.	K Ant
20.7	There shall be no evidence of a die (breakdown of insulation resulting		A TOP OF THE PERSON NAMED IN COLUMN TO PERSO	N N
	insulation/arcing over electrical spa evidenced by an appropriate signa	acings) as	Anbore And	apolek ek
	withstand test equipment as a resultest voltage. Corona discharge or a		ary	Anbore.
	discharge is not regarded as an die (i.e. insulation breakdown).	electric breakdow	n Annotek Annotek	Aupo.
20.8	If the battery system contains hygr that may affect spacings, this test is			N Am
	DUT or with the subassembly of the hygroscopic materials subjected	d to humidity	Dan potek Anbotek Anb	-otek
	conditioning of UL 60950-1/CAN/C 60950-1, Clause 2.9.2. As a result	of this testing,	Anbotek Anboten A	. abotek
Aupoten	there shall be no dielectric breakdo 20.7.	own as outlined ir	Aupotek Aupon	bi.
21 Maria	Continuity Test	00. Pr.	otek Anboten Anb	N
21.1 Anbott	This test evaluates the continuity of grounding and bonding system of		abolek Anbolek Anbo	N N
	system that is intended to provide conductive path from the point of a	an electrically	a Arbotek Anbotek Anb	notek.
	battery system or its representative components through normally non-	e parts or	Anborek Anbore A	anbotek
	conductors, equipment, or the eart supply source.		Anbotek Anbotek	Anbotel
21.2	An alternate test method outlined i if the construction of the protective		sed	N _{anb} o
ak anb	and bonding system adheres to the methods outlined in 7.6.5 – 7.6.7.	e construction	nbolak Anbo	COX D
	means vary from that outlined in 7. fault current method outlined in 21	6.6 and 7.6.7, the		potek
	default method for evaluating the sprotective grounding system.		Anbotek Anbotek	Anboten
21.3	The grounding system of an batter no more than 0.1-Ω resistance bet			N
	of the system that are measured in the continuity test of 21.4 and 21.5	accordance with		Anb.



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, bot	ANSI/CAN/UL1973: 20	018	Page 33 01 73
Clause	Requirement + Test	Result - Remark	Verdict
21.4	The voltage drop in a protective grounding system measured after applying a test current of 200% of the rating of the overcurrent protection device rating, for a duration corresponding to 200% of the time-current characteristic of the overcurrent protection device. If the duration for 200% is not given, a point closest on the time-current	Anbotek Anbo	nbotek Anbotek Anbotek
Nok Anbo	characteristic shall be used. The overcurrent protective device limits the fault current in the protective grounding system, and is either provided	d in	Anbolek potek
Anbotek Anbotek	the battery system or external to the battery system and specified in the installation instructions. The supply used to provide the test current shall have a no load voltage not exceeding	ak Anbo. Ar	nbotek Anbotek
21.5	Vdc. The voltage drop measurement is made between a	sek aboles	Anborak N Anbr
21.6	two conductive parts of the grounding system. The resistance shall be calculated from the measu voltage drop and current. The determined resistan shall be less than or equal to $0.1~\Omega$.		Arbook N
21.7	To check the continuity of the bonding connections the resistance can be measured between two poin on the bonding connections using a milli-ohmmete The measured resistance between any two bonding	nts er.	Anbotek Anbotek
22	connections shall be less than or equal to 0.1 Ω. Failure of Cooling/Thermal Stability System	oo, W. William	Anboten Anb.
22.1	The purpose of this test is to determine if the batte system can safely withstand a failure in the cooling/thermal stability system.	ery	ek AnbotekN
Anbotek	Exception: Testing may be conducted at a subassembly level if that is representative of the energy storage system.	Anbotek An	botek Anbotek
22.2	The DUT shall be fully discharged to the manufacturer's end of discharge condition EODV at then conditioned at maximum specified operating	and	Anbotek Nanbo
cek Anb	ambient for a period of 7 h or until thermally stable 8.3, whichever is shorter. While still in the condition chamber, the DUT, with its cooling/thermal stability	ning	ek Anbotek
Aupotek Po. b	system disabled shall then be charged at its maximum specified charge rate until completely charged or until operation of a protective device.	Anborek Ant	potek Anbotek
22.3	The DUT shall be fully charged (MOSOC per 8.1) athen conditioned at maximum specified operating ambient for a period of 7 h or until thermally stable	, otok	Anbotek Nanbo
ek Aupo	8.3, whichever is shorter. While still in the condition chamber, the DUT, with its cooling/thermal stability system disabled shall then be discharged at the	y Antores Ambore	anjotek A
Anbotek	maximum discharge rate until it reaches its specific end of discharge condition or until operation of a protective device.	ed Anbotek Ant	otek Anbotek



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· look	ANSI/CAN	/UL1973: 2018	h,	motel*	unboter Ar
Clause	Requirement + Test	abotek N	Result - Rem	nark	Verdict
22.4	During the test, one of the detection m in Section 9 shall be used to detect the combustible vapor concentrations. If re upon system design or installation, ver releases shall be continuously monitor testing per Section 13.	e presence of equired based nting of toxic	d Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotel	Anbotek Anbotek
22.5	If the DUT is operational after the test subjected to a discharge and charging accordance with the manufacturer's sp. See 12.2 for details regarding user research observation period per 8.5 is then one of the subject	cycle in pecifications. ettable devices	bylek S., botek	Vupotek Vupotek	Aupotek N Au
22.6	At the conclusion of the observation pershall be subjected to an "as received" voltage withstand test per Section 20. be examined for signs of rupture and eleakage.	eriod, the DUT dielectric The DUT shall	Anbotek Anbotek	anbotel Anbr	rek Anbor
22.7	The test method of 22.2 – 22.6 shall be the DUT conditioned at the minimum superating ambient.		Polek V	Anbotek	Anbolek N
22.8	As a result of the failure of cooling/their test, the following in (a) – (h) are consinon-compliant results. For additional in non-complying results refer to Table 1: a) E – Explosion;	dered nformation on	Anbotek Anbotek	Anbotek Anbotek	Anbote Anbote
ek Anbotel	 b) F – Fire; c) C – Combustible vapor concentration d) V – Toxic vapor release; e) S – Electric shock hazard (dielectric 		oo _{jek} v		Anbolsk Ant
Anbotek A	 f) L – Leakage (external to enclosure of the control of the control	osing	Anbotek	Anbotek Anbotek	Anbotek Anbotek
23	Working Voltage Measurements	PIL.	anbol Anbol	lek Wupo	N
23.1	This test is to measure the working volt system.	age of a batter	y ar		Name of the Name o
23.2	The working voltage between live parts polarity, live and dead metal parts, live	parts and	Arbotek .	Anboren	Anbotek N
	a metal enclosure, and live and ground under both normal charging and discha as specified by the manufacture is mea	rging condition	S Anboter		Anbotek
23.3	The dead metal parts and metal enclos assumed to be connected to the negati the system for testing purpose.	ure shall be ve terminal of		ak Anbot	botek M
23.4	The values obtained during the measur in 23.2 shall be used to verify electrical spacings criteria per 7.5.		d and and	Anbotek	Anbotek N p
24	Tests on Electrical Components	And	abotek	Anbore	N. N.
24.1	Locked-rotor test for low voltage dc fan secondary circuits	s/motors in	Anborek	Anboren	And N



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foda_	Br. Aupo. W.	ANSI/CAN/UL1973: 2	2018	ek Aupore	b.c.
Clause	Requirement + Test	otek anbotek	Result - Remark	otek anbi	Verdict
24.1.1	The purpose of this test is dc fan or motor does not in a locked rotor condition 507 are considered to conwithout test.	present a hazard n. Fans complying with U	L Anbotek	Anbotek Anbotek Anbotek	Anbotek Anbotek
24.1.2	A sample of the fan or moto board, which is covered wo of tissue paper, and the sa single layer of bleached approximately 40 g/m2.	vith a single layer cample in turn is covered	Anbert	Anbotek Anbotek	lotek N Amo
24.1.3	The sample is then opera application and with its rosteady conditions are est the longer.	tor locked for 7 h or until	o, bi.	Anbotek Anbotek	N Anbord
24.1.4	There shall be no ignition cheesecloth.	of the tissue paper or	Anbolisk Anb	otek Anbo	N P
24.2	Input	Anbotek Anbo	r botek	Aupole, A	N
24.2.1	The input current draw of separate from the pack scontrol or an accessory c from a system, shall be s 24.2.2.	uch as a mains supplied ontrol evaluated indepen	dent		Anbolek Anbolek
24.2.2	The current or watts input when connected to an ac	t to an ac mains supplied supply adjusted	l unit,	otek Vupo	Nyste
Anbotek Anbotek	to the test voltage specific more than 110% of the ra current or watts input dra connected to a dc supply rated/specified value of the	ated/specified value. The w of a dc supplied unit, w , shall not exceed the	k.		Anbotek Anbotek
24.3	Leakage current	Step Aupon	abolsk Anbols	hung.	N N
24.3.1	For separate controls or system that are cord con		Visolek Vipi	Potek Wup	N _{49fok} N
	ac mains circuits, the con Touch current and protec the Touch Current and Protection in UL 60950-1/C/	tive conductor current test rotective Conductor Curre	st of ent		Anbotek Anbotek
24.4	Strain relief test	stek Anbotek Ar	upo.	Aupolog	P
24.4.1	The purpose of this test is relief means for a non-de		n Anbo Anbo	tek Aupor	otek P Ar
	cord prevents damage or pulled.	displacement upon being	g Mahalek M		obotek



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Clause	Requirement + Test	nbo stek	anbotek.	Result - R	emark	Verdi	ct		
24.4.2	The battery system or a relief shall withstand with			ain	Anbotek	A horeh	Jk.		
	cord or conductors and pull of 156 N (35 lbf) ap			ect		otek Anb			
	Supply connections with disconnected from term when applicable. If the spolymeric enclosure or the mold stress test after temperature.	inals or splices strain relief is m part, the test is	during the te nounted in a conducted af	ter	Anbotek Anbotek	Anbotek Anbotek			
24.4.3	As a result of the pull fo displacement of internal			r (See Ta	able 24.4)	Anb P	ore		
	conductors may not elor from the pre-test positio		an 2 mm (0.08	3 in)		ofek An			
24.5	Push-back relief test	Pu,	otek.	anborek	Vupo,	ek N	0		
24.5.1	The purpose of this test relief of a non-detachab adequate protection to chazardous displacement	le accessible c connections an	cord provides ad prevent	Anbotek	Anbotek Anbotek	Anbotek Anbotek	ŀ		
Anbo	connections as a result		- /	ak Anbo		otek Anbo			
24.5.2	A product shall be teste and 24.5.4 without occu			olek bi	potek Am	unbotek N	nbo		
ek ut	following conditions:			Aupo		Aupolek			
	a) Subjecting the supplyb) Exposing the supply		100°	D-1		Anbotek			
	than that for which it is r		erature mgne	Anbore		anbotek			
	c) Reducing spacings (s clamp) below the minim			ef Anbot		stek Anbo			
All.	d) Damaging internal co	nnections or c	omponents.	Ofer An	lo-	nbotek Ar	nbo		
24.5.3	The supply cord shall be point where the cord or			ne		Anbotak N			
	the product and is then product. When a remove further than 25.4 mm (1 be removed prior to the	able bushing, vin) is present,	which extends			Anbotek Anbotek			
24.5.4	When the bushing is an the test shall be carried			en Ani	potek Anbo	botek N	nboʻ		
	bushing. The cord shall product in 25.4-mm (1-in			unbotak Lok		Anborek			
otok p	buckles or the force to pexceeds 26.7 N (6 lbf).	oush the cord in	nto the produc	ot Anboro	Anbotek	Antotek	<u> </u>		
24.5.5	The supply cord shall be compliance with 24.5.1.		to determine	Aupote Aupote	ak Anborek	tek Pupot	No		
24.5.6	If the strain relief is mou or part, the test is condu after the part has cooled	icted after the	mold stress te		anbotek Ar	nibotok N	pot		



