Hazard Analysis of Battery Leakage

China
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Contents

1.Background

Classification of Battery Leakage Hazard

- Liquid leakage（Completed in Phase 1）
- **Solid leakage**（Further research is needed）
- Gas leakage

  Gas production during battery use（JRC is in progress）

  Gas production during combustion（Further research is needed）

The main leakage of battery during combustion is toxic smoke

1.Background

The importance of toxic smoke hazard was proposed in ECE/TRANS/180/Add.20

I. A. 4. This United Nations Global Technical Regulation (UN GTR) introduces performance-oriented requirements that address potential safety risks of EVs while in use and **after a crash event**, including electrical shocks associated with the high voltage circuits of EVs **and potential hazards associated with lithium-ion batteries** and/or other Rechargeable Electrical Energy Storage Systems (REESS) (in particular, containing flammable electrolyte)

C. 1. 14. Quantification of venting for tests addressing **safety of REESS post-crash**;
C. 1. 15. Potential risk of **"toxic gases"** from non-aqueous electrolyte

F. 1. 240. Focus topics for Phase 2 are expected to include**:(e)flammability, toxicity and corrosiveness of vented gas** (e.g. quantification of venting for tests addressing safety of REESS post-crash, potential risk of 'toxic gases' from non-aqueous electrolyte);

II. 7.3 Requirements with regard to the safety of REESS - in-use.During the test, there shall be no evidence of **electrolyte leakage,** rupture (applicable to high voltage REESS only), venting (for REESS other than open-type traction battery), **fire or explosion**.

Toxic Smoke is the Key Research Content of Battery Leakage in Phase 2.

2.Sources of Toxic Smoke in EV

Toxic smoke is generated by continuous high temperature reaction of battery pack components, such as cables, glue, electrolyte and separator.

The high temperature reaction can be triggered by short circuit, combustion, thermal runaway, etc.

3.Differences of Toxic Smoke between EVs and Vehicles

Gasoline combustion (C,H,O compounds)

表 2　120#溶剂汽油燃烧烟尘的化学成分

序号	保留时间/min	化合物种类	化合物名称	分子式	峰面积百分比/%
1	3. 208	单环芳烃及其衍生物	甲苯	C_7H_8	25. 323
2	4. 679		乙苯	C_8H_{10}	2. 906
3	4. 815		对二甲苯	C_8H_{10}	7. 944
4	5. 194		苯乙烯	C_8H_8	1. 680
5	5. 237		间二甲基苯	C_8H_{10}	2. 323
6	6. 485		1-乙基-2-甲基苯	C_9H_{12}	0. 944
7	7. 070		1,2,3-三甲基苯	C_9H_{12}	1. 051
8	7. 602		1,2,4-三甲基苯	C_9H_{12}	0. 184
9	8. 707		1-甲基-2-甲基乙基苯	$C_{10}H_{14}$	0. 479
10	9. 316		1,2,3,4-四甲基苯	$C_{10}H_{14}$	0. 562
11	16. 751		二甲苯基醚同系物	$C_{14}H_{14}O$	1. 374
12	17. 271			$C_{14}H_{14}O$	8. 269
13	17. 601			$C_{14}H_{14}O$	3. 751
14	18. 110			$C_{14}H_{14}O$	10. 052
15	18. 373			$C_{14}H_{14}O$	9. 467
16	10. 421	稠环芳烃及其衍生物	萘	$C_{10}H_8$	2. 813
17	12. 172		2-甲基萘	$C_{11}H_{10}$	1. 144
18	12. 456		1-甲基萘	$C_{11}H_{10}$	1. 762
19	14. 146		2,6-二甲基萘	$C_{12}H_{12}$	0. 613
20	14. 458		1,6-二甲基萘	$C_{12}H_{12}$	0. 457
21	14. 531		1,4-二甲基萘	$C_{12}H_{12}$	0. 391
22	21. 743		蒽	$C_{14}H_{10}$	1. 032
23	17. 836		芴	$C_{13}H_{10}$	0. 513
24	13. 620	联苯及联苯撑脂肪烃及其衍	联苯	$C_{12}H_{10}$	0. 342
25	15. 099		联苯撑	$C_{12}H_8$	3. 183
26	10. 553		十二烷	$C_{12}H_{26}$	1. 166
27	12. 099		十三烷	$C_{13}H_{28}$	0. 271
28	13. 833		十四烷	$C_{14}H_{30}$	1. 610
29	17. 944		十六烷	$C_{16}H_{34}$	2. 117
30	18. 939		十七烷	$C_{17}H_{36}$	0. 665
31	19. 956		十八烷	$C_{18}H_{38}$	0. 663

Battery pack combustion (C,H,O,N,S compounds)

No.	Compound
1	2-Propenal (C_3H_4O)
2	Propanedinitrile ($C_3H_2N_2$)
3	Propanenitrile (C_3H_5N)
4	Naphthalene ($C_{10}H_8$)
5	Carbonyl sulfide (COS)
6	Butane, 1-isocyanato- (C_5H_9NO)
7	Oxirane, ethyl- (C_4H_8O)
8	1,3-Pentadiene （C_5H_8）
9	1-Butanamine ($C_4H_{11}N$)
10	1,3-Cyclopentadiene (C_5H_6)
11	2-methyl-2-Propanamine ($C_4H_{11}N$)
12	Propyleneoxide （C_3H_6O）
13	Sulfur dioxide (SO_2)
14	2-Butene （C_4H_8）
15	1,4-Dioxane ($C_4H_8O_2$)
16	Benzene(C_6H_6)

- Quantitative comparison of toxicity between EVs and Vehicles needs further research

4.Hazard situations of Toxic Smoke

Direct Hazard

（1）Obstacles to escape & rescue : If driver or passengers are injured in car accident and can't escape by themselves, it will take 20-60 mins to rescue. Toxic smoke leaking from battery packs may cause dizziness or death to passengers and rescuers (especially in buses).

