

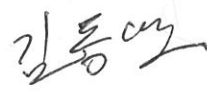
Document No. IV-BG-N-E710A-01	Date. Sep. 09, 2020	Rev. C3-1
Description Lithium Ion Battery EV 115342102 (71.0Ah)		

Technical Specification

Lithium Ion Polymer Rechargeable Battery

Model : CE0710C001A (N60 C3 SPL)

Customer: BESK

Department	Name	Date	Signature
Cell Development	D.Y. Kim	2020.09.09	
Quality Assurance			

SK innovation Co., Ltd

Battery Division

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Revision History

Revision No.	Date of revision	Description	Author
A0	2018-09-04	First release E710A specification (Draft)	S.H. LEE
A1	2018-10-04	A SPL Peak power and step charge updated	S.H. Lee
A1-1	2018-10-04	A SPL specified update	S.H. Lee
C0	2019-06-03	C SPL specified update	S.H. Lee
C1	2019-09-26	C SPL Nominal specification, Characteristics update	S.W. Park
C1-1	2019-10-16	C SPL OCV update	S.W. Park
C1-2	2019-10-25	Overcharge fault threshold(continuous charge) update	S.W. Park
C1-3	2019-11-22	Maximum Discharge Current Minimum Continuous Discharge Voltage Nominal Weight update	S.W. Park
C1-4	2020-01-22	Minimum Continuous Discharge Voltage update	S.W. Park
C3	2020-03-05	C3MP SPL specified update	S.W. Park
C3-1	2020-09-09	Step charge comment update	S.W. Park

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1. Scope

This product specification has been prepared to specify the rechargeable lithium-ion cell characters to be supplied to the customer by SK innovation.

2. Nominal Specifications

Item		Description	Note
Model Name		CE0710C001A	N60 E710A
<u>Nominal Capacity</u>		<u>71.0 Ah</u>	1/3C (Min.)
		<u>68.9 Ah</u>	1C (Min.)
Nominal Weight		900 g	± 15g
<u>Average Voltage</u>		<u>3.64 V</u>	1/3C
		<u>3.54 V</u>	1C
Usable SOC range in system		3 ~ 95 %	DOD92%
Operating Voltage range	DOD100%	<u>4.2~2.5 V</u>	25℃
	Usable SOC	<u>4.13~3.1 V</u>	25℃, DOD92%
Minimum Discharge Voltage		2.0 V	< 0℃, Peak
		2.3 V	< 0℃, Continuous
		2.3 V	≥ 0℃, Peak
		2.5 V	≥ 0℃, Continuous
Maximum Discharge Current		400 A	Peak 10 seconds
		300 A	Peak 15 seconds
		107 A	Continuous
<u>Maximum Charge Voltage</u>		<u>4.2 V</u>	15sec / Continuous
<u>Maximum Charge Current</u>		225 A	Peak 15 seconds
		<u>142 A</u>	Continuous
Energy		258 Wh	1/3C (Min.)
		244 Wh	1C (Min.)
Specific Energy		282 Wh/kg	1/3C (Min.)
		267 Wh/kg	1C (Min.)
Energy Density		644 Wh/l	1/3C (Min.)
		608 Wh/l	1C (Min.)
25℃ Cycle Life	400 cycle	DOD100% / Capacity ≥ 80%	Cha. 1C CV/Dis. 1C CC
	1200 cycle	DOD92% / Capacity ≥ 80%	Cha. 1C CV/Dis. 1C CC
45℃ Cycle Life	400 cycle	DOD100% / Capacity ≥ 80%	Cha. 1C CV/Dis. 1C CC
	900 cycle	DOD92% / Capacity ≥ 80%	Cha. 1C CV/Dis. 1C CC
Operating Temperature	Charge	-20 ~ 60℃	-
	Discharge	-30 ~ 60℃	-