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100.	ANSI/CAN/UL1973: 2018	k worken Ambe	he.
Clause	Requirement + Test R	esult - Remark	Verdict
V. 524	MACHANICAL TESTS	-48, -04	upotek P
25	Vibration Test (LER Motive Applications)	Aupo, Au	anb Prek
25.1	The purpose of this test is to determine the battery system's resistance to anticipated vibration in	Anborek Anborek	Photo
Anbore	LER motive installations and applies only to those systems intended for installation in that application.	tek Aupotek Aupotek	An ^t
25.2	The sample shall be secured to the testing machine by means of a rigid mount, which supports all mounting surfaces of the sample.	nbotek Anbotek Anbo	P
Anbotek Anbotek	Exception: The sample may be mounted within a mounting fixture representative of the intended end use application.	Anbotek Anbotek	Anbore Anbore
25.3	The fully charged sample (MOSOC per 8.1) shall be subjected to a vibration test in accordance with	lek Aupolen Aupo	P P
botek Anbotek	the Simulated Long Life Testing at Increased Random Vibration Levels Tests of IEC 61373, for the appropriate Category and Class of equipment as determined by the intended rail installation. (Category and Class of equipment is defined in IEC 61373.)	Anbotek Anbotek Ar	botek Anbotek Anbote
25.4	The DUT shall be subjected to vibration in 3 mutually perpendicular directions. During the test the OCV of the DUT and temperatures on the center cell/module shall be monitored for information purposes.	ek Anbotek Anbotek	P _{Anto}
25.5	During the test, one of the detection methods outlined in Section 9 shall be used to detect the presence of combustible vapor concentrations. If required based upon system design or installation, venting of toxic releases shall be continuously monitored during the testing per Section 13.	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotel
25.6	If the DUT is operational after the test it shall be subjected to a discharge and charging cycle in	potek Anbotek Anbot	P
	accordance with the manufacturer's specifications. See 12.2 for details regarding user resettable devices.	Anbotek Anboten An	Anbotek
Anbo.	An observation period per 8.5 is then conducted.	Anbore And	hobotel
25.7	At the conclusion of the observation period, the DUT shall be subjected to an "as received" dielectric voltage withstand test in accordance with Section 20. The DUT shall be examined for signs of rupture and evidence of leakage.	k Anbotek Anbotek	P Ambr



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You's	Aupo. W.	ANSI/CAN/UL1973: 2	2018	Aupor Am
Clause	Requirement + Test	notek sabotek	Result - Remark	Verdict
25.8	As a result of the vibration are considered non-complia		- (h) (See Table 25)	Anbotek
	additional information on no Table 12.1.	on-complying results re	fer to	potek Anbote
	a) E – Explosion;b) F – Fire;		Anbotek Anbotek	Anbotek Ant
	c) C – Combustible vapor od) V – Toxic vapor release;		Anbotek Anbotek	Anbolek
	e) S – Electric shock hazar f) L – Leakage (external to	V. (1)	n);	otek Albo
	g) R – Rupture (of DUT end parts as determined by 7.3		dous	Anbotek Anbote
h. anbois	h) P – Loss of protection co	10 PL/00	Huporg Wur	Anborek Ant
26	Shock Test (LER Motive A	194	Anboro An Sotok	anbolek P
26.1	The purpose of this test is t system's resistance to antic	cipated shock in LER	A notek anbote	A Arbotel P
Anbotek	motive installations and appointended for installation in t		ems Anbotek Anb	otek Anbore
26.2	The sample shall be secure means of a rigid mount, wh surfaces of the sample. Du on the center module are n purposes.	nich supports all mounting the test, temperatu	ng ires	Anbotek Anb
potek hotek	Exception: This sample ma mounting fixture representa end-use rail application.		Anbotek Anbote	otek Anbotek
26.3	A fully charged sample (MC subjected to a shock test in		tek Anbotek	inbotek APote
	61373 for the appropriate C equipment as determined to installation.		Aupotek Aupotek	Anbotak Anb
	(Category and Class of equ 61373.)	uipment is defined in IE	C Anbotek Anbotek	Anbotek
Anbotek	Exception: This test may be level if it can be shown that representative of the batter	t testing shall be	dule	nbotek Anbotek
26.4	Both positive and negative applied in each of 3 mutual		De .	Anbotek Panbo
K Anbo	directions for a total of 18 s	shocks.	Yun Viek Vupotek	Vupo, b
26.5	During the test, one of the oin Section 9 shall be used to		ned	Antole P
	presence of combustible varequired based upon system		ek Anbotek Anbo	hotek Anbotek
	venting of toxic releases sh monitored during the testin		potek Wipoter W	anbotek Anbo



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, bod	ANSI/CAN/UL19	973: 2018	Anbore An
Clause	Requirement + Test	Result - Remark	Verdict
26.6	If the DUT is operational after the test it shall subjected to a discharge and charging cycle i	10 U	K Albotek
Anbolek	accordance with the manufacturer's specifica observation period per 8.5 is then conducted.		botek Anbot
26.7	At the conclusion of the observation period, the shall be subjected to an "as received" dielectric with stand test in accordance with Section 20. shall be examined for signs of rupture and evileakage.	ric voltage The DUT	Anbotek P Ant
26.8	As a result of the shock test, the following in (are considered non-compliant results. For	nbo Ak hojek Anbi	stek Anb Pak
Anbotek	additional information on non-complying resultable 12.1. a) E – Explosion;	its refer to	nbotek Anb
rek Anbo	b) F – Fire; c) C – Combustible vapor concentrations;	Anborek Anbotek	Anbo ek
, botek	 d) V – Toxic vapor release; e) S – Electric shock hazard (dielectric breake) 	down).	Albotek
Anbotek	f) L – Leakage (external to enclosure of DUT) g) R – Rupture (of DUT enclosure exposing h); hotek Anbotek Anbo	hbotek Anbote
Anbote	parts as determined by 7.3.3); h) P – Loss of protection controls.	Anbotek Anbotek	Anboten And
27	Crush Test (LER Motive Applications)	ok potek Anboten	Anbe tekP
27.1	This test is conducted on a fully charged batte system intended for LER motive applications		tek Nipotek
Anborek	determine its ability to withstand a crush that occur during an accident and applies only to t	those	ipotek Aupotel
Vu.	systems intended for installation in that applic	cation.	Anbotek Anb
27.2	A sample shall be crushed between a fixed stand a ribbed test platen in accordance with the	ne Amb	Anbolsk P
Anbotek Anbotek	test fixture described in SAE J2464, with the fexceptions as noted below. Packs with 3 axes symmetry, are subjected to 3 mutually perper directions of press. A different sample of the I be used for each crush.	s of ndicular	ek Anbotek
Anbotel	Exception No. 1: The maximum force applied DUT shall be 100 ±6 kN.	And K notek	Anbotek Panbo
ek Aup	Exception No. 2: Battery systems with only 2 symmetry, such as cylindrical designs are sub 2 mutually perpendicular directions of press.	bjected to	Anbotek P A
Anbotek Anbotek	Exception No. 3: The DUT may be installed in protective framework representative of what is provided in the end use application.		ek AnborP
Anbotek Anbotel	Exception No. 4: A subassembly may be tested of a complete battery system if it can be demonstrated to be equivalent to testing a cobattery system.	botek Anbo. A.	Anbotek Anbo



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· cool	Value Value	ANSI/CAN/UL1973: 20	ло моток	Mupo, W.
Clause	Requirement + Test	and abotek	Result - Remark	Verdict
27.3	A detection method as outli used to detect the presence		anbotek An	potek Albotek
	vapor concentrations within gases may occur, but shall using the measurement me 13. The sample shall be sulperiod and the examined.	not exceed ERPG-2 level thods outlined in Section	n ak abotek	Anbotek Anbotek Anbotek Anbotek
27.4	As a result of the crush test are considered non-complia		(See Table 27)	ak Anbe P
	additional information on no Table 12.1.	on-complying results refe	er to	hotek Anbotek
	a) E – Explosion; b) F – Fire;		ek Aupolek	Anbotek Anbote
	c) C – Combustible vapor c d) V – Toxic vapor release;	oncentrations;	postek Aupotek	Anbotek Anb
28	Static Force Test	Potok Vipo,	Anbotek Anbote	Poppe New York
28.1	The purpose of this test is to has sufficient strength to sa that may be applied to it.			P
28.2	The enclosure of a fully cha 8.1) shall withstand a stead period of 5 s, applied in turn sides of the enclosure fitted suitable test tool providing of surface 30 mm (1.2 inch) in	y force of 250 N ±10 N f n to the top, bottom and l to the DUT, by means c contact over a circular pl	or a of a	Anbotek P Anbotek
	However, this test is not appendiosure having a mass of			Anbotek Anbotek
Anbotek Anbote	If the DUT is operational aft application of the static forc discharge and charging cyc manufacturer's specification per 8.5 is then conducted.	e, it shall be subjected to le in accordance with th	e kan kan kan	Anbotek Anbo
28.3	If deemed necessary (i.e. d anticipation of venting of ce		and 1	otek Anboten P
	detection methods outlined to detect the presence of co		ed Anbotok	inbotek Anbotek
	concentrations. If required to or installation, venting of to continuously monitored during 13.	kic releases shall be	br.	Anbotek Anbo
28.4	After the observation period subjected to an "as received		Aniotok Anbo	rek Antotek P
	withstand test in accordance shall be examined for signs	e with Section 20. The D	DUT	upotek lupo,
	evidence of leakage.		sek abotek	Vupo.



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Clause	Requirement + Test	anbotek .	Result - Remark	Verdict
28.5	As a result of the static force test, the (h) are considered non-compliant result for additional information on non-corefer to Table 12.1. a) E – Explosion;	sults.	- (See Table 28)	nbotal Anbota
ek Anbote	b) F – Fire; c) C – Combustible vapor concentra	tions;	Aupolek Aupolek	Anbotek Anb
botek	 d) V – Toxic vapor release; e) S – Electric shock hazard (dielect f) L – Leakage (external to enclosure) 	100	Anbotek Anbotek	Anbotek Anbotek
Aupotek Vapotek	g) R – Rupture (of DUT enclosure exparts as determined by 7.3.3);h) P – Loss of protection controls.	kposing hazardo	us Anbotek An	nbotek Anbotel
29	Impact Test	Yuga Viek	upolek Anbore	notek P
29.1	The purpose of this test is to evaluat integrity of the enclosure and its abil mechanical protection to the battery	ity to provide	AN Abotek	ArbotelP Arbotek
29.2	A fully charged sample (MOSOC pe subjected to a minimum of three imp	acts of 6.8	Anbotek Anbo	ibotek P Anbotek
ek Aupote	J (5 ft-lb) on any surface that can be during intended use. The impact sha dropping a steel sphere, 50.8 mm (2 diameter, and weighing 535 g (1.18 H, of 1.29 m (50.8 in). For surfaces of	all be produced be inches) in lb) from a height	nbotek nbotek	Anbotek Anbo
Anbotek Anbotek	of an enclosure, the steel sphere shaby a cord and swung as a pendulum the vertical height of 1.29 m (50.8 in) being impacted placed against a reswall. See Figure 29.1. A different sar for each impact.	all be suspended, dropping through, with the product training vertical	gh ct	botek Anbotek Anbotek Anbotek
29.3	If the DUT is operational after the im subjected to a discharge and chargin accordance with the manufacturer's observation period per 8.5 is then co	ng cycle in specifications. A	Spotek Aupo	Anbotek Anbotek
29.4	During the test, one of the detection in Section 9 shall be used to detect t combustible vapor concentrations. If upon system design or installation, v releases shall be continuously monit testing per Section 13.	he presence of required based renting of toxic	An.	Anbotek Anbotek Anbotek Anbotek
29.5	After the observation period, the DU subjected to an "as received" dielect withstand test in accordance with Se shall be examined for signs of ruptur leakage.	ric voltage ection 20. The Dl	7.1	Anbotek Anbotek



