Air regulations on Lithium batteries

2016. 10. 04

Choi Sung Eun
Senior Technician

Korea Conformity Laboratories
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1. Background and Cases (배경 및 사례)
2. Air transportation regulation (항공운송 시 규제)
3. Air transportation pre-test (항공운송 시 사전시험)
4. Air transportation dangerous goods package inspection (항공위험물 포장용기 검사)
1. Background and Cases

Accidental cases

UPS airplane accident
(Boeing 747-44AF)

- Date: September 3rd, 2010
- Location: Dubai International Airport → Cologne Bonn Airport
- Details: Explosion during flight after 50 minutes from take-off. All crews deceased.
- Note: Unreported lithium battery loaded at Dubai. Fire started during take-off.
- Cause: UAE Civil Aerial Organization announced the cause to be fire from Lithium ion battery.
Accidental cases

Asiana airlines accident

- **Date:** July 28th, 2011
- **Location:** Inchon international airport → Pudong International Airport
- **Details:** Received fire detection after 50 minutes from take-off.
  No contact after 1 hour from take-off.
  All crews deceased.
- **Note:** Includes lithium ion battery, paint, amino acid, 400 kg of synthetic resin.
- **Cause:** “Physical evidence of fire was unidentified, but it started from or near the pallet containing dangerous goods. Fire spread too fast to suppress, partial fuselage disintegrated and the aircraft fell.”

*Source: Ministry of Land, Infrastructure and Transport*
Risk of Li-ion battery

Li-ion battery

- Highly reactive metals → Explosion risk
- Due to melting point of approx. 180°C, possible melting after extinguished.
- Heat from spontaneous ignition of one battery may cause series of ignition of nearby batteries.
- Transportation through aircraft may cause serious safety issues.

Must be verified prior to air transportation
# 2. Air Transportation Regulation

## Undeclared Dangerous Goods Example

<table>
<thead>
<tr>
<th>No.</th>
<th>Classification</th>
<th>Date</th>
<th>Airline</th>
<th>Departures / Arrivals</th>
<th>Shipper</th>
<th>Substance (UN Number)</th>
<th>Location</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cargo (Export)</td>
<td>’16.2.19</td>
<td>Asiana</td>
<td>Incheon /Germany</td>
<td>Kukdo Chemical Co., LTD.</td>
<td>Flammable liquids (UN1866)</td>
<td>Germany (Leak solution)</td>
<td><img src="source" alt="Photo" /></td>
</tr>
<tr>
<td>2</td>
<td>Cargo (Export)</td>
<td>’15.12.9</td>
<td>FedEx</td>
<td>Incheon /Singapore</td>
<td>Boram Co., LTD.</td>
<td>Lithium Batteries (UN3480)</td>
<td>Singapore</td>
<td><img src="source" alt="Photo" /></td>
</tr>
<tr>
<td>3</td>
<td>Cargo (Transshipment)</td>
<td>’15.9.6</td>
<td>Asiana</td>
<td>Hong Kong /Incheon</td>
<td>Shenzen E-City</td>
<td>Lithium Batteries (UN3480)</td>
<td>Korea</td>
<td><img src="source" alt="Photo" /></td>
</tr>
</tbody>
</table>

*Source: Ministry of Land, Infrastructure and Transport*
## Air Transportation Regulation

### Undeclared Dangerous Goods Example

<table>
<thead>
<tr>
<th>No.</th>
<th>Classification</th>
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<th>Location</th>
<th>Photo</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Cargo (Export)</td>
<td>‘12.4.4</td>
<td>Asiana</td>
<td>Incheon /Hong Kong</td>
<td>Renault Samsung</td>
<td>Wet Batteries (UN2794)</td>
<td>Hong Kong</td>
<td><img src="image" alt="Battery" /></td>
</tr>
<tr>
<td>5</td>
<td>Cargo (Import)</td>
<td>‘12.3.24</td>
<td>Polar</td>
<td>USA/Incheon</td>
<td>Class Molding</td>
<td>Lithium Batteries (UN3480)</td>
<td>Korea</td>
<td><img src="image" alt="Battery" /></td>
</tr>
<tr>
<td>6</td>
<td>passenger</td>
<td>‘15.10.21</td>
<td>Asiana</td>
<td>Incheon /Vietnam</td>
<td>Vietnam Nationality</td>
<td>Lithium Batteries (UN3480)</td>
<td>Korea</td>
<td><img src="image" alt="Battery" /></td>
</tr>
<tr>
<td>7</td>
<td>passenger</td>
<td>‘12.8.5</td>
<td>Asiana</td>
<td>Incheon /USA</td>
<td>Korea Nationality</td>
<td>Sodium hydroxide (UN1823)</td>
<td>Korea</td>
<td><img src="image" alt="Battery" /></td>
</tr>
</tbody>
</table>