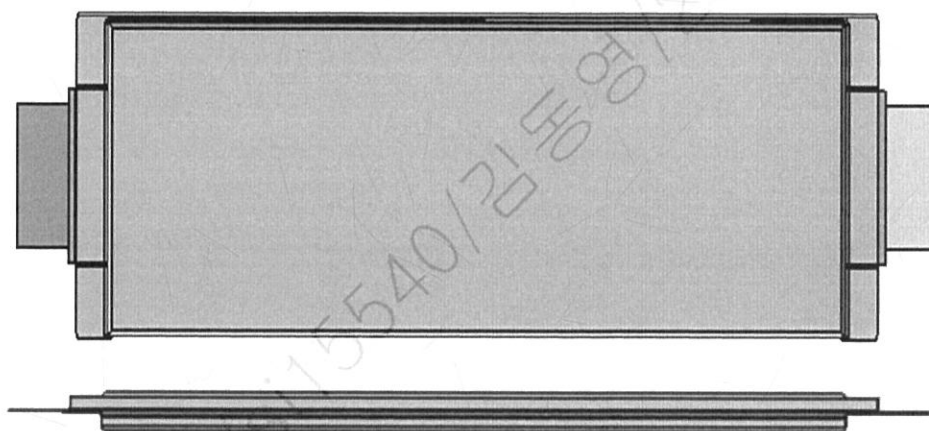
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Storage Temperature		-40 ~ 60 °C	-
Standard	<u>Charge</u>	1/3C, <u>4.2V/0.05C</u> <u>Cut-off</u>	Standard at 25 ± 2 °C
	<u>Discharge</u>	1/3C, <u>2.5V</u> <u>Cut-off</u>	
Internal resistance (1kHz)		0.7 ± 0.15	SOC 50%, 25 °C

3. Dimension and Appearance

3.1 Dimension

Width : 342 ± 1 mm (without positive/negative terminals)
 Height : 102 ± 1 mm
 Thickness : 11.5 ± 0.2 mm
 Weight: avg. 900 g



3.2 Appearance

SKI shall agree visual standard with BESK.

Pouch surface defects can be categorized such as dent, scratch, and stain.

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4. Standard Test Conditions

4.1 Environmental Conditions

Unless otherwise specified in a device-specific test plan, the ambient temperature for all tests should be controlled at a default nominal temperature of $25 \pm 2^\circ\text{C}$ and humidity $60 \pm 20\%$.

4.2 Equipment

- 4.2.1 All testing is to be performed on test channels with current and voltage capabilities adequate for the specific test procedures to be performed.
- 4.2.2 Except where specifically notes otherwise, all tests will be performed within a temperature chamber capable of controlling the chamber temperature to within $\pm 3^\circ\text{C}$.
- 4.2.3 Measurement Rates and Accuracy
Measured data shall be acquired at rates and with accuracies adequate to ensure that the usefulness of the data is not compromised. In the absence of more specific requirements by the test sponsor, the measurement accuracies in Table are acceptable.

Table. Measurement Accuracies

Parameter	Accuracy
Temperature	$\pm 2^\circ\text{C} \pm 5\%$ of reading
Voltage (volts)	
Current (amps)	$\pm 1\%$ of reading
Resistance (Ω)	

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5. Characteristics

5.1 Standard Capacity

Cells shall be fully charged and discharge with C/3 current. 10 minutes rest shall be applied between charge and discharge step.

Discharge capacity

Min. 71.0Ah

5.2 Rated Discharge Capability

Cells shall be fully charged with standard charge and discharged with rated current shows below.

Current	Discharge rate	
	C/3 (=23.67A)	1.0C(=71.0A)
Rate vs C/3 (Capacity, BOL)	≥100%	≥95%
Rate vs C/3 (Energy, BOL)	≥100%	≥94%

5.3 Temperature Discharge Characteristic

Cells shall be fully charged with standard charge and discharged at various temperatures shows below.

Charge Temp.(Std)	Discharge temperature		
	-15 ± 2 °C	25 ± 2 °C	45 ± 2 °C
25 ± 2 °C, C/3 (Capacity, BOL)	≥80%	≥100%	≥100%
25 ± 2 °C, C/3 (Energy, BOL)	≥75%	≥100%	≥100%

5.4 Charge Characteristic

5.4.1 Charge Operating Voltage

Item	Description	Condition	Note
<u>Maximum continuous charge current</u>	<u>142 A</u>	-	-
Maximum pulse charge current	225 A	15s	-
Maximum continuous charge <u>Cut-off voltage</u>	<u>4.13 V</u>	-	Filter time ≤5s
<u>Overcharge fault threshold</u> (continuous charge)	<u>4.2 V</u>	-	Filter time ≤5s
Overcharge voltage <u>recovery threshold</u>	4.14 V	Discharge allowed	Filter time ≤5s
Maximum pulse charge Cut-off voltage	4.2 V	-	Filter time ≤5s
Overcharge fault threshold (pulse charge)	4.25 V	-	Filter time ≤5s