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lodge.	AUD.	ANSI/CAN/UL19	113. ZUT8	Your Yes	an Aupo,	be.
Clause	Requirement + Test	tak abote	V- 05	Result - Remark	otek and	Verdict
29.6	As a result of the impact t are considered non-comp information on non-compl	liant results. For ad	ditional	(See Table 29	Anbotek	Anbotek Anbotek
	12.1. a) E – Explosion; b) F – Fire;	otek Anbotek		el Anborek		Anbot Ant
	c) C – Combustible vapor d) V – Toxic vapor release			po, au		0101
	e) S – Electric shock haza	700	10	Anbotek		Alpore Stek
	f) L – Leakage (external tog) R – Rupture (of DUT exparts as determined by 7.	nclosure exposing h		Anbotek		Anbore
Pur.	h) P – Loss of protection of	controls.	Anbot'	V VUD	k anbotel	k Ant
30	Drop Impact Test	o, botel	- 20	Pupp Vupp	1000	lek P
30.1	Modules that are intended mount or similar equipme			Albotek Anb		rbotelP
	impact test to determine t result of an inadvertent dr removal.	hat no hazard exists	s as a	Anbotek		Anbotek
30 3 20 10 10 10 10 10 10 10 10 10 10 10 10 10	And And	room tomporaturo	nor 0.2. o	Ann	Anbotek	Pulpor
30.2	After being equilibrated at fully charged module/com	ponent pack shall	Aupo,	K Kotel		P
	be dropped from a minimum for products weighing 7 kg (3.9 in) for products weigh than 100 kg (220.5 lbs), a	g (15.4 lbs) or less, ning >7 kg (15.4 lbs) nd 2.5 cm (0.98 in)	10 cm), but less for	100	ntek Anbo	upojek isk
Anbotek Anbotek	products weighing > 100 concrete or metal surface produce adverse results a representative of what we	in the position mos and in a manner mo ould occur during	t likely to st	Anbotek Anbotek		Anborel
	maintenance and handlin- system during installation orientation of the drop sha testing personnel from an	and servicing. The all be determined by	the	otek Anbotek	Anbor Anbor	lok bir.
	and servicing instructions	Anbotek Anbo		wolek v		por
	If using a metal test surface some manner of insulation will prevent inadvertent structure but will not affect test resultant.	n such as insulating nort circuiting to the	film that	Anbotek Anbotek		Anborel
30.3	The sample shall be drop However, if only one drop		one time.	otek Anbotek	ek Anbor	Р
	it shall not be a flat drop. then at least one other tes not a flat drop.	If one drop test is a		Anbotek Anbo		botek nbotek
30.4	The concrete surface shathick and the concrete or large enough in area to co	metal drop surface		Anbotek	Anbotek	Potek



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Clause	Requirement + Test	anbotek	Result - Remark	Verdict
30.5	After the drop, if the DUT is open subjected to a discharge and characteristic accordance with the manufacture observation period per 8.5 is the	arging cycle in er's specifications. <i>A</i>	An Anborek Anborek	stek Anbotek
30.6	At the conclusion of the observat received" dielectric voltage withs accordance with Section 20. The examined for signs of rupture and	tand test in DUT shall be	ge.	Anbotek P Anbotek
30.7	A spark ignition source or gas me Section 9 shall be used to detect combustible vapor concentration immediately after the drop and re of increasing temperatures.	the presence of s within the sample	Anbotek Anbo	tek Anbotek
30.8	As a result of the drop impact tes (f) are considered non-compliant		a) – (See Table 30)	Anbotek Panb
	For additional information on nor refer to Table 12.1.	n-complying results	Anbotek Anbotek	Anbo
Anbotek Anbotek	a) E – Explosion;b) F – Fire;c) C – Combustible vapor concer		Anbotek Anbotek	ek Anbotek
	 d) S – Electric shock hazard (die e) L – Leakage (external to enclosity) f) R – Rupture (of DUT enclosure parts as determined by 7.3.3); 	osure of DUT);	us'o'sk Anbotek	Amborek Amborek
31	Wall Mount Fixture/Handle Test	Aupore - K	Anbotek Anbotek	N _K
31.1ek Anbotek Anbotek	A wall mounting apparatus of a visystem or a handle(s) provided for field/rack installed module/pack, strength to support the battery sy carrying of module/pack. Compliating the test below.	or handling of a shall have sufficient /stem or allow for	Anborok An	Anborek Anborek
31.2	The wall mounting apparatus and be installed in accordance with the specifications. A force equal to the of the battery system is additional center of the mounting apparatus direction. The force shall be held modules/packs with a carrying has be supported by the carrying has to three times the weight of the Dapplied in a downward direction. carrying handle is provided, the adistributed between the handles.	ne manufacturer's nee times the weight ally applied to the sin a downward for 1 min.For andle(s), the DUT sindles and a force equal to a ditionally added weight shall the present and the shall the shall the present and the shall the shall the present and the shall the sha	hall lual	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
31.3	As a result of the applied force, the damage to the mounting apparate means when testing the wall more result of the applied force, there is handles or the handle mounting/stable.	here shall be no tus and its secureme unting fixture. As a shall be no damage	to Milbor Am	Anbotek Anbotek



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1000	Aupo, M.	ANSI/CAN/UL197	3: 2018	-otek	Aupor
Clause	Requirement + Test	ov potek	R	esult - Remark	Verdic
32	Mold Stress Test	Aribot Aribot	9/4	"upote, top,	ek Anbotek
32.1	The purpose of this test is made from molded polym an accelerated aging test safety of the enclosure.	eric material can with	stand	Anbotek An	Anbotek Anbo
32.2	One complete fully discharthe manufacturer's specific a full-draft circulating-air of temperature of at least 10 maximum temperature of during the Temperature at Test in Section 18, but no sample shall remain in the	ied EODV) shall be poven maintained at a 0°C (18°F) higher than the enclosure measured Operating Limits (ot less than 70°C (158	aced in uniform the red Check	tek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotek Anbotek Anbotek
32.3	After removal from the ov subjected to an observati observation period, the sa an "as received" dielectric accordance with Section examined for signs of rup	on period per 8.5. Aft ample shall be subjec c voltage withstand te 20. The DUT shall be	ted to st in	botek Anbotek	Anbotek Par Anbotek Anbotek
32.4	As a result of the mold str shall show no evidence o as cracking of the enclosi or reducing electrical spa from the enclosure.	f mechanical damage ure exposing hazardo	, such us parts	(See Table 21)	Anbotek Anbotek
33	Pressure Release Test	Inposes Vine		potek Anbore	N ₁₀
33.1	The purpose of this test is pressure relief valve oper the battery system and its test is applicable to valve as valve regulated lead a systems with resettable re	ates to prevent dama s electrolyte containm regulated technologic cid batteries and for r	ge to ent. This es such	Anbotek Anbotek Anbotek	otek Anbotek Anbotek Anbotek
33.2	A sample of the battery/container of mineral oil. F pressure relief valve need	or large batteries only		botek Anbotek	Anbotek N
33.3	A charging current shall be increased rate (to be specuntil bubbles are observe relief valve.	cified by the manufac	turer)	Anbotek Anbo	nbotek Anbot
33.4	Results are acceptable if the electrolyte containme leak and the DUT's casin	nt system does not ru		otek Anbotek	Anbotak N
34	Start-To-Discharge Test	Anbotek Anbota	ok bu	hotek Anbotek	Antion N
34.1	The purpose of this test is start to discharge pressur relief valve not provided vating.	e of a resettable pres	sure	Anbotek Anbo	nbotek Anbote



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	ANSI/CAN/UL1973: 201	8 An Arboten And
Clause	Requirement + Test	Result - Remark Verdict
34.2	A calibrated pressure gauge having a range of at least 150% of the anticipated maximum working pressure the pressure relief valve shall be installed to indicate pressures developed within the battery system during test.	of Anborek Anborek
34.3	To determine the start-to-discharge pressure setting a pressure-relief valve, each of three samples of the valve shall be subjected three times to a gradually increasing air pressure. The pressure at which the valve begins to open shall be recorded. The start-to-discharge pressure setting of each sample is considered to be the average value of the three trials	Anbotek Anbotek Anbotek Anbotek
34.4	The start-to-discharge value mentioned in 34.3 is the highest average value for the three samples tested.	otek Ambotek Ambotek Noo
34.5	The start-to-discharge pressure shall be in the range 90 – 100% of its assigned start-to-discharge pressure setting.	

	ENVIRONMENTAL TESTS		Anb P
35	Thermal Cycling Test (LER Motive Applications)	Aupo. W. Wolek	Pole
35.1	This test determines the electrical energy storage system's ability to withstand temperature fluctuations that may be anticipated during the end-use application. This test is only applicable to LER motive applications.	ek Anbotek Anbotek	P _{Anb} o
35.2	A fully charged battery system (MOSOC per 8.1) shall be placed in a test chamber and subjected	Anbotek Anbotek An	po, b
Anbotek	to the following cycles in (a) – (e). At the conclusion of the cycling, the samples shall remain at room temperature, 25 ±5°C (77 ±9°F) for 24 h.	Anbotek Anbotek	Anborek
art ak	a) Raising the chamber-temperature to 75 ±2°C (167 ±3.6°F) within 30 min and maintaining this temperature for 6 h.	ek Anbotek Anbote	ek Anto
otek	b) Reducing the chamber temperature to 20 ±2°C (68 ±3.6°F) within 30 min and maintaining this temperature for 2 h.	Anbotek Anbotek An	ootek botek
Anbotek	c) Reducing the chamber temperature to minus 40 ±2°C (minus 40 ±3.6°F) within 30 min and maintaining this temperature for 6 h.	Anbotek Anbotek	Anbotek
Anb	d) Raising the chamber temperature to 20 ±2°C (68 ±3.6°F) within 30 min. e) Repeating the sequence for a further 9 cycles.	k Anbotek Anbotek	k Aupo
14	Exception No. 1: Temperatures may need to be held	Polek Aupole Aup	otek P
lotek lotek	for longer periods for those larger systems where temperature stabilization may take longer. The time	Anbotek Anbotek Anh	anbotek
Aupo, andore	required in this case for systems that require longer exposures should be based upon the time it takes for the temperature on internal cells within the DUT to	Anbotek Anbotek	Aupotek
Anb	reach thermal equilibrium per 8.3 plus 1 additional hour. This time shall never be less than the exposure	k Anbotek Anbotek	k Anbo
16	times noted in (a) – (d) above.	W. Otek Vupote	6



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Notes Notes	ANSI/CAN/UL1973: 201	VI. VI., V.	40 01 73
Clause	Requirement + Test	Result - Remark	Verdict
Vipotek VI	Exception No. 2: Testing may be conducted at a subassembly level if that is representative of the energy storage system.	Aupotek Aupotek A	nbotek Anbotek
35.3	If the DUT is operational after the test, it shall be subjected to a discharge and charging cycle in accordance with the manufacturer's specifications. A observation period per 8.5 is then conducted.	ntek Anbotek Anbotek Anbotek Anbotek	Photei Anborel Anb
35.4	During the test, one of the detection methods outlined in Section 9 shall be used to detect the presence of combustible vapor concentrations. If required based upon system design or installation, venting of toxic releases shall be continuously monitored during the testing per Section 13.	dup Aupotek Aupotek Aupotek Aupotek Aupotek Aupotek Aupotek	p potek Anbotek Anbotek
35.5	At the conclusion of the observation period, the samp is then subjected to an "as received" dielectric voltage withstand test in accordance with Section 20. The DU shall be examined for signs of rupture and evidence cleakage.	e JT	P Anb
35.6	As a result of the thermal cycling test, the following in (a) – (h) are considered non-compliant results. For additional information on non-complying results refer to Table 12.1.	(See Table 35)	Amb Pak Ambotek
Anborel	a) E – Explosion; b) F – Fire;	nbotek Anbotek Anbotek	ek Anb.
upotek Aup	c) C – Combustible vapor concentrations; d) V – Toxic vapor release; e) S – Electric shock hazard (dielectric breakdown);	Arbotek Anbotek An	anbotek Anbotek
Ambotek Ambotek	 f) L – Leakage (external to enclosure of DUT); g) R – Rupture (of DUT enclosure exposing hazardor parts as determined by 7.3.3); h) P – Loss of protection controls. 	us. Anbotek Anbotek	Anbore
36	Resistance to Moisture Test	ootek Anbotes Anbo	, ok P
36.1	The purpose of this test is to determine that the batte system can safely withstand exposure to moisture anticipated in the end use.	anbotek Anbotek	Anbotek Anbotek
36.2	With the DUT in its normal operating orientation, it she subjected to a moisture resistance test based upoits IP rating in accordance with IEC 60529 or CAN/CSA-C22.2 No. 60529. The battery system shabe installed and connected as intended for this test for the end use application. For batteries located where they may be subjected to flooding conditions, the IP rating will need to minimally cover immersion. If the	III Anbotek Anbotek	Anborek Anborek
Anbotek Anbotek	DUT is operational after the conditioning, it shall be subjected to a discharge and charging cycle in accordance with the manufacturer's specifications. A observation period per 8.5 is then conducted.	nk Anbotek Anbotek	Anboten Anbot