*Source: Ministry of Land, Infrastructure and Transport*
2. Air Transportation Regulation

Air transportation regulation of lithium battery

Announcement of lithium-ion battery’s regulation (ICAO)

- Lithium battery Prohibition of lithium-ion battery that is transported outside of a device on passenger aircraft.

- According to UN 3480, PI 965, Section 1A and Section 1B, Lithium-ion cell and battery limited to 30% SOC of rated capacity.

  \(<SOC : \text{State Of Charge}>\)

- (Recommended) Effective April 1, 2016
## 2. Air Transportation Regulation

### Related Organization
- **International Regulation**
  - Recommendations on the Transport Dangerous Goods (위험물 운송에 관한 규정)
  - TI (기술지침) DGR (위험물운송규정)
- **Domestic Regulation**
  - Adopt international regulation
  - Aviation Act
  - Dangerous Air Transportation Regulation

### Tests conducted in accordance with MOLIT (Ministry of Land, Infrastructure and Transport)’s

<table>
<thead>
<tr>
<th>Related Organization</th>
<th>International Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>국가연합본부(UN)</td>
<td>Recommendations on the Transport Dangerous Goods (위험물 운송에 관한 규정)</td>
</tr>
<tr>
<td>ICAO</td>
<td>TI (기술지침) DGR (위험물운송규정)</td>
</tr>
<tr>
<td>IATA</td>
<td>Adoption of International regulation</td>
</tr>
<tr>
<td>Aviation Act</td>
<td>Dangerous Air Transportation Regulation</td>
</tr>
</tbody>
</table>

Tests conducted in accordance with MOLIT (Ministry of Land, Infrastructure and Transport)’s
2. Air Transportation Regulation

Domestic air transportation regulation of lithium battery

Strengthening of MOLIT’s safety control of aviation hazardous material

- Composition of private and public task force Team for safety control of aviation hazardous material
  (Kick off meeting. On March 25, 2016)

- Background: Necessity to strengthen safety control of aviation hazardous material regarding continuous shipping case exposure of undeclared hazardous material
  - Penalty effectiveness of violation of Aviation hazardous material’s regulation
  - Subdivision of penal provision and increasing penalty charge
3. Pre-test for air transportation

Pre-test for air transportation

Performance test

Marking for transportation

Lithium Ion Batteries Contained in Equipment

- Cells greater than 20 Wh, and Batteries greater than 100 Wh
  - UN3481
  - PI 967
  - Section I
  - IMP: ELI
  - Limit per package: Pax A/C = 5 kg
  - CAO = 35 kg

- Cells equal to or less than 20 Wh, and Batteries equal to or less than 100 Wh
  - UN3481
  - PI 967
  - Section II
  - IMP: ELI
  - Limit per package: Pax A/C = 5 kg
  - CAO = 5 kg

Lithium Ion Batteries (limited to a maximum of 30% SoC)

- Cells greater than 20 Wh, and Batteries greater than 100 Wh
  - UN3480
  - PI 965
  - Section I
  - IMP: ELI
  - Limit per package: Pax A/C = Forbidden
  - CAO = 35 kg

- Cells ≤ 20 Wh, and Batteries ≤ 100 Wh
  - UN3480
  - PI 965
  - Section II
  - Limit per package: (not more than 1 package)
    - ≤ 2.7 Wh: ≤ 2.5 kg, or cells ≤ 2.7 Wh ≤ 20 Wh = 8 cells; or batteries > 2.7 Wh ≤ 100 Wh = 2 batteries
    - ≤ 100 Wh = 2 batteries

- Cells equal to or less than 20 Wh, and Batteries equal to or less than 100 Wh
  - UN3481
  - PI 966
  - Section I
  - Limit per package: Pax A/C = 5 kg
  - CAO = 5 kg

Lithium Ion Batteries Packed With Equipment

* exceptions exist to the labelling requirements – see PI 967 Section II
3. Pre-test for air transportation

- Section 38.3 of ‘UN Manual of Test and Criteria mentions about testing of Lithium ion cell and batteries.

