

Cabin Safety Aspects in Accident Investigations: A Crucial Link

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Several accidents have had significant cabin safety components, and resulted in a turning point in the field of cabin safety. Some of those accidents include the following cases.

In June 1983, a DC-9-32 on a scheduled passenger flight from Dallas to Montreal via Toronto, with 41 passengers and 5 crew members on board, experienced a fire which was discovered by cabin crew members in the aft lavatory during cruise flight (1). The crew made an emergency descent and landed at the Greater Cincinnati International Airport. When the aircraft came to a stop, the cabin crew and passengers began to evacuate. Approximately 60 to 90 seconds after the exits were opened, a flash fire enveloped the aircraft interior. 23 passengers were fatally injured; the aircraft was destroyed by fire (refer to Figure 1). Recommendations in the accident report included: requirements for smoke detectors and automatic fire extinguishers in lavatories; the need to review of cabin crew training and procedures, including firefighting and crew resource management; and the implementation of passenger instructions on how to open emergency exits as an international best practice.

Figure 1 – DC-9-32 in-flight fire

In January 1989, a B737-400 on a scheduled passenger flight from London to Belfast, with 118 passengers and 8 crew members on board, experienced a fan blade fracture in the No. 1 engine (2). Believing that the No. 2 engine suffered the damage, the flight crew shut it down and diverted to East Midlands Airport. The No. 1 engine subsequently suffered a major thrust loss and the aircraft impacted a field near the embankment of a motorway. 47 passengers were fatally injured and 74 occupants, including 7 crew members and 1 infant, sustained serious injuries. The aircraft was destroyed. The investigation cited that many people on board, including 3 cabin crew members saw flames which had emanated from No 1 but never informed the pilots. This was deemed a contributing factor to the incorrect response from the flight crew (i.e. shutting down the wrong engine). During the diversion, the captain made an announcement explaining to passengers that trouble with the right engine had produced smoke and it was shut down. The accident report noted that many of the passengers who saw the fire in the left engine were puzzled by the captain's reference to the right

engine but never brought the discrepancy to the attention of the cabin crew. Among the recommendations, the report stated that training exercises for pilots and cabin crew should be introduced to improve coordination between flight and cabin crew in response to an emergency.

In March 1989, a Fokker F-28 Mk1000 on a scheduled passenger flight from Thunder Bay to Winnipeg via Dryden, with 65 passengers and 4 crew members on board, crashed off the end of the runway after take-off from the Dryden Municipal Airport (3). The aircraft failed to gain altitude after its attempted take-off and crashed. A third of the passengers and 3 crew members, including the captain, the first officer, and 1 of the 2 cabin crew members, were fatally injured. Contamination on the wings resulted in a loss of control. The final report into the accident noted that one of the cabin crew members and several passengers had noticed ice build-up on the wings, but failed to transmit this information to the flight crew. Poor crew resource management and deficiencies in cabin crew training were also cited as contributing factors. Recommendations included the requirement for each operator to provide to the competent authority an operator cabin crew manual, either as part of the operations manual or as a separate manual; and the need for regulations setting the training and competency requirements for cabin crew members.

In February 1991, a B737-300 with 83 passengers and 6 crew members on board collided with a SA-227-AC (Metroliner) at Los Angeles International Airport (4). All 12 occupants on board the turboprop as well as a quarter of passengers and 2 crew members on board the Boeing were fatally injured. Several passengers seated aft of the overwing area who made their way to the rear of the cabin reported using emergency floor path lighting (refer to Figure 2). This improvement was a result of the earlier DC-9 accident in 1983. The accident report cited as a finding that the exit row briefing provided by the operator of the B737 increased the preparedness of passengers for the evacuation.

Figure 2 – Emergency floor path lighting

In August 2005, a B737-300 on a scheduled passenger flight from Larnaca to Athens, with 115 passengers and 6 crew members on board, failed to pressurize due to the aft outflow valve being partially open (5). As the aircraft climbed, the cabin altitude warning horn sounded. The flight crew misidentified the warning as a take-off configuration warning and attempted to troubleshoot. Meanwhile, the oxygen masks in the cabin automatically deployed; and it is presumed that cabin crew became aware of the decompression. However, the aircraft continued to climb and both flight crew members succumbed to hypoxia. The aircraft continued to fly on auto-pilot until it suffered from fuel exhaustion and crashed. There were no survivors; the aircraft was destroyed. It should be noted that cabin crew are (or should be) trained to know that a decompression is followed by a rapid descent. The fact that the aircraft kept climbing should have been a clear indication to them that there was a problem. In fact, the investigation concluded that one of the factors that could have contributed to the accident was the lack of cabin crew procedures to address events involving loss of pressurization and continuation of the climb despite passenger oxygen masks deployment. As a follow up to the accident, the European Aviation Safety Agency (EASA) issued a Safety Information Bulletin (6), which

recommends that operations manuals should be reviewed and amended to address such procedures (an intervention by cabin crew).

In August 2005, an A340-300 on a scheduled passenger flight from Paris to Toronto with 297 passengers and 12 crew members on board, overran the runway after landing at Toronto International Airport (7). The aircraft was not able to stop on the runway and departed the far end. It stopped in a ravine and caught fire. All passengers and crew members were able to evacuate the aircraft before the fire reached the escape routes. A total of 10 passengers and 2 crew members were seriously injured during the crash and the ensuing evacuation; the aircraft was destroyed by fire. The accident report noted that the evacuation was impeded because nearly fifty per cent of the passengers retrieved carry-on baggage. The report also stated that the evacuation was successful due to the training and actions of the whole cabin crew. The performance of the cabin crew was deemed exemplary and professional, and was a significant factor in the successful evacuation of the aircraft. The report cited effective communication between the flight and the cabin crew members. This accident highlights the importance of cabin safety and training.