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Pode	Aupo M.	ANSI/CAN/UL1973: 20	18	Anbor An
Clause	Requirement + Test	tak abolek	Result - Remark	Verdict
Anbotek Anbotek	Exception No. 1: Enclosure Ratings as identified in NFI Section 2 of C22.1, are subtesting outlined in UL 50E/G the IP Code.	PA 70, Article 110, or ojected to the environmer		hek Alborek hborek Anborek
Anbor	Exception No. 2: Testing m subassembly level if that is energy storage system.		Potek Vipotek	Anbotek P Anh
36.3	During the test, one of the in Section 9 shall be used to combustible vapor concent anticipated. If required bas installation, venting of toxic continuously monitored during 13.	to detect the presence of trations if venting of cells ed upon system design o c releases shall be	is r	botek Anbotek
36.4	At the conclusion of the obshall be subjected to an "as withstand test in accordance shall be examined for signs leakage.	s received" dielectric volta ce with Section 20. The D	age DUT	Anbotek P
36.5	As a result of the resistance following in (a) – (h) are conversely. For additional information results refer to Table 12.1.	nsidered non-compliant	(See Table 36)	Anbotek Anbotek
	a) E – Explosion;b) F – Fire;		Anbolek Anbolek	Anbolak I
	c) C – Combustible vapor ofd) V – Toxic vapor release;	V 1/2	Anbotek Anbot	otek Anbotek
	e) S – Electric shock hazar f) L – Leakage (external to	- No.	k Anbotes An	Anbotek Anbotel
	g) R – Rupture (of DUT enparts as determined by 7.3	20	ous	Anbotek Anb
K Anb	h) P – Loss of protection co	ontrols.	Arr. Anbotek	Aupo, Mek
37	Salt Fog Test	Anborek Anborr	All work Anbore	M. Maga, B
37.1 Anbotek Anbotek Anbotek	This test determines the elesystem's ability to safely will exposure to a salt fog conditionary and stationary systems installed whose internal components deterioration from salt fog the enclosure. This test would not intended to be installed as indicated in the installation.	ithstand anticipated ditions due to use near would apply to those d near sea environments s may be exposed to through openings in the not apply to those system in ear marine environments.	ns nts	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
Anbotok	enclosure is designed to pr with protection against corr	revent ingress of moisture	hotek Anb	otek Anbote



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_\4	notel	ANSI/CAN/UL1973: 2018	Va. VV	40 01 73
8.	Clause	Requirement + Test	Result - Remark	Verdict
200	37.2	A fully charged electrical energy storage system (MOSOC per 8.1) shall be subjected to the test methor per IEC 60068-2-52, with a severity level of 1 or 2 depending upon the application and location of installation.	od Anbotek Anbotek Anbotek	Anbotek Anbotek
4.	Anbotek	Exception: A sample at the subassembly level that would be representative of the battery system may be used for this test.	horsek Anbotek Anbotek	P Anbi
0,0	37.3	If the DUT is operational after the conditioning, it shall be subjected to a discharge and charging cycle in accordance with the manufacturer's specifications.	Anbotek Anbotek A	Anbotek
10,	37.4	During the cycling, one of the detection methods outlined in Section 9 shall be used to detect the presence of combustible vapor concentrations if venting of cells is anticipated. If required based upon system design or installation, venting of toxic releases shall be continuously monitored during the cycling per Section 13. An observation period per 8.5 is then conducted.		Photek Anbotek
4	37.5	At the conclusion of the observation period, the DUT shall be subjected to an "as received" dielectric voltag withstand test in accordance with Section 20. The DU shall be examined for signs of rupture and evidence of leakage.	ak shotek Anbo	Anbotek Anbotek
200	37.6	As a result of the salt fog test, the following in (a) – (h) are considered non-compliant results. For additional information on non-complying results refer to Table 12.1. a) E – Explosion; b) F – Fire;	(See Table 37)	P Anbotek
4	Anbotek Anbotek	c) C – Combustible vapor concentrations; d) V – Toxic vapor release; e) S – Electric shock hazard (dielectric breakdown); f) L – Leakage (external to enclosure of DUT);	Anborek Anborek Anborek Anborek Anborek Anborek	otek Anbor
100	Anbotek botek	 g) R – Rupture (of DUT enclosure exposing hazardous parts as determined by 7.3.3); h) P – Loss of protection controls. 	S Ambotek Ambotek	Anbotek
	38	External Fire Exposure Test	Anb tek nbotek	Ninpos
170	38.1	The purpose of this test is to determine that a battery system will not explode as evidenced by projectiles breaking through the test cage as a result of being exposed to a hydrocarbon pool/brush fire.	Anbotek Anbotek Anbote	K N An
	Anbotek Anbotek	Exception No. 1: The battery system may be subjected to the external fire exposure test in UL 2580 instead of the method outlined in 38.2.		Anbotek
	Anborek Anbor	Exception No. 2: Testing may be conducted on a representative subassembly rather than a complete battery system if determined that equivalent results to testing a battery system can be obtained.	otek Anbotek Anbotek	Nupo,



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200	ANSI/CAN/L	JL1973: 2018	8	nbore Am
Clause	Requirement + Test	botek	Result - Remark	Verdict
ibotek Ar	Exception No. 3: If the cells employed in comply with UL 1642 or UL 2054 projection system is exempted from this test.		Vupotek Vupotek	Anbotek Anbotek
Anborek Anborek	Exception No. 4: This test does not apply intended for outdoor use only that are monon-combustible surface such as a concrextends a minimum of 91.4 cm (3 ft) beyonerimeter of the battery system.	ounted on a rete pad that	All tok anbo	nbotek Ant
38.2	A fully charged DUT at normal operating is subjected to a hydrocarbon pool fire for fuel used shall be heptane or similar hydrocarbon.	r 20 min. The	e bypo	Anbote N
38.3 ek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	The pan, which provides the fire containing constructed of steel of sufficient thickness warping during the course of the 20-min to upper lip shall have a steel angle welded similar reinforcement to prevent warping. The pan shall be sized, in relation to the long surface, to provide a nominal 61-cm (2-ft) hydrocarbon fuel surface and its height so a 39.4 cm (8 – 15.5 inches) in height to a the fuel and water levels. A threaded fitting supply shall be centered on the long side and be located no more than 2.54 cm (1 is bottom of the pan. There should be nomin (6 in) of water in the pan prior to adding the hydrocarbon fuel to protect the fuel pan are for consistent flame output during the test shall be added as needed during the test sufficient fuel for the test duration.	s to prevent test. The all around o during testind DUT support above the hould be 20. ccommodate of the panin) from the nally 15.24 cent to provide	or g. t 3 e el	Anbotek
38.4	A suitable means to extinguish the fire in within 15 s, or remove the battery from at shall be provided. This may be accomplisdrawing a cover over the pan, or by movi from over the pan or removing the pan as fire out may be difficult and should not be underestimated.	pove the fire, shed by ng the DUT s putting the		botek Anbotek
38.5	The DUT shall be fully supported centere fire containment pan above the surface of The DUT support structure shall be robust withstand the weight of the DUT for the different without allowing the DUT to lean or to pan shall be sized large enough to cover of the DUT. See Figure 38.1 for details of	f the heptand at enough to uration of the apple. The the dimension	e. Anborek	anbotek Anbotek
38.6	During the test, the temperature of the ce within the DUT shall be monitored for info purposes.		es Anborek Anborek	Anbotek N
38.7	After the 20-min fire exposure, the DUT is a hose down in accordance with the guid Conduct of Hose Stream Test of UL 263, fire fighter response the system may be eduring a fire.	elines of the to represent	Ar. sek abote	N Anborek



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	ANS	I/CAN/UL1973: 201	8	
Clause	Requirement + Test	abotek	Result - Remark	Verdict
38.8 Anbotek Anbotek Anbotek Anbotek Anbotek	To determine that an explosion had the DUT with pan fire test set up swithin a circular inner perimeter makes with paint or a similar marking mashall be no thicker than 12 mm (0 the circular inner perimeter area of greater than 1.0 m (3.3 ft) from the longest side of the DUT. The DUT inner perimeter marking shall be couter perimeter consisting of a prea a noncombustible material such a concrete and wall thickness suital projectiles during the test. The outlocated a minimum of 1.5 m (4.95 perimeter marking.	shall be centered narked on the floor aterial. The marking 0.47 in) and the size marking shall be note outer edge of the T, test set up and enclosed within an otective barrier wall as masonry or ble for containing ater perimeter shall be	of Anbotek of Anbotek Anbotek Anbotek Anbotek	botek Anbotek
38.9	As a result of this test, there shall the DUT that results in projectiles circular inner perimeter described 12.1 for additional details.	falling outside of the		Anbolek N

	TOLERANCE TO INTERNAL CELL FAILURE TESTS		Notek
39 Maria	Single Cell Failure Design Tolerance	abotek Anbot	N
39.1	General	ek społek Anbołes	N
39.1.1	There have been field incidents with various battery technologies that have been attributed to a cell failure, which led to a hazardous event. The cell failures in these incidents were the result of either manufacturing defects or insufficient cell or battery design or a combination of both. Since there is a possibility that a cell may fail within a battery system, the battery system shall be designed to prevent a single cell failure from propagating to the extent that there is fire external to the DUT or an explosion.	Anbotek	N Anbotek Anbotek Anbotek
39.1.2	The cell failure mechanism used for this testing shall reflect what is known or anticipated to occur in the field for a given technology. If the cell failure mechanism cannot be exactly replicated, a close simulation of what is known to occur in the field through the use of an external stress such as applied heating or mechanical force shall be utilized for the test. Examples of methods to simulate a single cell failure are outlined in Appendix F. Multiple tests and possible multiple failure methods may need to be conducted as part of the analysis before a final methodology for testing is determined.	Anbotek	Anbotek Anbotek Anbotek
39.2	Single cell failure design tolerance (lithium ion)	Pupo, by Spolek	Aupolo



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lod.	18270BC20004201	ANSI/CAN/UL1973: 20	018	Page 51 0173
Clause	Requirement + Test	notek probotek	Result - Remark	Verdict
39.2.1	A lithium ion battery system mitigate a single cell failure runaway of that cell. With often the effects of propagdue to the heating effect of leads to hazardous events or module) shall be design thermal runaway failure from hazard as evidenced by find DUT and/or an explosion.	e leading to a thermal lithium ion batteries, it is pation to surrounding cells of the initial cell failure that is. The DUT (e.g. battery paed to prevent a single cell or creating a significant	t pack III	anbotek Anbotek Anbotek Anbotek
39.2.2	Any number of methods consingle cell thermal runaway thermal runaway in cells considered use of heaters, nail penetrotesting agency is responsified demonstrating an approproce thermal runaway. It is reconsidered to evaluate the cell fast surrounding cells. During a suitable failure method, tell on the cell casings, and voinformation purposes. See several methods of inducing chosen shall be agreed up	y failure. For example, an be achieved through the achieved through the action, overcharge, etc. The ble for selecting and itate method for inducing the action of a small subassembly considered and effects to an effort to establish a amperatures should be taken of the action of the	of ken e on d	Anbotek
39.2.3	The details of the method cell's reaction that can imple documented. For example achieve failure: e.g. the type dimensions, location on the placed and how it is placed attained including temperatime until reaction, temper state of charge of the cell heating phase, etc. The tempersentative of the actual any modifications should rest results. For example, out, the heat conduction pube hindered as that may result the street of the street of the actual any modifications.	pact the results are to be e, if heating the cell to pe of heater and its he cell where the heater is d, maximum temperature ature ramp rate, length of ratures on cell and voltage at the beginning of the lest article shall be all battery configuration are not significantly impact the if overcharge is to be carriath between tabs shall no	e, nd e ried ot	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek



