Investigation Report

The Investigation Report was written in accordance with para 18 Law Relating to the Investigation into Accidents and Incidents Associated with the Operation of Civil Aircraft stating facts only.

Identification

Type of Occurrence: Serious incident
Date: 21 August 2018
Location: Frankfurt Main Airport
Aircraft: Airplane
Manufacturer / Model: Airbus Industries/A320
Injuries to Persons: One person suffered minor injuries
Damage: Aircraft not damaged
Other Damage: None
State File Number: BFU18-1272-FX

Factual Information

During approach to runway 07 of Frankfurt/Main Airport, at an altitude of about 2,200 ft AMSL, great heat and smoke developed at a battery charger of a passenger. One flight attendant used a Halon fire extinguisher. The battery charger was cooled and then stowed in one of the lavatories. There was no open fire.
History of the Flight

On 21 August 2018 the occurrence flight departed, Portugal, for a flight to Frankfurt/Main, Germany. Six crew members and 168 passengers were on board.

At about 1242 hrs\(^1\), the aircraft was on approach to runway 07L, in approximately 2,200 ft AMSL\(^2\), when smoke development of a battery charger was discovered.

The following course of events is based on the written report of the flight crew.

Shortly before landing, approximately 6 NM prior to runway 07L, a passenger noticed smoke development of a battery charger in her carry-on luggage. She tried to remove the battery charger. Due to the great heat this was not possible. The cabin crew noticed the smoke also. The flight attendant applied the fire protection procedure using a Halon fire extinguisher. Then she cooled the charger with water and stored the carry-on in a trash can in the aft left lavatory.

The flight attendant informed the cockpit crew about the incident after the landing at the parking position. Subsequently, the cockpit crew informed the Tower and requested the airport fire brigade and medical care. A short time later, an airport fire fighter boarded the airplane but did not find any fire or smoke. The airplane was not damaged. The airport fire brigade sized the carry-on luggage, including the battery charger, and turned it over to the BFU.

The passenger suffered minor injury on her hand and was treated on site by a physician.

Personnel Information

Pilot in Command

The 35-year-old pilot in command was deployed as captain under supervision (training). He held an Airline Transport Pilot’s Licence (ATPL(A)) issued in accordance with Part-FCL (Flight Crew Licensing) on 8 September 2016 by the Portuguese Civil Aviation Authority.

\(^1\)All times local, unless otherwise stated.
\(^2\)Above Mean Sea Level
The licence listed the following ratings:

**Aircraft Type:**  **Valid:**

- Airbus A340  
  28 February 2019
- Airbus A330/350  
  31 August 2018
- SEP\(^3\) (Land)  
  30 April 2019
- IR (ME)\(^4\)  
  31 August 2018

The BFU was provided with a class 1 medical certificate, valid until 3 March 2019. The PIC stated that he had a total flying experience of 6,736 hours, of which 4,450 hours were flown on A320.

**Co-pilot**

The 47-year-old co-pilot was a training captain during this flight. He held an ATPL(A) issued on 6 April 2017 in accordance with Part-FCL by the Portuguese Civil Aviation Authority.

The licence listed the following ratings:

**Aircraft Type:**  **Valid:**

- Airbus A320  
  28 February 2019
- TRI\(^5\) (MPA) Airbus A320  
  31 March 2020
- IR (ME)  
  28 February 2019

The BFU was provided with a class 1 medical certificate, valid until 13 February 2019. The co-pilot stated that he had a total flying experience of 9,654 hours, of which 8,279 hours were flown on A320.

**Purser**

The Flight Safety Department of the operator stated that the flight attendant had a total flying experience of 10,144 hours, of which 2,330 hours were accumulated on A320.

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\(^3\) Single Engine Piston  
\(^4\) Instrument Rating; Multi-Engine  
\(^5\) Type Rating Instructor; Multi Pilot Aeroplanes
Aircraft Information
The A320 is a transport aircraft equipped with two fan jet engines. It is used as short and medium range aircraft.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Airbus Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>A320</td>
</tr>
<tr>
<td>Year of manufacture</td>
<td>1999</td>
</tr>
<tr>
<td>MSN (Manufacturer Serial Number)</td>
<td>960</td>
</tr>
<tr>
<td>Operating Time</td>
<td>66,369 hours</td>
</tr>
<tr>
<td>Landings</td>
<td>33,176</td>
</tr>
<tr>
<td>Maximum take-off mass</td>
<td>75,000 kg</td>
</tr>
</tbody>
</table>

Meteorological Information
At the time of the incident it was daylight. According to the aviation routine weather report (METAR) of Frankfurt/Main Airport at 1220 hrs horizontal visibility was more than 10 km. Wind with 3 kt from various directions. Cloud cover was 1/8–2/8 at 4,300 ft GND. Temperature was 27°C, dewpoint 14°C, and air pressure (QNH) 1,020 hPa.