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5.4.2 Standard Charge

Item	Description	Condition
<u>Current</u>	<u>23.67 A</u>	25 °C
<u>Voltage</u>	<u>4.13 V</u>	-
Chare mode	CC-CV	4.13 V, 3.55 A cut-off
Temperature	25 ±2 °C	Cell temperature

Cells can be charged using on board charger. Maximum charge current and SOC using on board charger refers below.

Charge procedure will be provided for each temperature later.

5.4.3 Step Charge

Cells can be charged by step charge method. Maximum charge current and voltage at various temperatures refers table below and linear interpolation applied for unspecified temperature. **充电倍率**

Step #	<u>Cutoff V</u>	-20 °C	-15 °C	-10 °C	-5 °C	0 °C	5 °C	10 °C	15 °C	25 °C	45 °C
1	3.87	0.16	0.22	0.30	0.42	0.58	0.79	1.07	1.37	2.00	2.00
2	3.88	0.15	0.21	0.29	0.40	0.55	0.75	1.02	1.30	1.90	1.90
3	3.89	0.14	0.20	0.27	0.38	0.52	0.71	0.96	1.23	1.80	1.80
4	3.91	0.14	0.19	0.26	0.36	0.49	0.67	0.91	1.16	1.70	1.70
5	3.92	0.13	0.18	0.24	0.33	0.46	0.63	0.86	1.09	1.60	1.60
6	3.95	0.12	0.17	0.23	0.31	0.43	0.59	0.80	1.03	1.50	1.50
7	3.97	0.11	0.15	0.21	0.29	0.40	0.55	0.75	0.96	1.40	1.40
8	4.01	0.10	0.14	0.20	0.27	0.37	0.52	0.70	0.89	1.30	1.30
9	4.05	0.09	0.13	0.18	0.24	0.34	0.46	0.63	0.80	1.17	1.17
10	4.08	0.09	0.12	0.17	0.23	0.32	0.44	0.59	0.75	1.10	1.10
11	4.13	0.08	0.11	0.15	0.21	0.29	0.40	0.54	0.68	1.00	1.00
12	↓	0.07	0.10	0.14	0.19	0.26	0.36	0.48	0.62	0.90	0.90
13	↓	0.06	0.09	0.12	0.17	0.23	0.32	0.43	0.55	0.80	0.80
14	↓	0.06	0.08	0.11	0.15	0.20	0.28	0.37	0.48	0.70	0.70
15	↓	0.05	0.07	0.09	0.13	0.17	0.24	0.32	0.41	0.60	0.60
16	↓		0.06	0.08	0.10	0.14	0.20	0.27	0.34	0.50	0.50
17	↓		0.05	0.06	0.08	0.12	0.16	0.21	0.27	0.40	0.40
18	↓			0.05	0.06	0.09	0.12	0.16	0.21	0.30	0.30
19	↓				0.05	0.06	0.08	0.11	0.14	0.20	0.20
20	↓					0.05	0.05	0.05	0.07	0.10	0.10
21	↓								0.05	0.05	0.05

2倍率*71A
=142A

* Current and voltage below 15 °C are under discussion and need to be updated at the time the discussion is completed.

5.4.4 Rate Charge Capacity & Energy

Cells shall be fully discharged with standard discharge and charged with rated current shows below.