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1000	ANSI/CAN/UL1973: 20	8 Hotek Anbore	D.c.
Clause	Requirement + Test	Result - Remark	Verdict
39.2.4	Once a suitable method of cell failure has been determined, the fully charged DUT (MOSOC per 8.1 shall be subjected to the single cell failure tolerance test, which consists of inducing a fault in one interna cell that is within the DUT, until cell failure resulting in thermal runaway as defined in 6.47 occurs, and determining whether or not that failure produces a	k Anbotek Anbotek	N N
	significant external hazard or whether or not that faile does not cause the failure of neighboring cells. If cascading occurs, the cascading shall not propagate beyond the DUT. Prior to choosing the specific cell to fail, an analysis of the DUT design to determine the location considered to have the greatest potential to lead to a significant external hazard shall be	o cell	botek Anbotek Anbo
	conducted, taking into consideration the cell's proxin to other cells and materials that may lead to potentia for propagation. If it can impact the results, the samp shall be at the maximum specified temperature durin charging and operation with some tolerance as necessary for movement of the sample outside of the chamber during testing, but within ±5°C (±9°F). Once the thermal runaway is initiated, the mechanism use to create thermal runaway is shut off or stopped and the DUT is subjected to a 24-h observation period.	I ble g e e e	Anbotek Anbotek
Anbott Ant	Exception No. 1: Testing may be repeated on another sample with a cell in a different location within the DI if it is not clear which location represents the worst case scenario. The location of the failed cell shall be documented for each test.	JT ^o Annotek Anbo	ok N
Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Exception No. 2: Testing may be conducted on a representative subassembly consisting of one or mo modules and surrounding representative environment if it can be demonstrated that there is no propagation beyond the subassembly. When testing at the module or subassembly level, consideration needs to be made of the vulnerability to combustion of those componer surrounding the module in the final assembly. Temperatures on DUT external surfaces and surface of parts in contact with or near the DUT in the final assembly, shall be monitored to determine if excessing temperature on these adjacent parts could result in a potential for propagation within the full battery system.	nt, n le de de nts es ve a n. all f a	Amborek Amborek Amborek Amborek
39.2.5	Temperatures on the failed cell and surrounding cell are to be monitored and reported for information purposes.	Anbotek Anbotek	Anbo'N
39.2.6	As a result of the testing of 39.2, there shall be no fir propagating from the DUT or explosion of the DUT.	e (See Table 39)	Nat
39.3	Single cell failure design tolerance (other technologie	es)	N



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loo's	ek Aupo, Air.	ANSI/CAN	I/UL1973: 2018	8	k Aupole,	Vu
Clause	Requirement + Test	nbo	nabotek p	Result - Remark	otek anbe	Verdict
39.3.1	Other technologies such sulfur, sodium nickel chl there may not be enoug tolerance to single cell fi subjected to a single ce 39.2, except as modified mechanism for these technologies than that of lithium ion a may not result from the ion, when choosing a cell	oride, and lead h field data regallure events, all failure test med as noted belochnologies may nd thermal runcell failure. Sim	I acid where parding their ure to be ethod similar to w. The failure be different away may or hilar to lithium	- V	Anbotek Anbotek Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotek
Anbotek Anbotek Anbotek	be representative of what particular technology. The shall consider failures didefects for that technologies design deficiencies that the cell, and that would individual cell safety testing.	at can occur in the failure mech ue to potential ogy and/or cell a could lead to la not be evident	the field for the nanism chosen cell anufacturin and battery atent failures of	ng knbotsk	Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotek
39.3.2	For other technologies, recommended to evaluating a small subassem failure and effects to sure to establish a suitable fashould be taken on the emeasured for information for guidance on several failure. The method chothe testing agency.	ate a candidate ably of cells to extrounding cells. Fillure method, to cell casings, and purposes. See methods of income.	method first evaluate the ce During an effo emperatures ad voltages ee Appendix F ducing cell	II Anbotek Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotek Anbotek	bote N Anbotek Anbotel Anbotel Anbotel
39.3.3	When a suitable worse cell failure has been det subjected to the internal location within the DUT the potential for propaga condition that reflects its worst moment such a fathe DUT shall be at its no During the test, tempera critical locations such as to record the rise in tem failure. If no thermal run single cell failure, the test temperature has stabilized temperature, and the DU observation period. If a mechanism used to creator stopped and the DUT observation period.	ermined, the D cell failure occ considered mo ation. The DUT coperating para illure could occ cominal operation adjoining cells perature due to away occurs as st is stopped w ded or reaches dut is subjected thermal runawa ate thermal run	UT is to be curring in the set vulnerable to shall be in a sameters at the ur. For exampleing temperature monitored in a during the test of the internal is a result of the hen the DUT ambient room I to a 24-h ay is initiated, the away is shut of the curring is shut of a way is shut of the curring is shut of a way is shut of the curring in the curring is shut of the curring in the curring in the curring is shut of the curring in the curring in the curring is shut of the curring in t	e, e, e. tt	nbotek Anbotek	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
Anbotek Anbotek	Exception No. 1: Testing sample with a cell in a difficult if it is not clear which loo worst case scenario. The be documented for each	lifferent location cation tested re e location of th	n within the DU presented the	T Anbore	Anbotek Anbotek	Anbotek Anbotek



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	ANSI/C	AN/UL1973: 2018	
Clause	Requirement + Test	Result - Remark	Verdict
Anbotek Anbotek Anbotek	Exception No. 2: Testing may be correpresentative subassembly consist modules and surrounding represent if it can be demonstrated that there is beyond the subassembly. When testor subassembly level, consideration of the vulnerability to combustion of surrounding the modules in the final	ing of one or more ative environment, s no propagation ting at the module needs to be made those components	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
39.3.4	As a result of the testing per 39.3.3, fire propagating from the DUT or ex		anbotek AlboteN

	MANUFACTURING AND PRODUCTION LINE TESTS	3	Notel
40	General	Aupolek Aupo	N
40.1 Anborek	Manufacturers of battery systems shall have documented production process controls in place that continually monitor the following key elements of the manufacturing process that can affect safety, and shall include corrective/preventative action to address defects found affecting these key elements: a) Supply chain control; and b) Assembly processes.	ek Anbotek	N Amborek
40.2	Battery systems shall be subjected to 100% production screening to determine that any active controls utilized for safety are functioning.	otek Anbotek Anbot	N Arr
potek	Exception: This check of the safety controls can be conducted on subassemblies or components of the system before final assembly.	Anbotek Anbotek An	Anbotek Anbotek
40.3	An "as received" dielectric voltage withstand test as outlined in the Dielectric Voltage Withstand Test, Section 20 shall be conducted on 100% production of Assemblies/packs with circuits exceeding 60 Vdc or 42.4 V peak as outlined in Section 20.	Anbotek Anbotek	Anbot Anbot
Vupotek Potek	Exception: The time for the test may be reduced to 1 s if the test voltage values are increase by 2.4 times the values in Section 20 or as outlined in the routine test criteria of 5.2.2 in UL 60950-1/CAN/CSA-C22.2 No. 60950-1.	Anbotek Anbotek An	orek N Anborek
40.4	A continuity check of the grounding system using a milliohmmeter or other method, shall be conducted on 100% production employing protective grounding. The continuity check shall determine that measurements made on any two points of the grounding system do not exceed 0.1 Ω .	otek Anbotek Anbotek	N Anbot



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Clause	Requirement + Test	Result - Remark	Verdict			
40.5	Each resettable non-ASME coded pressure-relief is shall be tested by the manufacturer for the start-to-discharge pressure by subjecting the pressure-relievalve to a gradually increasing air pressure until the valve begins to open. The start-to-discharge pressure shall be in the range of 90 – 100% of its rated start discharge pressure rating.	ef e eure	Anbotek Anbotek Anbotek			

	MARKINGS		Poton
41	General	Vipotek Vipo, V	Por
Anbotek Anbotek Anbotek Antotek	Advisory Note: In Canada, there are two official languages. Therefore, it is necessary to have CAUTION, WARNING, and DANGER instructions and markings in both English and French. Appendix G lists acceptable French translations of the CAUTION, WARNING, and DANGER instructions and markings specified in this Standard. When a product is not intended for use in Canada, instructions and markings may be provided in English only.	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Amborek Amborek Borek
41.1	Required markings shall be permanent. Examples of permanent marking are ink stamping, engraving and if adhesive labels, compliance to UL 969 or CSA C22.2 No. 0.15 for the surface adhered and conditions of use. Markings required by this standard including nameplate markings per 41.2 and any cautionary markings shall be legible, provided in text color that contrasts with the background color and visible upon installation of the battery system.	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Potek Anbotek Sotek
41.2	Batteries shall be marked with the manufacturer's name, trade name, trademark or other descriptive marking which may identify the organization responsible for the product, part number or Model number, and electrical ratings in volts dc and capacity in Ampere-hours or Watt-hours and chemistry. The battery system terminals shall be marked to indicate whether they are positive (+) or negative (-). The battery shall also be marked with its IP rating.	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Potes Anbotek Anbotek
41.3	Battery systems shall be marked with the maximum short circuit current and duration (at maximum short circuit current) at the system output terminals.	Anbotek Anbotek	ArPortale Anbot
41.4	Battery systems shall also be marked with the date of manufacture, which may be in the form of a code that does not repeat within 20 years.	otek Anbotek Anbote	otek Otek
41.5	A battery system intended for use with specific chargers shall be marked with the following or equivalent: "Use Only () Charger".	Anbotek Anbotek	Anbotok Anbotok
41.6	A battery system evaluated for protection against ingress of moisture per 7.3.5, shall be provided with the appropriate IP Code rating.	Anbotek Anbotek	P _{Anbot}



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	ANS	SI/CAN/UL1973: 201	18	
Clause	Requirement + Test	abotek	Result - Remark	Verdict
41.7	Systems shall be marked with a indicating to read all instructions operation and maintenance of th marking may be in the form of th example: ISO 7000, "caution" Sy (exclamation point inside triangle instruction manual" Symbol No. using symbols, their meaning shall instruction manual.	before installation, e system. This e symbol(s) for mbol No. 434 e) followed by the "re 790 (open book). If	ok botok	potek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
41.8	Systems that must be operated i for safe operation, shall be provious indicating the correction orientation	ded with markings	on Anbotek Anbote	otek Anbotek
41.9	Systems shall be marked with a indicating risk of electrocution ne battery terminals.		ge all hotek	Anbotek Anbr
41.10	Systems with replaceable fuses, rating and type of fuse for replac shall be located near the fusehol	ement. The marking		k Arbotek
41.11	Separable accessories and contintended for connection to the maprovided with markings that incluname, part number of the access ratings in voltage, frequency, phacurrent or watts.	ains supply shall be ide the manufacture sory and electrical	r's	otek Anb P Anbotek Anbotek Anbotek Anbo
41.12	A ground terminal shall be marke	ed as outlined in 7.6	.8. botek Anbo	ate/P
41.13	Additional warning markings for located in restricted access locat regarding hazardous moving or surfaces, etc., to alert service or personnel and prevent hazards, the battery systems in locations visible those persons having acc	tions such as warning electrical parts, hot other trained shall be provided or where they will be	Anbotek Anb	otek Anborek Anborek Anborek Anborek