- Currently the Product complied with UN 38.3 can be transported by air.

- But, prototype or low productivity (less than 100 cell or batteries) exempted UN 38.3 test and transported with permission from ministry of land, infrastructure and transportation according to A88 exception.

Department: Electric & Electronic Team
Researcher: Mun Jong Geun, Senior researcher.
199, Gasan digital 1-ro, Geumcheon-gu, Seoul, Korea
Tel. 02-2102-2793
### 3. Pre-test for air transportation

#### UN Manual of Test and Criteria’s section 38.3

<table>
<thead>
<tr>
<th>Test items</th>
<th>Cell</th>
<th>Small Batteries (Less than 12 kg, 6200 Wh)</th>
<th>Large Batteries (More than 12 kg, 6200 Wh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T.1 Altitude simulation</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>T.2 Thermal</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>T.3 Vibration</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>T.4 Shock</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>T.5 External Short Circuit</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>T.6 Impact / Crush (Pouch cell is applied Crush Test)</td>
<td>○</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>T.7 Overcharge</td>
<td>X</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>T.8 Forced overcharge</td>
<td>○</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

**Criteria:**

No leaking, venting, rupture. No fire, No disassembly
3. Pre-test for air transportation

T.1 Altitude simulation (고도시험)
- **Purpose**: Air shipping low pressure environment condition
- **Test detail**: Cell, Battery stored in decompression chamber and then tested

T.2 Thermal Test (열충격 시험)
- **Purpose**: Through rapid change in temperature, internal electrical binding and property of cell and battery tested

T.3 Vibration (진동시험)
- **Purpose**: Simulate the vibration condition during transportation
- **Test detail**: 3 axes (X, Y, Z) direction, sine wave, 12 cycles

T.4 Shock (충격시험)
- **Purpose**: Simulate the shock during transportation
3. Pre-test for air transportation

T.5 External Short Circuit (외부단락시험)
◆ Purpose: Simulate the short circuit during transportation

T.6 Impact / Crush (충돌/압축)
◆ Purpose: Simulate the impact during transportation

T.7 Overcharge (과충전)
◆ Purpose: Testing the capability of overcharge condition

T.8 Forced Discharge (강제방전)
◆ Purpose: Testing the capability of forced discharge condition
4. Air transportation dangerous goods pkg. inspection
4. Air transportation dangerous goods pkg. inspection

Registration Condition: Assigned ID to the specialized company in packaging with 2 people completed air transportation dangerous goods training.

Test item: Appearance, marking, construction, size, drop test, layer stack test, water resistance, spill resistance, Internal pressure, etc.

Test duration: 24 h and 28 day.

Certificate label provided (refer to below image).

<Inspection Application>
Purpose: Packaging drop test which is one of UN transportation test, test the PKG during transportation

Test Condition

- height: 1.2 m, no. of drops: 5 Times (one for each drop)
- First drop: flat on the bottom
  Second drop: flat on the top
  Third drop: flat on the long side
  Fourth drop: flat on the short side
  Fifth drop: on the corner

Criteria

- No internal Content out of PKG box
4. Air transportation dangerous goods pkg. inspection

Packaging Performance test (Stacking test)

- **Purpose**: Stacking test which is one of UN transportation test, test the PKG during transportation

- **Criteria**
  - No internal Content out of PKG box

Packaging Performance test (Water Resistance)

- **Purpose**: Water resistance test which is one of UN transportation test, test the PKG during transportation

- **Criteria**
  - more than 155 g/m²
4. Air transportation dangerous goods pkg. inspection

Example of Lithium-ion battery PKG

Sample Packaging: Lithium Batteries
Blister Pack
Cushioning
Divider

Best practice recommended by IATA
4. Air transportation dangerous goods pkg. inspection

