ZÜRICH AIRPORT

Fuel Dumping

Contents

1. Procedure

Long-range aircraft are heavier at take-off than they are supposed to be when landing. The maximum take-off weight of a Boeing B-777-200LR aircraft for example lies at 766,000 lb, yet the maximum landing weight is 492,000 lb with a maximum fuel capacity of 181,000 l. This difference is usually compensated by burning fuel during the flight to the destination. But in case of an emergency during or after take-off, when the aircraft has to return immediately, it can only be landed safely when the maximum landing weight is not exceeded. Reasons for an immediate landing could be engine failure, hydraulic control problems or a medical emergency on board.

In Switzerland, controlled fuel dumping is subject to strict regulations by the Federal Office for Civil Aviation (FOCA): Instructions for aircraft crews and air traffic control are given in the AIP (Aeronautical Information Publication) Switzerland (ENR 1.1-1, Chapter 1.1.3 Fuel Dumping Regulations). The choice of the dumping area is determined by the urgency of the incident, the actual flight path, meteorological conditions and the general air traffic situation. The aircraft is led to a selected area by the air traffic control to dump fuel. At the minimum speed of 250 knots at an altitude of 6,000 ft, but usually with 350 knots at 14,000-16,000 ft fuel is dumped over two valves which are at the wing edges (Fig. 1). There exist no predefined dumping areas because emergencies do not allow to be planned.

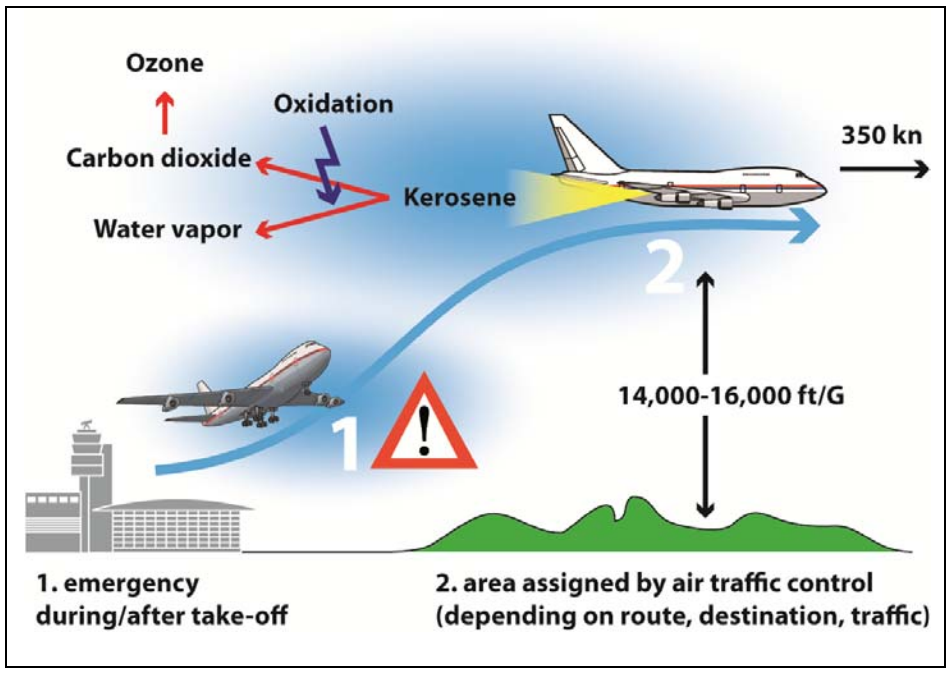

Figure 1 Diagram fuel dumping

2. Composition of Kerosene

Kerosene (Jet-A1) is a mixture of hydrocarbons (C_9-C_{16}) and contains more than 500 individual substances. The composition depends on the crude oil, the cracking process and the mixing ratio of different oil streams. It is produced as distilled substance from mineral oil or via a crack process (crack of hydrocarbon molecules) from heavy oil. Kerosene contains several additives (anti-oxidants and antistatic), some more might be added (metal deactivator, corrosion inhibitor, anti-icing and biocides). All these additives are free of halogens. The sulphur content of kerosene is 0.004-0.1 percent by weight (limit: 0.3), benzene content is less than 0.1%.

Kerosene is equivalent to petroleum which is often used for hobby and household purposes (Lufthansa Technik, 1997).

The dumping nozzle is placed at the wings of an aircraft, most often in a central position (Fig. 2). Each pump delivers up to 2,000 l fuel per minutes.

Figure 2 Fuel dumping nozzle of an Airbus A-330

3. Atmospheric processes

When being pumped (this can last up to 30 minutes), kerosene is being vaporized into very small drops and diluted within a large volume of air (Fig. 3). The affected area can be as large as 2,000 km^2. The concentration in a distance of some 100 to 1000 meters behind an aircraft is as low as 0.12 g/m^3.

When burning kerosene in the engine, due to the incomplete combustion pollutants like oxides of nitrogen and others are emitted besides carbon dioxide and water vapour. During fuel dumping however, kerosene is being jettisoned unburned into the atmosphere. In this case, kerosene is still oxidized to water vapour and carbon dioxide, even though at a slower reaction rate. However, depending on the yearly season, a contribution to the ozone formation is possible.