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Current	Charge rate	
	<u>C/3 (=23.67A)</u>	<u>1.0C(=71.0A)</u>
CC vs CV ratio (Capacity, BOL)	≥90 %	≥80 %
CC vs CV ratio (Energy, BOL)	≥90 %	≥73 %

71/3=23.6666

1倍率为71.0A

5.5 Discharge Characteristic

5.5.1 Discharge Operating Voltage

Item	Description	Condition	Note
Standard discharge current	1/3C	25 °C	23.67A
Maximum continuous discharge current	107A	-	-
Maximum pulse discharge current	400A	10s	-
	300A	15s	-
	300A	30s	-
Minimum continuous discharge voltage	[-30 °C ~ -5 °C] 2.6V [0 °C ~ 5 °C] 2.8V [10 °C ~ 15 °C] 3.0V [25 °C ~ 55 °C] 3.1V	Unspecified temperature, linear interpolation	Filter time ≤5s
Minimum pulse discharge voltage	[-30 °C ~ -5 °C] 2.6V [0 °C ~ 5 °C] 2.8V [10 °C ~ 15 °C] 3.0V [25 °C ~ 55 °C] 3.1V	Unspecified temperature, linear interpolation	Filter time ≤5s
Cell over-discharge failure voltage	[-30 °C ~ 0 °C] 2.0V [0 °C ~ 60 °C] 2.3V		Filter time ≤5s

5.6 Pulse Power Characteristic

5.6.1 30sec Peak Discharge Power

30sec Peak discharge power measured by HPPC method is shown on the table below. 300A for I_{dis_max} will be used unless cell voltage meets cutoff condition within 30sec of discharge or charge at that point and linear interpolation applied for unspecified temperature.

$$(I_{chg} = 0.75 \cdot I_{dis})$$

(Unit : W)

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Table 1. 30S Discharge Pulse Power Matrix (cell unit: W)

SOC	-30℃	-20℃	-15℃	-10℃	-7℃	-5℃	0℃	5℃	10℃	15℃	25℃	45℃
Vmin/V	2.6	2.6	2.6	2.6	2.6	2.6	2.8	2.8	3.0	3.0	3.1	3.1
0												
5%×Qt	11	19	23	32	39	48	51	71	78	106	163	396
10%×Qt	17	33	45	68	85	108	118	164	190	242	343	647
20%×Qt	55	122	176	237	292	333	388	519	514	626	742	1058
30%×Qt	98	213	288	373	452	498	568	749	726	855	989	1383
40%×Qt	129	266	357	459	546	602	688	891	862	1005	1164	1594
50%×Qt	159	316	418	533	628	692	786	999	983	1129	1330	1860
60%×Qt	187	380	488	617	721	780	875	1104	1106	1245	1491	2042
70%×Qt	213	447	559	702	815	878	974	1224	1229	1388	1690	2325
80%×Qt	233	492	617	764	874	942	1050	1303	1331	1505	1869	2567
90%×Qt	247	547	663	812	915	995	1111	1381	1423	1631	2076	2941
100%×Qt	256	561	673	825	928	1014	1131	1381	1467	1703	2189	3054

5.6.2 Peak charge power

15sec Peak charge power measured by HPPC method is shown on the table below. 225A for I_{chg_max} will be used unless cell voltage meets cutoff condition within 15sec of discharge or charge at that point and linear interpolation applied for unspecified temperature.

$$(I_{chg} = 0.75 \times I_{dis})$$

(Unit : W)

Table 1. 15S Charge Pulse Power matrix (Brake energy recovery) (Cell unit: W)

SOC	-20℃	-15℃	-10℃	-7℃	-5℃	0℃	5℃	10℃	15℃	25℃	45℃
Vmax/V	4.13	4.13	4.13	4.13	4.13	4.13	4.13	4.13	4.13	4.13	4.13
0	233	338	456	581	634	868	1147	1279	1431	1811	2451
10%×Qt	169	246	360	483	538	762	1048	1239	1444	1953	2904
20%×Qt	152	231	338	439	494	704	975	1170	1376	1879	2673
30%×Qt	152	227	329	421	479	683	936	1152	1340	1830	2563
40%×Qt	139	208	294	387	434	616	864	1059	1256	1713	2401
50%×Qt	114	175	248	324	355	511	721	874	1048	1421	1948
60%×Qt	77	116	170	246	246	362	519	640	772	1064	1460
70%×Qt	46	73	111	189	168	255	375	468	568	792	1098
80%×Qt	25	44	73	87	100	154	226	281	343	481	669
90%×Qt	9	15	24	36	38	58	86	108	133	189	263
95%×Qt	6	9	15	20	23	36	51	65	80	113	155
100%×Qt											

5.7 Storage Characteristic

5.7.1 Storage

Cells shall be stored during 4 weeks at room temperature after standard charge.