Aerodrome Information
Frankfurt/Main Airport (EDDF) is located 12 km south-west of Frankfurt. Aerodrome elevation is 364 ft AMSL. Runway 07L has a concrete surface and the orientation 67°. Its dimensions: 2,800 long and 44 m wide.

Flight Recorders
The BFU was provided with the recorded data of the Quick Access Recorder.

Fire
During the flight, great heat and smoke developed in a battery charger of a passenger. According to the report of the purser there was no open fire.

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6 Ground
The defective battery charger was examined at the BFU laboratory. It was an accumulator with a capacity of 2,200 mAh / 8.1 Wh and a voltage of 3.7 V. It was approximately 10 cm long and had a diameter of about 2 cm.

A so-called thermal runaway of the lithium battery was identified as the cause of the heat development.

Fig. 1: Damages on the battery charger

Source: BFU
Organisation and Procedures of the Operator

The operator’s Operating Manual (OM) for the cabin crew Cabin Crew Airline Policy defines in chapter Guidelines for In-Flight Fumes, Smoke and Fire Management in the checklist Abnormal/Emergency Procedure – Fire Protection of 14 February 2017 the handling of lithium batteries on board.

Fig. 2: OM - Cabin Crew Airline Police, Abnormal/Emergency Procedures – Fire Protection
Source: Operator/BFU
Carrying Batteries on Board an Aircraft

The operator allowed passengers to carry electronic devices which had a maximum battery capacity of 100 Wh on board an airplane. In the OM Part A chapter 9.01 DANGEROUS GOODS AND WEAPONS – CARRIAGE OF DANGEROUS GOODS of 15 may 2018 page 6 depicted a table with the respective dangerous goods, which were allowed on board carried by passengers and crew - Table 9.1 A - Provisions for Dangerous Goods Carried by Passengers or Crew.

![Table 9.1 A - Provisions for Dangerous Goods Carried by Passengers or Crew](image)

Fig. 3: Table 9.1 A - Provisions for Dangerous Goods Carried by Passengers or Crew

Source: Operator/BFU
Additional Information

The following table lists all occurrences reported to the BFU which are connected to Lithium batteries and occurred in European Airspace. The following table lists the occurrences from the ECCAIRS\textsuperscript{7} data base. The respective descriptions were not changed.

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Occurrence/Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 May 2014</td>
<td>Aircraft in cruise flight</td>
<td>Potential fire risk from mobile phone (PED).</td>
</tr>
<tr>
<td>3 July 2016</td>
<td>Aircraft in cruise flight</td>
<td>Passengers phone (PED) dropped into seat mechanism. Fire risk</td>
</tr>
<tr>
<td>9 March 2016</td>
<td>KEWR (EWR)</td>
<td>Passengers IPod (PED) trapped in seat mechanism.</td>
</tr>
<tr>
<td>21 June 2016</td>
<td>Aircraft in cruise flight</td>
<td>Dropped phone (PED) causing smoke and fire.</td>
</tr>
<tr>
<td>28 September 2016</td>
<td>EGKK (LGW)</td>
<td>Lithium battery fire in PED at holding point of runway.</td>
</tr>
<tr>
<td>11 September 2017</td>
<td>LFLL (LYS)</td>
<td>Lithium battery phone charger burned.</td>
</tr>
<tr>
<td>1 April 2018</td>
<td>Aircraft in cruise flight</td>
<td>Passenger IPad caught fire.</td>
</tr>
<tr>
<td>1 April 2018</td>
<td>EGLL (LHR)</td>
<td>Passenger PED caught fire.</td>
</tr>
<tr>
<td>6 May 2018</td>
<td>Aircraft in cruise flight</td>
<td>E-cigarette lithium battery fire.</td>
</tr>
<tr>
<td>31 May 2018</td>
<td>EGLL (LHR)</td>
<td>Battery of crushed PED caught fire during removal by engineer.</td>
</tr>
<tr>
<td>4 July 2018</td>
<td>LIMC (MXP)</td>
<td>Lithium battery fire from an item in overhead locker.</td>
</tr>
</tbody>
</table>