Figure 3 Fuel Dumping TriStar (USA, 2001; Foto: Richard Zeman)

Generally, air masses are only moved vertically very slowly, usually at a settling rate of approximately 60 centimetres per second. In addition the upper limit of the planetary boundary layer (PBL) at the altitude of approximately 3000 ft over ground renders the air flow from the upper to the lower layers more difficult. Therefore the chance that even a small quantity of fuel reaches the ground is estimated to be unlikely. The dumped fuel evaporates completely or it is transformed before reaching the ground. Only at significant lower dumping altitude or during strong precipitation it may be possible that finest fuel droplets reach the ground. However, a contamination of soil or water caused by fuel dumping could not be proved to date (FOCA, 2004).

4. Incidents

The atmosphere is polluted by approximately 40 t of hydrocarbons per incident, with a range of between 1 and 75 tons. Since 1972, each incident at Zurich Airport is covered statistically. Over the past few years, 0-1 incidents per year have been registered in the Zurich air navigation area. Figure 4 shows the continued decrease of incidents, thanks to improved technologies and higher reliability.

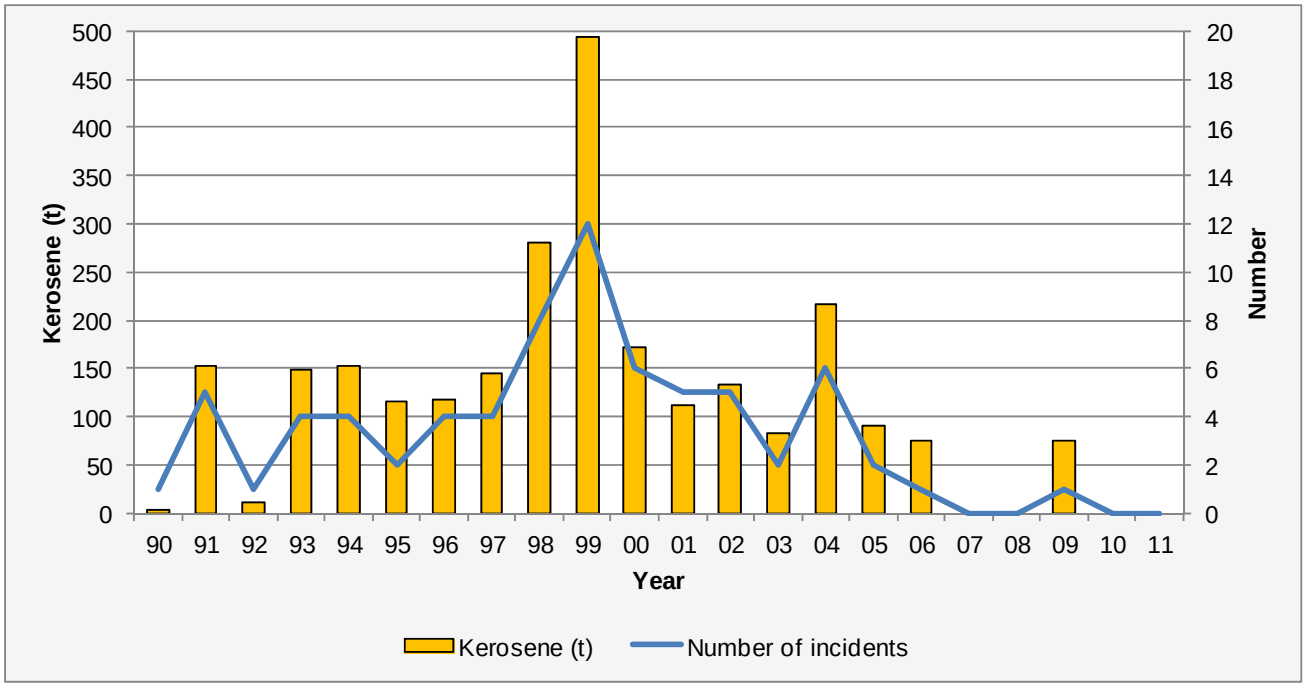

Figure 4 Fuel dumping incidents in the Zurich air navigation area 1990-2011.

5. Emergency procedure

Fuel dumping is an emergency procedure to grant the safety of the passengers. Modern aircraft design and manufacturing allows more and more aircraft to land at maximum take-off weight. Only long range aircraft like B-747, B-767, B-777, MD-11, A-330, A-340 or A-380 can dump fuel. As an exception, there are some small business jets which use the fuel mass for weight and balance and might dump fuel in case of flight abortion.

Fuel dumping prior to landing for reasons of "lower landing fees" (landing fees are based on the maximum certified take-off weight) or "safer landing" (go around is not possible with empty fuel tanks) has never been taking place; it would even be dangerous. Costs of a fuel dumping (without consequential costs) by an A-330 quickly exceed 70,000 Swiss francs (or 300 francs per passenger).

6. Wake vortices

Fuel dumping is often erroneously taken for the visible wake vortices at the wing edges in the final approach of aircraft (Fig. 5). Those are produced by a small vacuum where the humidity is condensed.

Figure 5 Wake vortices (Avro RJ-100)

Figures

Version	Date	Name	Modifications
1.0	9.2.2012	Fleuti	

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