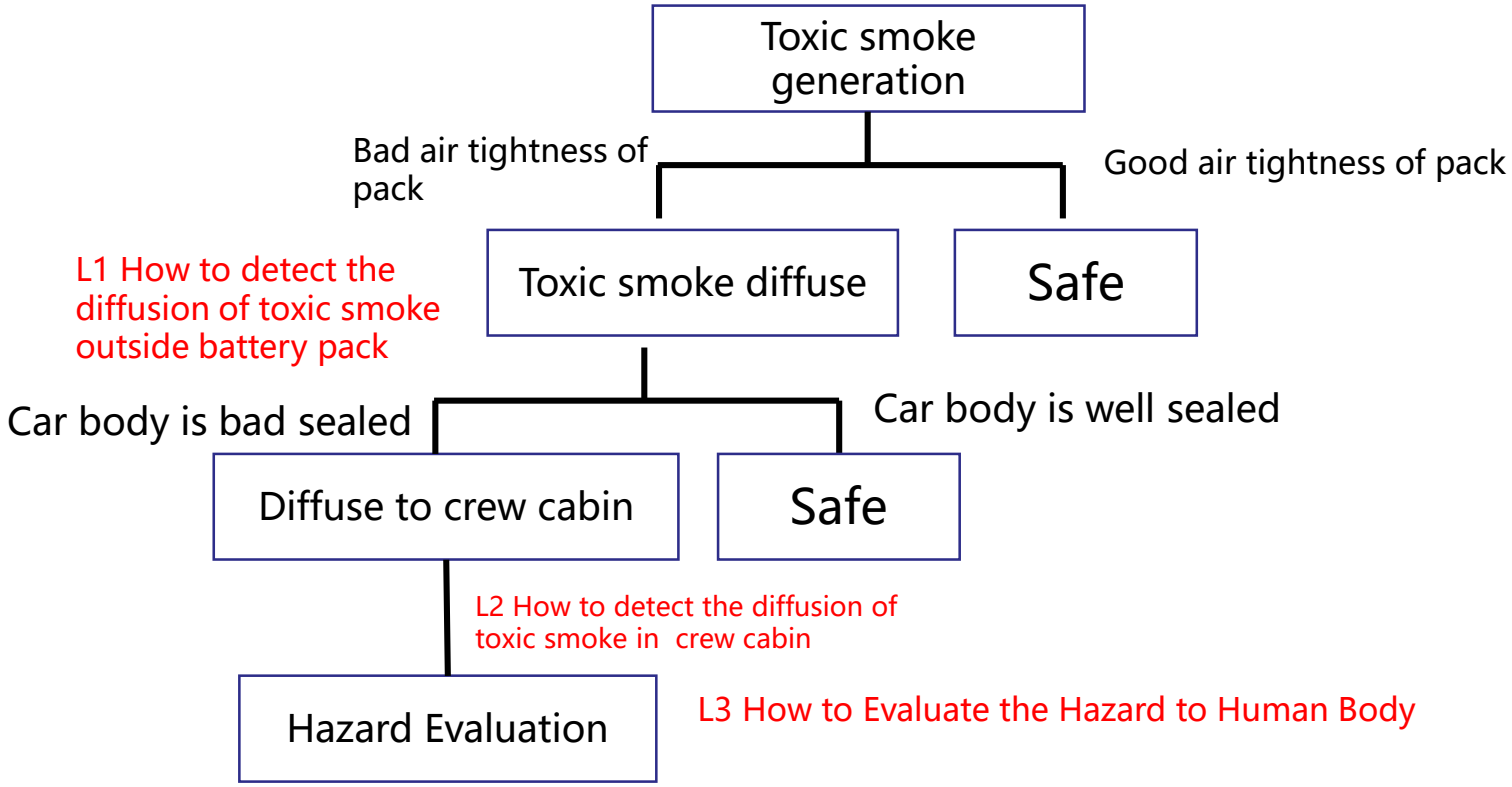
（2）Affecting driving: Battery internal failure will cause leakage of toxic smoke. If the driver and passengers unaware of that, the driver may faint in driving and leading to traffic accidents.

Indirect Hazard

（1）Air pollution: When battery pack is caught fire, a large number of toxic smoke will pollute the surrounding air.

（2）Dust explosion: Spreading toxic smoke may trigger large-scale dust explosion in a closed/semi-closed space.

5.Framework of Toxic Smoke Testing



1 2 3 Warning Level of Toxic Smoke

- L1: Safe——Stop driving,examine and repair
- L2: Safe——Stop driving,flee immediately
- L3: Asphyxia，dizziness，toxicosis

6.Research Contents of Toxic Smoke

(1) Analysis of Toxic Smoke Components

- Mechanism of toxic smoke generation
- Different Cathode/Anode material
- Different temperature

(2) Test and Evaluation of Toxic Smoke

- Detection Method of L1
- Detection Method of L2
- Quantitative Evaluation of L3

(3) Toxic Smoke Suppression Method

- Emergency Treatment of Toxic Smoke Leakage
- Design of Reducing Toxic Smoke Generation
- Design of Toxicity Reduction