Tab 1: ECCAIRS occurrences involving Lithium batteries

European Aviation Safety Agency information regarding Lithium batteries

In September 2017 the European Aviation Safety Agency (EASA) issued “More practical information - Lithium batteries” on their website:

\textit{What are lithium batteries?}

\textit{Lithium batteries are mainly of two types: lithium metal batteries and lithium ion batteries. Basically, the difference between them is that lithium metal batteries are those that are not rechargeable, thus, primary, and lithium ion batteries are those that can be recharged. As an example, your laptop or cell phone is likely to have a lithium ion battery, whereas your watch may have a lithium metal battery.}

\textit{What are the risks?}
If damaged, short-circuited, heated, or sometimes because of a bad design, batteries may catch fire and explode. This is a particularly dangerous situation that must be avoided at all cost during the flight.

How to understand which ones are allowed

You are allowed to carry portable electronic devices (such as watches, cameras, phones, laptops…) that contain lithium metal or ion cells or batteries for your personal use under the following conditions:

- They should be carried in your carry-on luggage, although they may be in your checked baggage if needed as long as you take measures to prevent unintentional activation.

- The battery must not exceed a Watt-hour (Wh) rating of 100 Wh or 2 grams of lithium content (the first limit is for rechargeable lithium-ion batteries and the second for lithium metal batteries, which are usually not rechargeable). To calculate Watt-hours, just multiply the battery voltage by the Amp hours (Ah), as the Wh rating is not marked on them.

- If the Wh is higher than 100 but not higher than 160, you will need an approval from the operator to carry the item. It is not allowed to transport any item which battery exceeds 160 Wh.

You may also carry spare batteries or a power bank for these devices for your personal use. However, these may never be in your checked baggage and they must be individually protected to prevent short circuits (with insulating the terminals with tape, putting each battery in a plastic bag, or using any other appropriate way). The limits in terms of Wh and lithium content are the same as above.

Also, spare batteries, including power banks, should not be recharged while on board the aircraft. Additionally, power banks should not be connected or providing power to a device while on board the aircraft.

All batteries must have been properly tested in accordance with the United Nations Manual of Test and Criteria. To ensure this, buy all your batteries from original retailers and avoid purchasing cheap articles from untrustworthy sources.

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8 https://www.unece.org/trans/danger/publi/manual/manual_e.html
When you hand your bag at the gate to be put on the hold, please remember to take all your spare batteries and electronic devices out.

How to identify and react if something happens?

The fact that a battery is swollen, too hot or producing smoke is a clear sign that something is wrong with it. If you notice anything different in your battery during the flight or in the airport, you should immediately contact a cabin crew member or a member of the airport’s staff. The temperatures that the battery may reach are quite high. Batteries are usually made of more than one cell. If one of the cells of the battery catches fire, it might spread to adjacent cells, provoking unexpected explosions and unforeseen flames. Do not try to put out the fire yourself, as you may worsen the situation or get hurt. Allow cabin crew to do their job.

Should you lose your device or battery during the flight, immediately call a cabin crew member and do not operate your seat. Moving your seat can damage or crash the battery in the device and this can start a fire.

EASA Safety Information Bulletin Operations

On 11 March 2016 EASA issued the Safety Information Bulletin Operations - No. 2016-04 with the title “Carriage of Personal Transportation Devices” to passenger and freight operators: Excerpt:

**Applicability:**

Operators of Passenger and Cargo Aircraft.

**Description:** Small lithium battery-powered personal transportation devices, also known as hoverboards, self-balancing devices, or gravity boards, are transported in increasing numbers by passengers in checked or carry-on baggage and they are also shipped as cargo.

These devices, which have acquired high popularity recently, should not be mistaken with “mobility aids”. They are “portable electronic devices” and contain lithium ion batteries, the capacity of which is expected to exceed 100 Wh. Besides the risks that lithium batteries normally pose, there is a higher risk with these devices as, in an attempt to reduce the price of the product, many of them are not properly manufactured or tested

[...]
This SIB is issued to provide a recommendation and further clarifications on the applicable provisions for those operators who intend to continue to allow the on-board carriage of these devices, either by passengers, crew, or as cargo.

**Recommendation(s):**

EASA recommends Operators to:

- require passengers to carry such devices in the cabin, where an incident can be immediately mitigated, and not in checked baggage regardless of whether baggage is checked in at the counter, at a selfcheck-in desk, or removed from the passenger at the gate,
- ensure all staff handling such devices are aware of the restrictions that apply,
- ensure that passengers are aware of the restrictions that apply, and
- include these devices within their dangerous goods related procedures, with an explicit mention in their manuals, and provide dedicated training.