INSTRUCTIONS		P
42	General	hotek Anborek
42.1	Components of a battery system shall be provided with a complete set of instructions for proper installation and use in a battery system. These instructions shall include normal operating specifications.	Anbotek Anbot



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200	iek Anbor All A	NSI/CAN/UL1973: 201	18	Anbore. An
Clause	Requirement + Test	rek spotek	Result - Remark	Verdict
42.2	Systems shall be provided wit for installation in the end use a instructions shall include the foother instructions necessary for installation of the system and intended end use: a) Insulated tools, insulated gl	application. Installation ollowing along with any or the safe and correct its accessories in the	Anbotek Anbotek Anb	otek Anbotek Anbotek Anbotek
	equipment, and clothing and connecessary for safe installation b) The necessary housing required.	other measures of the battery system; puirements for protectio	Anbotek Anbotek	Aupotek Aupotek
	against ingress of moisture ar persons; c) Ventilation requirements to hydrogen greater than 25% of d) Protective components and	prevent accumulation of hydrogen LFL;	bu.	nbotek Anbotek
	end use installation such as full wiring, and other devices such in accordance with NFPA 70 (e) Circuit diagrams and instru	uses, circuit breakers, n as disconnect devices or C22.1. See 7.8.1.4;	V Lotek	Anbotek Anbotek
	connection of the system and such as separate controllers, f) Warnings and instructions re electrolyte;	any ancillary devices monitoring devices, etc	Anbotek Anbotek	nbotek Anbotek
	g) Instructions regarding any checks necessary before place h) Table or list, etc. of symbols i) The necessary information to	cing system into service s used and their eaning to complete an arc	e; gs;	Anbotek Ant
	flash/blast analysis, including 1/2 bolted fault current (1/2 IB clearing time, and protective capability at a minimum, if apparent	F), protective device device current interrupt	Anborok Anboro	tek Anbotek
Anboten	j) If applicable, the manufacture information on design consider minimum system configuration modules installed in series, m	erations for maximum ans, such as number of	Polsk Vupo,	Anbotek Ani
upotek Vitek	maximum inductance to preve energy from exceeding the re- Protective Equipment Categor CSA Z462-15.	quirements of Personal	Anbotek Anbotek	ek Anbotek
2.3	Battery systems intended for i access location per 6.41 shall instructions indicating this with type of location required, its re other information to be provide	have installation n instructions defining the estrictions, signage and	he .	Anbotek Ant
12.4	A system shall be provided wi proper use including charging storage, recycling and disposa shall include temperature limit discharging limits as well as in use of any controls or monitor	and discharging, al. These instructions ts, charging and nstructions regarding th	An Anbotek Anbotek Anbotek	ek Anbotek Anbotek



	ANSI/CAN/UL1973: 2018	
Clause	Requirement + Test Result - Remark	Verdict
42.5	A system shall include the following statements or equivalent: a) An attention word, such as "DANGER,""WARNING,"	hbotek Anbotek
	or "CAUTION."	Anbot Anbot
	b) A brief description of possible hazards. c) A list of actions to take to avoid possible hazards regarding disposal of the system such as do not crush, disassemble, dispose of in fire, or similar actions.	tek Anbotek An
42.6	The system shall be provided with a maintenance manual that includes a schedule for maintenance of the system and accessories including a check of wiring and connections, etc. The maintenance manual shall include necessary safety precautions regarding handling or conducting maintenance on the system and its connections and accessories.	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
A Pro-	tek hoperen Aup ak hotek Anbot Anbot	ek aboter
	APPENDIX A (Normative)	_{oo} te\N
	A1. Standards for component	N.
· upotek	Anbot At solek Anbotek Anbo sok botek	Anboro Ano
	APPENDIX B (Normative)	P
h. coto	Test program for sodium-beta battery cells	nbotek Pant
P.U.D.	otek anbotek Anbotek Anbotek Anbotek	ek solek
V- 40	APPENDIX C (Normative)	_ote ^N N
ole.	Test Program for flowing electrolyte batteries	N×
abolek	Anbores Anbores Antonia Antonia Mariantes	Anbotek Anbo
50-7	APPENDIX D (Normative)	N
Lote!	Metal compatibility table	Anboten Nant
MUL	otek Anbotek Anbotek Anbotek Anbotek	k potek
P	APPENDIX E (Normative)	otek P
0,00	Alternative Cell Test Program	Р
51°°°	General	Anbotek Pro
E1,100tek	The following is an alternate program to be used to evaluate lithium ion cells or other secondary lithium cells instead of that outlined in 7.11.2.	Anbotek Anb
anb ^c	Exception: Samples of secondary lithium cells other than lithium ion shall be subjected to charge/discharge cycling as outlined in UL 1642 prior to conditioning outlined in E1.2.	otek Anbotek



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	ANSI/CAN/UL1973: 20	118	
Clause	Requirement + Test	Result - Remark	Verdict
E1.2	Prior to testing, the samples shall be conditioned by first discharging them down to the manufacturer's specified end point voltage and then charging them the manufacturer's specified upper limit charging voltage using the manufacturer's specified maximur charging current. Samples shall be charged at the upper temperature limit of the charging operating region and the lower limit of the charging operating region for those tests as identified in Table E.1.	to Annotes Annotes	Anborek Anborek Anborek
E2	Short Circuit	Anbotek Anbotek	Alpo, b
E2.1	Fully charged, conditioned cells are stored in an ambient temperature of 25°C ±5°C (77°C ±9°F) untitheir casing reaches ambient temperature, and then subjected to a short circuit condition using an extern resistance of $\leq 20~\text{m}\Omega$.	h. otek anbote.	Anbot Anbot
E2.2	The external resistance shall be applied to the cell terminals for 7 h or until temperatures on the cell co to within ±10°C (18°F) of ambient conditions.	ol Albotek Anbotek Anb	P
E2.3	As a result of the short circuit test, the cells shall not show signs of fire or explosion.	t (See Table E2)	Anto P
E3 _{Anboten}	Cell Impact	otek Anbotek Anbot	Р
E3.1	Fully charged, conditioned cells are subjected to an impact test as outlined in UL 1642. The cells shall b an ambient temperature of 25°C ±5°C (77°C ±9°F) prior to testing.		P ^{An}
E3.2	As a result of the impact test, the cells shall not show signs of fire or explosion.	w (See Table E3)	Aupo Pk
E4 botek	Drop Impact	Ann John Anbotek	NP
E4.1	Fully charged cells shall be dropped three times from height of 1 m (3.3 ft) onto a flat concrete or metal surface. The cells shall be at an ambient temperature of 25°C ±5°C (77°C ±9°F) prior to testing.	Hotek Anbore Ane	P _A nb
E4.2	The cells shall be dropped in a manner that the impacts occur in random orientations.	Anbotek Anbotek	Anborek
E4.3	After completion of the impacts, the cells shall be subjected to a minimum one hour observation perio before being examined.	d Anborek Anborek	Anb
E4.4	As a result of the drop impact test, the cells shall no show signs of fire or explosion.	t (See Table E4)	e ^N P
E5	Heating	And tek Supotek Ar	P
E5.1	Fully charged, conditioned cells are subjected to a heating test as outlined in UL 1642.	k Anbotek Anbotek	Anbole P
E5.2	As a result of the heating test, the cells shall not sho signs of fire or explosion.	ow (See Table E5)	P Anbr
E6 Antibo	Overcharge	Posey Vipos	P



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loo's	ek Anbo	ANSI/CAN/UL1973: 201	18	Aupore Au
Clause	Requirement + Test	tok abotok	Result - Remark	Verdict
E6.1	Fully charged conditioned cer accordance to manufacturer's the specified end point voltage in an ambient of 25°C ±5°C (and with the cell casing at an (77°C ±9°F) at the start of the	s specifications down to se. The test is conducted 77°C ±9°F) ambient of 25°C ±5°C	abotek Anbo	tek Anborek
	temperature of the cell shall be test.		Anbotek Anbotek	Anborek An
E6.2	The cells are charged with a maximum specified charge of the cell reaches 120% of the charge voltage value or 130% whichever is reached first. The terminated while the cell temperature drops and return test ambient.	urrent until the voltage of maximum specified 6 State of Charge (SOC) he charge is then perature continues to be ded when the cell	;), e	botek Anbotek
E6.3	As a result of the overcharge show signs of fire or explosio		(See Table E6)	Arbote ^P P
E7otek	Forced Discharge	Anboreli Anbor	k abotek Anbot	Pup P 10
E7.1	Fully charged cells shall be d to manufacturer's specificatio end point voltage. The test is of 25°C ±5°C (77°C ±9°F).	ons down to the specifie	den Ande	Anbotek Anb
E7.2 And	The discharged cells are sub- discharge at a constant curre the discharge voltage limit no value of the upper limit charg the cell. If the discharge volta the 90 min, the cell shall be of voltage discharge equal to the determined low voltage cutoff decreasing as necessary unt reached.	nt 1.0 It A for 90 min wint to exceed the numeric ing voltage specified for ge limit is reached befolischarged at a constant e manufacturer's f, with the current	re	Anbotek Anbotek Anbotek Anbotek Anbotek
E7.3	As a result of the forced disch not show signs of fire or explo		II (See Table E7)	An Pek
E8	Projectile	Ans anbotek	Aupo, Mr.	otek ArBotek
E8.1	Two fully charged cells shall projectile test criteria as outlin 1 of 7.11.2.		tek Anbotek Ano	Anbotek Panbo
E8.2	As a result of the projectile te be an explosion of the cells re sufficient force to penetrate the	esulting in projectiles wi		Ankotek P

		APPENDIX F (Informative)					N. W.
	abolek	Cell Failure Methods	anbotek	Anbo.	, work	Aupoten	Napo
F1	,	General	botek	Aupore	Ann	abole	N An



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nnbo [§]	h. 10/6.	AN/UL1973: 201	- Noote	Aub.
Clause	Requirement + Test	anbotek	Result - Remark	Verdict
F1.1 polek Anbotek Anbotek	This appendix provides some recomfor simulating cell failure for the Sing Design Tolerance test of Section 39 below represent some known methotype of testing and considered repredepending upon the technology and are not intended to be an all-inclusive be employed.	le Cell Failure The methods ods utilized for thi sentative, battery design, b	is but	ek Anbotek Anbotek Anbotek Anbotek Anbotek
F1.2 Annotek Ambotek Ambotek Ambotek Ambotek Ambotek	Probable cell failure techniques reprhappens in the field are preferable for contamination, separator defects or compromise due to internal or externetc.) as this would be the closest appround occur to a cell to cause it to fawith internal defects require the use constructed cells with known weaknethem, and may not always be availated Alternatively, the effects of a cell fail simulated to a realistic degree through the simulated through the simulated through	or the test (e.g. separator nal fault condition proximation of whil. However, cells of specially esses built into ble for testing. ure may be gh external way that is	ns, hat	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
F1.3 Anbotek Anbotek Anbotek Anbotek	The following methods may be used simulate potential technology specific could lead to thermal runaway and/or end use application. The test method be based upon potential failure medianufacturing defects or latent defectle as a result of stresses from the may lead to a propagation event for being evaluated. It is recommended methods be conducted at a small middle level to determine surrounding the internal cell failure.	c cell failures that or propagation in d chosen should hanisms due to cts introduced in pattery system that these failure ulti-cell or sub-	at an a a aat	otek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
F1.4	For this evaluation, all cells are to be state (> 95% MOSOC) and if necess technology, heated to an active state	sary for the	ed Annotak	Anbotak N
F1.5 Anbotek Anbotek Anbotek Anbotek Anbotek	During the test, temperatures on the surface or casing, and if applicable, or casings of the surrounding cells s monitored. The open circuit voltage failed should also be monitored. The of applying the failure mechanism to observable initiation of the cell failure recorded. The observable results of and impact to the surrounding cells as well, and videotaping may be used the test methodology should be documentation of all parameters impresults.	the outer surface hould be of the cell to be time from the state the cell to be the cell failures should be recordeful. The details cumented including	ed of	anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
F2 Anbotek	Replicating Internal Cell Failures thro	ough Internal	work Anbotek A	nbotan Nab