Recovery capacity

≥ 80% of nominal capacity

5.8 Self-discharge Characteristic

Item	Description	Condition
Self-discharge	Capacity retention ≥95% Capacity recovery ≥97%	25℃ / SOC100% / 28days

5.9 SOC-OCV Table

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Item	Open circuit Voltage at 25°C						
SOC	100	95	90	85	80	75	70
Voltage	4.175	4.097	4.075	4.038	3.986	3.938	3.900
SOC	65	60	55	50	45	40	35
Voltage	3.861	3.817	3.767	3.704	3.667	3.639	3.615
SOC	30	25	20	15	10	5	0
Voltage	3.591	3.563	3.524	3.471	3.409	3.367	3.163

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6. Handling Precaution



Proper Use and Handling of Li-Ion Polymer Battery

This User's Reference explains how to properly use the Li-ion Polymer Battery (hereafter called as "battery") supplied by SK Innovation Co., Ltd. (hereafter called "SKI") to ensure its safe use and maximize its efficiency. The battery should not be used for any purposes other than its originally intended uses. If you encounter any problems from its use, please do not hesitate to contact SKI for further information and consultation. Please make sure to read this Reference carefully before using the battery.

1. Reference Content:

This User's Reference describes the requirements and cautions accompanying the use of SKI-supplied Li-ion Polymer Battery for both the device makers to ensure proper assembly and the end-customers to ensure its safe use.

2. Battery specification

- ① Model : EV 115342102
- ② Nominal Capacity : 71.0 Ah
- ③ Capacity on shipping : Less than SOC 30%
- ④ Voltage on shipping : 3.55 ~ 3.65 V

3. Use Environments and Conditions

- ① Do not expose the battery to any liquids. It can cause battery swelling, heat, explosion, or fire.
- ② Do not leave the battery next to any heat sources like a stove. It will cause swelling, heat, explosion, or fire.
- ③ Do not leave the battery in any place where the temperature is expected to rise, such as exposing the battery to prolonged direct sunlight. It can cause swelling, heat, explosion, fire or it will shorten battery life
- ④ The temperature range for charging the battery is -20 ~ 60 °C. Charging it under any temperatures outside this range may cause swelling, heat, explosion, and fire.
- ⑤ The operating temperature range is -30 ~ 60 °C. Do not operate outside this temperature range.

4. Handling Cautions for Moving

Handle carefully when moving the battery to avoid any damages. If the battery is damaged by moving equipments during its transportation, it can cause swelling, heat, explosion, and fire. If you see any damages to the packing box, stop and isolate the damaged box, check to make sure there is no actual damage to the battery itself, and then resume transporting the item only after repackaging it.

5. Storage Cautions

Please store the battery under the following conditions and environments (storing it in an improper environment

or condition may lower its performance and cause swelling, heat, explosion, and fire.)

- ① Please store indoor without direct exposure to sunlight.
- ② The proper storage environment is as below:
Temperature: 23 ± 5 °C, Humidity: 60 + 10%, - 20% RH
- ③ Cautions for long-term storage
If you intend to store the battery for more than 6 months, please store in its original SOC condition as you found it when it was first shipped by SKI. Storing the battery for an extended period of time in a condition other than this original shipping condition of SKI may lower the battery performance.