Additionally, EASA reminds Operators of the following provisions of the ICAO Technical Instructions that apply to these devices:

- When carried by passengers or crew, devices containing lithium ion batteries having a Watt-hour rating of 100 Wh or less may be permitted under the provisions for portable electronic devices containing lithium metal or lithium ion cells or batteries contained in Part 8 of the Technical Instructions, provided all applicable criteria listed in the restrictions column of Table 8-1 are met. Devices containing lithium ion batteries having a Watt-hour rating exceeding 100 Wh but not more than 160 Wh may be carried subject to an approval by the operator. Those exceeding 160 Wh are not permitted to be carried by passengers or crew.

- When transported as cargo, devices containing batteries must be assigned to UN\(^9\) 3171 - Battery-powered vehicle and are subject to all

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\(^9\) UN numbers that identify hazardous materials, and articles in the framework of international transport.
applicable requirements of the Technical Instructions. Batteries not contained in the device must be consigned as UN 3480 - Lithium ion batteries.

IATA recommendation for cabin crews regarding on-board fire fighting

In May 2017, IATA published “Baggage with Integrated Lithium Batteries and/or Electronics, 1st Edition”. It contains recommendations for passenger and freight operators regarding the transport of Lithium batteries and fire-fighting procedures of the cabin crews. Excerpt:

 […]

Recommendations for Operators

Operators should ensure that airport check-in and passenger services staff and cabin crew are made aware of the potential for items of checked and carry-on baggage to contain lithium battery power banks and tracking devices such as GPS/GSM.

Check-in and passenger services staff and cabin crew should be made aware of the restrictions that apply to the carriage of this smart baggage. Specifically that:

a) All lithium batteries must comply with the limits set out in the DGR\textsuperscript{10} for the watt-hour rating or lithium metal content, as applicable;

b) Any PED\textsuperscript{11} equipped with a power bank offered as checked baggage must have the power bank removed prior to being checked-in. The power bank must then be carried in the passenger’s carry-on baggage where permitted by security regulations;

c) Where a bag intended to be carried in the cabin is surrendered at the boarding gate or on the aircraft to be loaded in the cargo compartment the passenger should be asked if the bag contains any spare lithium batteries, including power banks. Where it is identified that there are spare lithium batteries or power banks, the passenger must remove them from the bag before it can be loaded into the cargo compartment. The spare battery/power bank must then be carried in the cabin, where permitted by security regulations.

\textsuperscript{10} DGR - Dangerous Goods Regulation
\textsuperscript{11} PED - Portable Electronic Device
To alert passengers as to the requirements and limitations on the carriage of this smart baggage operator should include specific information on their booking and check-in websites, ticket purchase and check-in counters, baggage drop-off areas and boarding gates. Operators should also consider including information contained within in-flight magazines, or other tools used to communicate with passengers.

**Cabin firefighting procedures**

Firefighting procedures require that any lithium battery showing signs of overheating should be cooled as quickly as possible using water or non-flammable liquid.

The majority of PEDs powered by lithium batteries are held and/or used during flight. Passengers and cabin crew are therefore more able to identify an overheating device and take appropriate action to cool it before the point of ignition.

In the case of batteries installed within carry-on bags, these are more difficult to identify at an early stage, due to their stowage in the cabin. This should be considered in the safety risk assessment.

To effectively cool an overheating lithium battery either before or after ignition, the battery should be fully immersed in water or non-flammable liquid where possible. Where a battery is not able to be removed quickly or safely, the device in which it is contained should be immersed in water.

Where the overheated device is the size of a carry-on bag, it is unable to be fully immersed in water or placed in a fire containment device. This is a considerable hazard and should be carefully considered by the operator before determining a policy on acceptance for carriage.

[...]

Investigator in charge: Norman Kretschmer
Assistance: Phillip Lampert
Braunschweig, 7 January 2020
This investigation was conducted in accordance with the regulation (EU) No. 996/2010 of the European Parliament and of the Council of 20 October 2010 on the investigation and prevention of accidents and incidents in civil aviation and the Federal German Law relating to the investigation of accidents and incidents associated with the operation of civil aircraft (Flugunfall-Untersuchungs-Gesetz - FlUUG) of 26 August 1998.

The sole objective of the investigation is to prevent future accidents and incidents. The investigation does not seek to ascertain blame or apportion legal liability for any claims that may arise.

This document is a translation of the German Investigation Report. Although every effort was made for the translation to be accurate, in the event of any discrepancies the original German document is the authentic version.

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