As highlighted by some of these cases, findings and recommendations from past accident investigations have led to significant improvements in the fields of cabin safety and aircraft manufacturing, over the past thirty years such as: 16G seats, lavatory smoke detectors and fire extinguishers, floor proximity emergency escape path marking, new requirements for cabin and insulation materials and inclusion of human performance training for cabin crew members. These improvements have increased the survivability of occupants involved in latter accidents and helped reduce fatalities among passengers and crew. A review of ICAO accident data from 2009-2013 involving commercial scheduled air transport, indicated that the majority of accidents (87.7%) resulted in no fatalities (refer to Figure 3). The fact that most occupants survive accidents can be linked to improvements made in occupant protection. These improvements result from survival factor investigations, which address cabin safety aspects during accident investigations.

Figure 3 – ICAO data on accident survivability (2009-2013)

Cabin safety aspects, including survival factors, should be addressed as part of the investigation process. However, these are often overlooked, thus States and industry may be missing out on the possibility for further safety enhancements. The goal of a cabin safety investigation is to analyse all aspects of an accident or incident, in relation to the actions of cabin crew members and passengers, as well as the cabin environment, and relevant systems and equipment on board, in order to identify safety deficiencies and lessons learned. The investigation may result in the development of recommendations related to operator procedures, fatigue (e.g. scheduling practices), training, safety and emergency equipment, aircraft systems, etc.

ICAO recently published the *Manual on the Investigation of Cabin Safety Aspects in Accidents and Incidents* (Doc 10062) to encourage the uniform application of the Standards and Recommended Practices contained in Annex 13 — *Aircraft Accident and Incident Investigation*, particularly in relation to survival aspects. It provides information and guidance to States on the procedures, practices and techniques that can be used when investigating cabin safety aspects of an occurrence.

This manual was developed with the involvement of the ICAO Cabin Safety Group (ICSG), which is an international, joint Industry-Regulatory study group composed of cabin safety experts from civil aviation authorities, airlines, aircraft manufacturers and international organizations. The International Society of Air Safety Investigators (ISASI) and the United States National Transportation Safety Board (NTSB) were among the members who provided support, advice and input for this manual. The content of this manual is consistent with guidance materials contained in the *Manual of Aircraft Accident and Incident Investigation* (Doc 9756). Its publication marks a significant milestone, as it is the first ICAO manual dedicated solely to cabin safety in investigations.

The new ICAO manual provides recommended qualifications and competencies for cabin investigators (CI), thereby allowing the appropriate personnel to carry out the necessary functions during an investigation. ICAO defines a CI as the person responsible for examining and documenting the factors that affect the survival of occupants involved in accidents or incidents. In addition to survival factors, the CI is responsible for determining factors that affect the safety of flight and contribute to an occurrence and its outcomes. ICAO developed a competency framework, which encompasses performance criteria, skills, knowledge that should be demonstrated by persons prior to the issuance of a CI qualification. Guidance includes the content of the CI training programme, to assist States and industry implement such training. The content related can be adapted to any role, e.g. CI employed by an accident investigation authority or by an air operator.

In order to assist States and industry investigate cabin safety aspects in occurrences, the ICAO manual contains detailed guidance on the types of events which often include a cabin safety dimension and are classified as accidents, as per ICAO's definition. These include the following: evacuation; ditching or inadvertent water contact; fire, smoke, and/or fumes; turbulence; decompression; aircraft damage; and fatal or serious injuries (e.g. where aircraft may not be damaged).

For each of these types of occurrences, the manual contains templates which assist investigators address all areas of the survival factors/cabin safety portion of an investigation. These templates explain what to gather (i.e. specific information to collect and document) and why (i.e. the objective of the analysis), with great detail. Information is presented under six main categories:

- 1) general information that should be gathered on the occurrence;
- 2) documentation that needs to be reviewed from several sources (operator, State of the Operator, aerodrome, etc.);
- 3) aircraft and cabin specific information regarding the examination and recording of relevant aircraft systems (e.g. emergency exits and evacuation slides), safety and emergency equipment specific to the type of occurrence, and conditions of the cabin (refer to Figure 4);
- 4) human performance, including actions by cabin crew members and passengers;
- 5) additional information which should be examined, specific to the occurrence, such as emergency response or search and rescue; and
- 6) guidelines for conducting cabin crew and passenger interviews.

Figure 4 – Example of conditions in the cabin

In addition, the manual includes guidance for the investigation of incidents, which do not meet the ICAO definition of an accident and do not require a formal investigation by the State of Occurrence. It highlights that incidents can provide evidence of hazards or deficiencies within the aviation system and should not be overlooked. Guidance is aimed at the State of the Operator as well as the individual air operators, who may wish to conduct voluntary internal investigations. Templates contain detailed guidance for three types of incidents deemed of common concern to air operators: inadvertent slide deployments, medical events on board, and occurrences involving unruly passengers.

Safety improvements over the past thirty years are result of cabin investigations. As demonstrated in past accidents, the role of cabin crew members expands far beyond that of service on board. Their primary duty is safety and they play a vital role in accident prevention and survivability of occupants in occurrences, such as aircraft evacuations. Further enhancements can be made by focusing a part of an investigation on cabin safety, as this is a crucial link in development and maintenance of a safe aviation system. The ICAO *Manual on the Investigation of Cabin Safety Aspects in Accidents and Incidents* (Doc 10062) was developed to provide in-depth guidance to all stakeholders, when conducting investigations in order to promote the examination of cabin safety aspects and further enhance safety in the future.

References

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