6. Handling/Use Cautions

- ① Make sure to read the reference before using the battery, as well as to keep the Reference safely for future consultation when needed. If you do not understand any part of the Reference, please contact SKI for further assistance (Contact info is provided at the end of this Reference).
- ② For information on how to charge the battery, consult the handling manual for the charger. Please use the designated chargers only for Li-ion batteries.
- ③ Your battery has its polarity (+/-). When charging or installing, do not use excess force, and make sure to place the battery in the proper position for its polarity. Placing it with its polarity reversed will undermine its charging process and inflict internal damages, and it will cause leakage, swelling, heat, explosion, or fire.
- ④ After purchasing the battery, if you encounter any rust, strange odor or unusual heat coming from the battery, stop your use and contact SKI (Contact info is provided at the end of this Reference).
- ⑤ The battery is partially charged before shipping, allowing you to use it immediately to test your device. Please be careful not to touch battery terminals with hands
- ⑥ Please keep the battery out of reach that has no experience of battery. When the battery is to be used by them, please make sure to explain to them clearly how to use it properly as outlined in this Reference. Once they start to use it, also make sure to check and verify that they are indeed using the battery properly.
- ⑦ When using the battery, please make sure to heed to the following warnings.
Do not throw into fire or heat it. This will not only melt and damage its enclosure but it can also cause swelling, heat, explosion, or fire.
Do not use with its polarity (+/-) reversed. Reverse charging will not only lead to abnormal chemical reaction internally, but it may undermine the proper flow of its electrical current, causing the battery to swell, heat, explode, or catch on fire.
Do not let the terminal ends (+/-) of the battery come into contact with any metals.
Do not carry or store it with any metal objects such as jewelry or hair pins. It will short-circuit the battery, leading it to emit high voltage current and causing it to swell, heat, explode, or catch on fire.
Do not apply blunt force or throw it. It will damage and cause the battery to swell, heat, explode, or catch on fire.
Do not nail, hammer, or step on it. It will

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undermine the physical integrity of the battery, and may cause it to swell, heat, explode, or catch on fire.

Do not heat or solder the battery directly. Insulation will melt and be damaged by heat, causing the battery to swell, heat, explode, or catch on fire.

Do not use with disposable batteries or other batteries with different capacity, type, or brand. The resulting emission of excess voltage and overcharging may trigger abnormal chemical reaction inside the battery, causing it to swell, heat, explode, or catch on fire.

Do not disassemble or modify the battery.

- ① Use a proper charger with specified voltage and current. The recommended voltage accuracy of the charger is $4.20V \pm 0.3mV$ / Cell. Standard charging time takes about 4.0 hours. (Standard Charging : CC/CV 1/3 CA, 4.2V, 0.05 CA Cut-off)
- ② For over-discharged cells or batteries, you need to begin charging them by applying micro voltage. Rapid charging may lower their performance.

Cautions for Discharging

Avoid over-discharging the battery below the standard voltage (2.5V). Over-discharging may lower the performance of battery or cause swelling.

12. SKI Contact Information

- ① Marketing Team, Battery Biz Unit
Tel: +86-186-1018-2955
Responsible Person: Haifeng Li
- ② Quality Assurance Team, Battery Biz Unit
Tel: +82-41-950-8108
Responsible Person: Sangmok Lee

7. Repair and Maintenance Recommendations

- ① If not used for an extended period of time, your battery may not be charged fully. If you intend not to use the battery for a long period, charge it fully once every six months.
- ② When the terminal ends of the battery get dirty, clean them with a dry cloth and then use. If the connection with the device is poor, electricity may be interrupted or the battery may not be charged.

8. How to Handle Troubles

- ① While using or storing the battery, if you detect any strange odor, heat, discoloring, or physical alteration, or any aspect that appears different from your usual use, remove the battery from your device or charger and stop using it. Continuing to use under such conditions may cause the battery to heat, explode, or catch on fire. In addition, if charging is not completed even after sufficient time has gone by, stop charging.
- ② If you detect any leakage or strange odor, immediately move the battery away from any source of open fire. The spilled battery liquid may ignite and cause the battery to explode or catch on fire.
- ③ If the battery leaks and your eyes come into contact with its liquid, do not rub but rinse thoroughly with clean water, and seek doctor's help immediately. Your eyes may get damaged if you do not take these precautions.
- ④ If the battery leaks and its liquid come into contact with your skin or clothes, immediately wash with clean water, as the failure to do so can damage your skin.
- ⑤ In case of ingestion, Dilute by giving plenty of water and get immediate medical attention. Assure that the victim does not aspirate vomited material by use of positional drainage. Assure that mucus does not obstruct the airway.
- ⑥ In case of inhalation, Move to fresh air and ventilate the contaminated area. Give oxygen or artificial respiration if needed.
- ⑦ In case of electrolytes being spilled out of batteries onto the floor, Wipe up and wash with large amounts of water.

9. Cautions for Disposing Depleted Batteries

- ① When disposing depleted or damaged batteries, please make sure to tape over their terminal ends (+/-) or dispose them by placing each of them separately in a plastic bag.
- ② Do not burn when disposing. It may explode if placed into fire.

10. Cautions for Charging