Example of Lithium-ion battery PKG
4. Examples

Fibreboard box

Fibreboard box - internal

Fibreboard box

Fibreboard box - internal
4. Examples

- Plywood box
- Plywood box - internal
- Fibreboard box
- Fibreboard box – internal
4. Examples

- Plywood box
- Plywood box – internal
- Fibreboard box
- Fibreboard box – internal
### 5. Conclusion

- Transportation of Li-ion battery through aircraft may cause serious safety issues.
- Must be verified prior to air transportation.
- Lithium-ion cell and battery limited to 30% SOC of rated capacity. (ICAO)
- Must be declared Dangerous Goods for safety.

Safe air transportation can be completed if the regulation was observed well.
Thank you

Korea Conformity Laboratories
항공위험물 포장용기 검사 업무 안내

담당부서: 패키징기술센터
담당연구원: 최성은, 유병열, 박상미
사업장 주소 및 연락처: 서울시 금천구 가산디지털 1로 199 운송시험실
/ 02-2102-2775
출장소 주소 및 연락처: 서울시 강서구 하늘길 210 한국공항공사(김포공항청사) 344-3호
/ 02-2666-9053
KCL은 항공으로 운송되는 항공위험물의 안전성 검사를 전문적으로 하는 위험물 포장 용기 검사기관으로서의 역할을 하고 있다.

주요 연혁

2016 [09.19] 김포공항화물청사 현장검사 사무실 설치

2016 [01.02] 위험물취급포장용기검사 담당부서 변경 (담당부서 : 패키징기술센터)

2015 KOLAS 인정 (1.013 물리적 시험) IATA DGR2015 제KT-002호

2006 [10.18] 위험물취급포장용기검사관리 지정 (담당부서 : 포장물류팀)
KCL은 항공으로 운송되는 항공위험물의 안전성 검사를 전문적으로 하는 위험물 포장 용기 검사기관으로써의 역할을 하고 있다.

### 검사 사무실

- 위치: 서울시 금천구 가산디지털 1로 199 운송시험실 내
- 장비: 소형물낙하시험기 외 8대
- 검사원인력: 박상미 선임기술원
  유병열 선임시험원
  최성은 선임시험원
- 주요 업무: 항공위험물 검사 신규/기신청의 시험검사 및 검사증/검사필증 발급

### 김포공항 화물청사 내 사무실

- 위치: 서울시 강서구 하늘길 210 한국공항공사 (김포공항청사) 344-3호
- 상주인원: 검사원 1명씩 교대 근무
- 임대면적: 43.89㎡
- 임대기간: 2016년 8월 22일~2017년 12월 31일
- 임대료: 5,948,040원/년 (단, 2016년에는 2,456,210원)
- 주요 업무: 항공위험물 기신청 검사 및 검사증/검사필증 발급
제3항

KCL은 항공으로 운송되는 항공위험물의 안전성 검사를 전문적으로 하는 위험물 포장용기 검사기구로써의 역할을 하고 있음.

항공위험물 관련 기구

국제연합본부(UN)  

국제민간항공기구(ICAO) Technical Instruction

국제항공운송협회(IATA)

항공위험물운송기술기준

항공위험물 운송 절차도

포장업체는 시험/검사완료 후 검사증 및 검사필증을 받아 항공사로 바로 가져가 운송하므로 업무절차가 신속하게 처리되고 있음.

국토교통부의 항공위험물운송기술기준에 따라 시험을 진행하고 있음.
4. 주요업체현황

KCL은 항공으로 운송되는 항공위험물의 안전성 검사를 전문적으로 하는 위험물 포장 용기 검사기관으로써의 역할을 하고 있다.

의뢰업체 리스트 (16업체)

ImDG 주식회사
아이진수출포장
세이프지 얼레스
㈜제이와이에스
에어비즈니스
디지월드넷서비스
대국수출포장
진성물류
디지씨티
세운지얼레스
화산수출포장
디지카고
디지프렌드 로지스틱스
써엔씨에어로지스
헨켈테크놀러지스(유)
디지알 서비스 주식회사

항공위험물 포장전문업체 분포도
Thank you

한국건설생활환경시험연구원