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lod.	ek Vupo, V.	ANSI/CAN	/UL1973: 201	8	iek aupoli	Vu,
Clause	Requirement + Test	upo stak	abotek	Result - Remark	notek ant	Verdict
F2.1	Single cell conductive co	ontamination	Anbotek	Nupore M	botek	N Poten
F2.1.1	This method reproduces the introduction of conduction of conduction connects cathode and a This method requires the with a known defect be remaining cells in the terrepresentative of productions.	uctive contamin mode in an inte at a special cell utilized as the fa sting subassem	ation that rnal short circu constructed ailed cell. The	Anborek Anborek Anborek Anborek	Anbotek Anbotek ek Anbote botek Anbote	Ant Nek Anbore Ant
F2.1.2	The failure in the cell sh heating or other means) should be recorded/doc and voltages measured above.	and the results umented, and to	of the failure emperatures	h Anbotek Anbotek	Anbotek Anbotek	Anbotek Anbotek
F2.2	Single cell separator de	ect		Ann Ann		N Vup
F2.2.1	This method reproduces in a cell separator that can internal short circuit. use of a special cell con The other cells in the DU production. The defect in separator should be actimeans that may include determine the effects of surrounding cells. Testir defective cell failure actiultimate results occur.	onnects cathod also structed with the JT should be reported to the cell with the cell with the charge/discharathe defect on the gis continued.	le and anode in so requires the element the element to the element	n e ct.	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	orek N Anbotek Anbotek Anbotek
F2.3	Internal heater application	on Anbore	VII.	Anbotek	Aupo	N _N
F2.3.1	This method utilizes a sheating element installe single cell failure through method requires the use contains an internal heat cell subassembly should production. The internal failed is activated within temperature ramp is does should be representative failure of the cell. Once heater should be turned failure observed and does in the cell of the cell o	d within the cell h heating of cell e of a specially leter wire. The ot do be represental heater within the atime frame accumented. The e of what can of the cell goes into off and the res	to create a I contents. Thi built cell that her cells in the tive of he cell to be and the heating ramp ccur during fie to failure, the	s Id	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	N Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
F3 Anb	Replicating Internal Cell of External Stress	Failures Throu	gh Application	otek Anb	otek Anbo	rek N ar
F3.1	External heater applicat	ion	Anbore	Pu.	unbotek Ar	N
F3.1.1	This method utilizes and to a portion of the cell to This method is a suitable uncontrolled heating that a result of an internal de	be failed to cre e method to rep t can occur who	eate the failure present the rap	i. pid	Anbotek Anbotek	N



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hote.	18270BC20004201	ANSI/CAN/UL1973: 2018	8 Anburge	rage 03 01 73
Clause	Requirement + Test	stek enbotek	Result - Remark	Verdict
F3.1.2	A thin film heater should be a failed in a location on the cells affect the other cells in the as should only be affected by the conduction (electrical and the the failed cell and not the app	s that does not directly sembly. The other cells e local effects and ermal) through the tabs or	Anbotek Anbotek Anbotek Anbote Anbotek Anbote	Anbotek Anbotek Anbotek Anbotek
F3.1.3	The heater should have suffice heating ramp should be of sure what occurs when a cell fails. goes into failure, the heater is results of the cell failure obse	fficient speed to replicate Once the heated cell to be turned off and the	aboren Anbo	Anbotek
F3.2	External indentation without of	casing/surface penetratio	on Anbotek Anbo	Notel
F3.2.1	This method creates a single indentation of the cell casing mechanism that results in shoof the cell electrode to create does not puncture the cell casonly be utilized, if it is possible to conduct this testing during Design Tolerance test of Secgain access to the cell does rest.	with a blunt indentation orting over several layers a single cell failure, but sing. This method can e to access the trigger cethe Single Cell Failure tion 39 and the method that affect the results of the	ell co ne	Anbotek Anbotek Anbotek Anbotek Anbotek
F3.2.2	he press equipment to be use stepper-motor-powered press control/monitoring system and chamber with the following at a) Control system should provequipment every 100 ms; b) Minimum load capacity of tlbf) or greater as necessary to on sample during the test; c) Sampling rate for the load aper second or more frequently d) Press speed: 0.1 ±0.01 mr e) Sampling rate for the open measurement: once per second f) Noise limit on the OCV read	s equipment with a d integral conditioning tributes: vide signal to press the press: 1,500 N (337.20 provide sufficient force force measurement: onc y; m/s; circuit voltage (OCV)	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek



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200	All Anborra	NSI/CAN/UL1973: 201	8	Anbote. An
Clause	Requirement + Test	ak abotak	Result - Remark	Verdict
F3.2.3 Anbotek Anbotek Anbotek Anbotek	For the test, the cell to be failed from a blunted tip indenter at the cylindrical cells the force should length of the cell and for prisms should be at the center of the findenter consists of a tungsten a recommended hardness equabove and with the tip rounded the cell's case. The nail diamed and the dimension of the tip manecessary for the form factor of Figure F.1. During the test, the the force applied to the cell cast the probe, and the open circuit cell is monitored continuously of displacement sampling rate of measurements/second. The matemperature, OCV drop, force should be included in the test responsible.	ne center of the cell. For d be at the center of the atic cells the force lat face of the cell. The carbide steel probe what to SKD-11 steel or d to avoid penetration of the cell case temperature as and displacement of voltage (OCV) of the with an OCV, force and displacement of and displacement of and displacement	or ne e vith of)	anbotek
Anbotek Anbotek	Exception: For cells constructe intentional gaps in electrode la should be adjusted to be cente	yers, indenter position	6/1.	otek AnboNik
F3.2.4	The speed of indention at the or should be at a rate of is 0.1 mr cell being failed should be mor indentation should be halted w drop of 500 mV, which is indicated circuit through a limited number	n/s. The voltage of the nitored and the hen there is a voltage ative of an internal sho	upolek Aupor	Anbotek N Anbo
F3.2.5	Once the voltage drop occurs, stopped and the results of the		Anbotek Anb	otek Anbotek
F3.3	Nail penetration through cell ca	asing	tek Anbotek A	mbe N
F3.3.1	This method creates a single of puncture of the cell with a shar through multiple layers of the confailure. This method can only be to access the internal cell surfatesting during the Single Cell F test of Section 39 and the method loes not affect the results.	p nail moving slowing sell electrodes to create the utilized, if it is possible to conduct this failure Design Tolerand to gain access to the For additional details of the sell of the se	ce he on	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek
F3.3.2	The press equipment used for F3.2.2. During the test, the cell force applied to the cell case a probe, and the open circuit volt monitored continuously with ar displacement sampling rate of measurements/second. The m temperature, OCV drop, force should be included in the test results.	I case temperature, the nd displacement of the tage (OCV) of the cell n OCV, force and 100 onitored values of and displacement	is Annotak	Anbotek N Anbotek Inbotek Anbotek



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· odra	le. Vun	ANSI/CAN/U	L 19/3: 201	104 - 1001-	v Vupo,	he.
Clause	Requirement + Test	lan Yafar	otek	Result - Remark	otek pabo	Verdict
F3.3.3	The nail used for this test slimits the area of the cell the recommended thickness of between 1 – 3 mm (0.04 – should have sufficient streed amage to the indenter due enough to be able to punct some test methods, a confor creating the short. Other nail to be provided with inside used so that the current through the nail, which mad Regardless of the nail mat documented in the test residence.	nat is impacted. If the indenter s 0.12 in). The m ngth to prevent ring the test and ture the cell case ductive metal nate ar methods call sulation or that a t does not have y affect the residental used, it she	The hould be naterial used breaking or d sharp sing. For ail is require for the metal a ceramic nall a path ults.	d ed al	Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek	Anbotek Anbotek Anbotek Anbotek Anbotek
F3.3.4	The rate of indentation of the voltage of the cell being and the movement of the rate be halted when there is a movement of the rate of the cell, whichever comes dropped or the depth of percell has occurred, the nail the results of the cell failur	ng failed is to be nail through the voltage drop of rough approxim first. Once the enetration through penetration is s	e monitored cell should at least 500 nately half o roltage has gh half the	Anbotek Anbotek	tek Anbotek hbotek Ar Anbotek Anbotek	N And botek Anbotek Anbotek
F3.4	Single cell short circuit	ek shotel	Anbo	r bus	Anbolek	NAnb
F3.4.1	This method simulates a s through a very low resistar event to create a cell failur recommended for cell coninternal protection devices cell failure may not be able	nce external sho e. This method structions that o such as PTCs	ort circuit is not contain	Arbotek Anbotek	botek Anbotek	anbotek
F3.4.2	The cell failure should be i of a very low resistance sh terminals. The total resistance she seen from the cell terminal practicable. The external runtil ultimate results occur used should be as close a internal resistance. The ch should be agreed to by the manufacturer.	nort circuit applied ince of the short ince of the short is should be as esistance should. The external responsible to the losen external responses in the short ince in the short	ed to the ce t circuit as low as d be applied esistance e cells esistance	ll botek Anbotek	Anbotek Anbotek Anbotek Anbotek	N
F3.5	Single cell overcharge	ek anbotek	Anboy	k hotek	Anborek	N
F3.5.1	This method creates a sing overcharge of the cell beyonereate a cell failure. This may for cell constructions that of devices such as PTCs or for the able to be initiated. Useful for pouch type cells may result from the overchability to initiate a failure in	ond the cell spenethod is not recontain internal uses, as a cell for This method much where excessionarge, which ma	cifications to commended protection ailure may ay not be ve swelling	Anbotek Anbotek	Anbotek Anbotek Anbotek Anbotek	N Andorek



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Clause	Requirement + Test		Result - Remark	Verdict
Clause	rtequirement + rest	rok Anboro	Result - Remark	Verdict
F3.5.2	The failure should be initiated charging of the fully charged of ultimate results occur. The surcell should be capable of bring the level where cell failure will for lithium ion). The charging semaximum charge voltage and held for 1 min before increasing until ultimate results occur. The at 110% of the maximum specified that point of ultimate results, it stopped. Test voltage and cur and provided with the test results.	cell to be failed until pply used to charge to ging the cell voltage to be initiated (e.g. 6 V) should begin at the libe increased by 1 V and the voltage to the charge rate should cified charging rate. A he charging may be trent should be record	up to dc and cell I be At	tek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek Anbotek

1/2		APPENDIX G (Normative)								PAnbo
6.	Ans	Safety marking translations	No	bu. Polek	Anbo	ION VI	rek.	700	No	P



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	TABLE: List of critica	I components			AnboteP
Object/part No.	Manufacturer/ trademark	Type/model	Technical data	Standard (Edition / year)	Mark(s) of conformity ¹)
Cell	Jiangxi Anchi New Energy Technology Co., Ltd.	IFP23140160- 50Ah	3.2V, 50Ah	ANSI/CAN/UL 1973: 2018	Test with appliance

15	TAB	LE: Overcha	arge Test					Р
	nple o.	OCV at start of Test, Vdc	Fault Condition Imposed	Measured Maximum Charge Voltage, Vdc	Measured Maximum Charge Current, A	Max Temp Measured, °C	Dielect Voltage Break-down? Y or N?	Results
В	10,000	11.26	S-C MOS	16.06	100	48.9	potek N Anbo.	P
		Charge/		bustible entration		Toxic Gas	Concentration	
Sample No.		Charge/ Discharge Cycle at end?	≥ 25% LFL?	Spark Ignition?	Potential Toxic gas	Chamber Volume, m3	Measured concentration of toxic gas, ppm	OSHA TWAs Limit Values, ppm

	16	TAB	LE: Short Ci	ircuit Test					Р
30	Sam _l No		Initial OCV, Vdc	Meas. Max. SC Current A#/Time to operation of protection, s	$\begin{array}{c} \text{Measured} \\ \text{External} \\ \text{Short Circuit} \\ \text{Resistance,} \\ \text{m}\Omega \end{array}$	Measured Maximum Temperature on sample, °C	Fault Condition Imposed	Dielectric Breakdown?, Y or N	Results
	B2	No to	13.86	And	19.6	34.6	S-C MOS	tek Nanbotek	P

^{# -} The maximum short circuit was measured as well as the time it took from the application of the short circuit resistance to operation of the protection device.

[] See attached chart of current/time for short circuit test.

Load at between 85% to 100% of short circuit protector trip current:

Sample No.	Initial OCV, Vdc	Measured Maximum Short Circuit Current, A	Measured Maximum Temperature on Sample, °C	Fault Condition Imposed	Dielectric breakdown?, Y or N	Results
anbot	y - Vupo,	All work	k Anbotek	Anbo. Anbo.	botek Anbote	- Amb



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17 TAE	BLE: Overdis	scharge Prot	ection Tes	i			Р
				ured Maximum arge current, A	Max Temp Measured	Rreakdown?	Results
В3	13.82	O tel	s anbo	100	37.8	Notes	AND A
	Charra/	Comb Concer			Toxic Gas	Concentration	
Sample Discharg No. e Cycle ≥ 25% Sp		Spark Ignition?	Potential Toxic gas	Volume concentration of			
18K	anbotek.	Vupo.	h.,	lek - Vupojer	PUP	ak -bolek	Anboro

18 TABLE: Temperature	And Operation	Limits	Check	Test				Р
Sample No.	work.	Anbo	(6.	Ano	N.	bolek	Aupor	bu.
Thermocouple Location	Max Ter chargi	np during	g			np during ging, °C		x Temp nit, °C
Jotek Anboten Anb	Measured	Calcul	ated	Measur	ed	Calculated	-	rupo.
Chamber Ambient	23.4	botek -	Anb	23.8	AUP	- 10k - 10bo	lek.	25
Casing of cell	38.6	58.	4	42.3	PIL	58.8	botok	60 Anbore
Module surface	37.6	78.	4	40.8		78.8	Lotel	80
Internal wire	47.6	198	.4	51.4	hr	198.8	Dun	200
PCB	43.5	128	.4	48.6	otek	128.8	VUP.	130
MOSFET	45.3	148.4		49.3		148.8		150
Control IC	38.6	148	.4 Anb	43.6	Vien	148.8	ek.	150
Location of voltage	e measured		Volta mod	neasured age on ule/cell, /dc		lin measured voltage on odule/cell, Vdc	Op rai mod	ormal erating nge of lule/cell, Vdc
Cell	W. Vupo.	o.V.	Sofon	3.64	3,0,	2.08	3.	65-2.0
Module	otek Aupor		1	4.58	nbote	10.64	14	.6-10.5



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	-10-0				, - O		M.	-0/- 5//	1
19	TABI	LE: Imbalance	ed C	haring Tes	st				P
San	nple	Initial OCV	M	easured	Measured	Measured	Measure	ed Dielectr	Results
No	0.	of partially	M	aximum	Maximum	Maximum	Maximu	m ic	
		charged	(charge	charge	Voltage on	Temp o	n Break	
		module/	V	oltage,	current, A	partially	partiall	y Down?,	
		cell, Vdc		Vdc		charged	charge	d Y or N	
						module/cell,	module/c	ell,	
						Vdc	°C		
В	4 nbox	12.62	rek	14.60	100	3.62	35.3	NAME	P P
San	nple	Charge/		Com	bustible		Toxic Gas C	Concentration	
No	0.	Discharge)	Conc	entration				
		Cycle at end	d?	≥ 25%	Spark	Potential	Chamber	Measured	OSHA
				LFL?	Ignition?	Toxic gas	Volume,	concentration	n TWAs
							m3	of toxic gas,	Limit
								ppm	Values,
									ppm
	1001	yk bupo.		b/s.	K - Joole	AUD		otek Anbo	Vice Vice
	200		400	100	Dr.		100		

24.4 T	TABLE: Strain Relief Test											
Samp	' I Lest incation	Applied Pull force, N	Comments									
B6	6 Case	156	And atek anbotek									

25	TABL	E: Vibration Test(LEV M	otive Applications)		Р
	ample No.	Voltage at the start of test.Vdc	Voltage at the end of test.Vdc	Comm	nents
6,00	B7	13.84	13.82	abotek -	Aupole.

26	TABL	E: Shock Test(LEV Motiv	ve Applications)		Р
	nple lo.	Voltage at the start of test.Vdc	Voltage at the end of test.Vdc	Comments	
Е	38	13.83	13.80	Dojer Vup.	atek and

27	7 TABL	.E: Crush Test(LEV Mo	otive Applications)	5001		Р	
A.S.	Sample No.	Voltage at the start of test.Vdc	Voltage at the end of test.Vdc	Maximum Force applied to the battery during crush,kN	Co	mments	
	B9	13.86	13.72	100	Aupo.	ok wole	

28 TA	BLE: Static Force Test				Р
Sample No.	Voltage at the start of test.Vdc	Voltage at the end of test.Vdc	Force Applied position	Co	mments
up-	13.84	13.82	Тор	hotek	Anbotek
B10	13.82	13.82	Bottom	"otek	- Anborek
Anbo.	13.82	13.81	Sides	VU.	ek - Anbote

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29	TABL	ABLE: Impact Test								
	Sample No. Voltage at the start of test.Vdc		Voltage at the end of test.Vdc	Comments						
B1	11	13.82	13.80	K Potok-	Anbotek					

30	TABL	TABLE: Drop Impact Test							
	nple lo.	Voltage at the start of test.Vdc	Voltage at the end of test.Vdc	Drop Height,m	Co	mments			
rek B	12 pm	13.83	13.82	0.01	-	'upo, bi			

32	TABLE: Mold Stress Test							
	nple lo.	Voltage at the start of test.Vdc	Voltage at the end of test.Vdc	Maximum temperature applied to test., °C	Co	mments		
В	13	13.85	13.75	ambotek 70 Ambot	Vi.	itek Anboi		

35	TABL	TABLE: Thermal Cycling Test (LEV Motive Application)							
	Sample No. Voltage at the start of test.Vdc		Voltage at the end of test.Vdc	Comments					
В	314	13.82	13.45	Anbotek -	Anbo.				

3	36 T	ΓABL	TABLE: Resistance to Moisture Test								
14		Sample Voltage at the start of test.Vdc			Voltage at the end	of test.Vdc	Comn	nents			
o re	B15	5 Ant	13.80	Anbore	13.78	anbotek	Vupo,	" Potek			

37	TABL	TABLE: Salt Fog Test(outdoor use)							
S	ample No.	Voltage at the start of test.Vdc	Voltage at the end of test.Vdc	Comm	ents				
la.	B16	13.83	13.76	otek anbo	lek Vupo,				

E2	E2 TABLE: Short circuit (cell)							
Samp	Sample No. Ambient T($^{\circ}$ C) Voltage at the start of test.Vdc Resistance of circuit, ($^{\circ}$ M Ω) Charging temperature:0 $^{\circ}$ C							
Charg								
C	1	23.5	3.32	18.5	52.1	P		
Charg	ing ten	nperature: 45°C	cotek anbotek	Anbore	hotek Anbo	Valent Valent		
C	2	23.5	3.45	18.8	53.8	potek P N		



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E3 TABL	E: Cell Impact		Р
Sample No.	Voltage at the start of test.Vdc	Maximum Temperature on Cell Casing, °C	Comments and Condition
Charging te	emperature:0°C	notek anbotek Anb	or Ar hotek Anbotek
C3	3.31	24.5	inbots Ans otek Anbote
Charging te	emperature: 45°C	Anbo tek nbotek	Anbore And
C4	3.42	24.8	Anbore Anb

E4 TABL	4 TABLE: Drop Impact									
Sample No.	Voltage at the start of test.Vdc	Voltage at the end of test.Vdc	Comments and	Condition						
C3	3.42	3.41	Mupo stek upote	Anbole.						
C4	3.43	3.42	Anbo.	olek Anbol						

E5	TABL	.E: Heatin	g							Р
	nple lo.	Volta	ge at the s test.Vdc	tart of		ge at the test.Vdc		Com	ments and	Condition
Char	ging te	mperature	e:0°C	Nek	anbotek	Vupo.	Pr.	hotek	Anboten	Ano
C	C5	Anbol	3.32	-1e/k	anbotek	3.26	0/-	"olek	Ankotek	Aupo
Char	ging te	mperature	e: 45°C	AUPO	nbote	14	Aupolou	Aur	k anbo	sek Pupo
, C	26	otek	3.43	Anbo	de A	3.34	Aupole	VUP	Hele -	hotek Ar

E6	TABL	.E: Overcharge				Р
Sample No.		Measured Maximum Charging Voltage (V dc)	Initial OCV, V at	Maximum Temperature on Cell Casing, °C	Comm	ents
Charg	Charging temperature:0°C					
С	7	4.38	2.23	38.4	Yupo rok	bolek And
Charg	ging te	emperature: 45°C	Aupolo A	hotek Anbotek	Vupo. V	abotek
Pose	8	4.38	2.24	37.9	Anbo	Pr. Potek

200		Pri-	210.	- W	Ollin	No.		
E7	TABLE: Forced Discharge							
	nple lo.	Initial OCV, V at	Final Voltage, V	Max Discharge Current, A	Comme	ents		
, C	9	2.21	Ann Otek	50	notek An	potek Ant		
С	10	2.24	And tek	50	Ann	vupotek.		

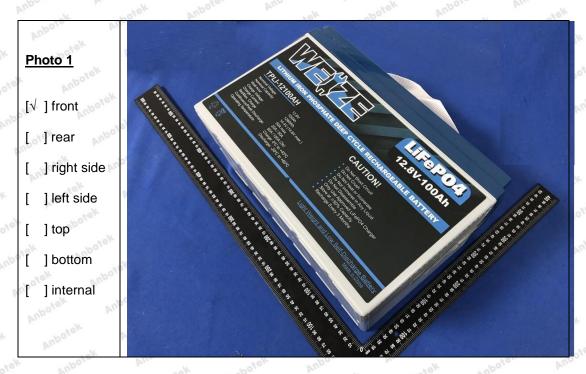
Е	8 T <i>A</i>	TABLE: Projectile									F)		
	Sample No.		Voltage at the start of test.Vdc					Comments						
	C9	O,e,	Anb	-tok	3.42	botek	Anbol		Ann		uposek	Aupo,	. No.	bree.
NB F	C10	Anbot	0/4	Yupo.	3.40	abotek	An	oter	Anbo	101	anbotek	Pul	2010	Vur

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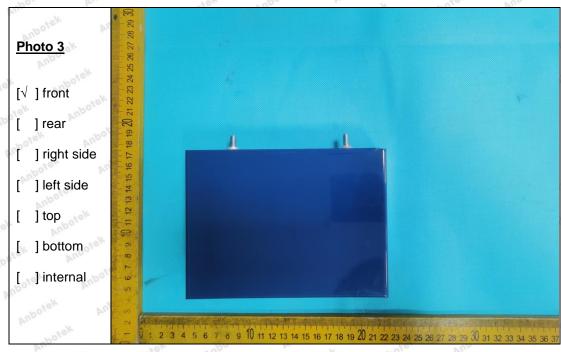
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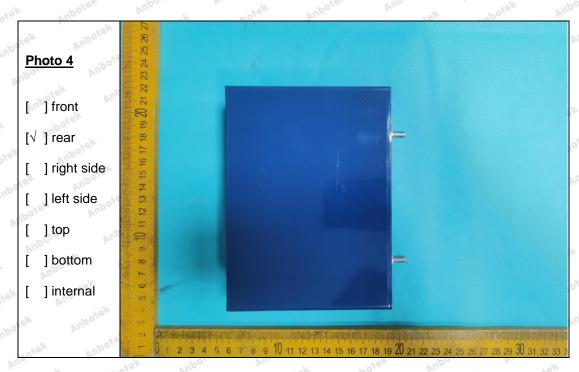






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End of the report