SERIOUS INCIDENT

Aircraft Type and Registration:	Airbus A330-323, N276AY	
No & Type of Engines:	2 Pratt & Whitney PW400 turbofan engines	
Year of Manufacture:	2001 (Serial no: 0375)	
Date & Time (UTC):	26 June 2016 at 1115 hrs	
Location:	London Heathrow Airport	
Type of Flight:	Commercial Air Transport (Passenger)	
Persons on Board:	Crew - 12	Passengers - 277 Ground staff - 2
Injuries:	Crew - None	Passengers - 1 (Minor)
Nature of Damage:	APU failure	
Commander's Licence:	Airline Transport Pilot's Licence	
Commander's Age:	61 years	
Commander's Flying Experience:	31,635 hours (of which 1,912 were on type) Last 90 days - 200 hours Last 28 days - 28 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The cabin filled with smoke whilst the aircraft was on stand after boarding. The cabin crew were unsuccessful in making contact with the commander, and one of the flight attendants (FAs) initiated a passenger evacuation.

Several passengers exited using the emergency slides from the two aft doors, but most left using the jetbridge at exit 2L. Passengers opened the two emergency exits situated immediately aft of the wings (exit 3L and exit 3R). Exit 3L had not been armed, so the slides did not deploy and the passengers did not use the exit. Exit 3R was armed and opened by a passenger and the slide deployed, but this exit was not used either.

The commander attempted to halt the evacuation, (because he believed he had isolated the source of the smoke) which caused some confusion until the FAs encouraged all remaining passengers to exit via the jetbridge.

Air Traffic Control (ATC) observed the incident and alerted the emergency services, which reached the scene quickly. Three passengers and several FAs received treatment for the effects of smoke inhalation and one passenger suffered a minor leg injury while using an escape slide.

The source of the smoke was traced to a failure of the Auxiliary Power Unit (APU) load compressor carbon seal that allowed hot oil to enter and pyrolyse in the bleed air supply.

Metallic debris in the shared oil system compromised the load compressor bearing, leading to the failure of the load compressor carbon seal.

The APU manufacturer has taken action to address this type of event, and the relevant section of the Master Minimum Equipment List (MMEL) has been reviewed and amended.

Six Safety Recommendations are made in the areas of interphone design, passenger briefings and the co-ordination of pilot and cabin crew training. A further two Safety Recommendations are made concerning modification to enhance automatic APU shut-down protection in the event of lubrication system contamination.

History of the flight

The crew, comprising three pilots[1] and nine FAs (designated A-FA to H-FA and K-FA), prepared the aircraft for departure from Stand 307 at Heathrow while ground engineers dealt with defects raised by the crew of the inbound flight. Passenger boarding began later than scheduled, with engineers, caterers and cleaners still working on-board. Some of the FAs felt more pressured than usual as a result of having to supervise the passenger boarding during this other cabin activity.

The APU was being used for air conditioning, but external electrical power was connected because the APU generator was unserviceable[2]. The engineers departed one hour after boarding began and all the exit doors were then closed and armed. In preparation for this, the FAs briefed the passengers seated in four '*exit seats*[3]', referring them to their safety instruction cards which contained guidance on opening the adjacent exit. Before the doors were armed passengers occupying these seats were required to agree they were able and willing to open these exits if necessary.

The jetbridge was removed at 1057 hrs but two minutes later the commander requested further engineering assistance because there was an indication of a navigation system defect. All the doors were disarmed, the jetbridge was re-attached at exit 2L (Figure 1), and an engineer went to the flight deck, accompanied by the Gate Operational Co-ordinator (GOC).

The In-flight Entertainment system (IFE) was inoperative so the FAs needed to provide a manual passenger safety demonstration using equipment stored in on-board pouches. Before departure, their duty stations were mostly, but not exclusively, in the vicinity of their jump-seats; the K-FA's duty station for boarding was at 2L. Because there were no pouches stored next to exits 3L and 3R, the F-FA went forward towards exit 2L and the G-FA went aft towards exit 4R, to retrieve pouches stored near these locations. Meanwhile, the K-FA was also looking for a demonstration pouch in the vicinity of the aft galley on the left side of the aircraft.

Footnote

1 The flight deck crew comprised the commander, the co-pilot and an International Relief Officer (IRO), who was a qualified co-pilot occupying the cockpit jump seat.
2 See *Dispatch with APU generator inoperative*.
3 Seats 25A, B, G and H are designated as exit seats because they have direct access to either exit 3L or exit 3R. See *Exit seat*s.

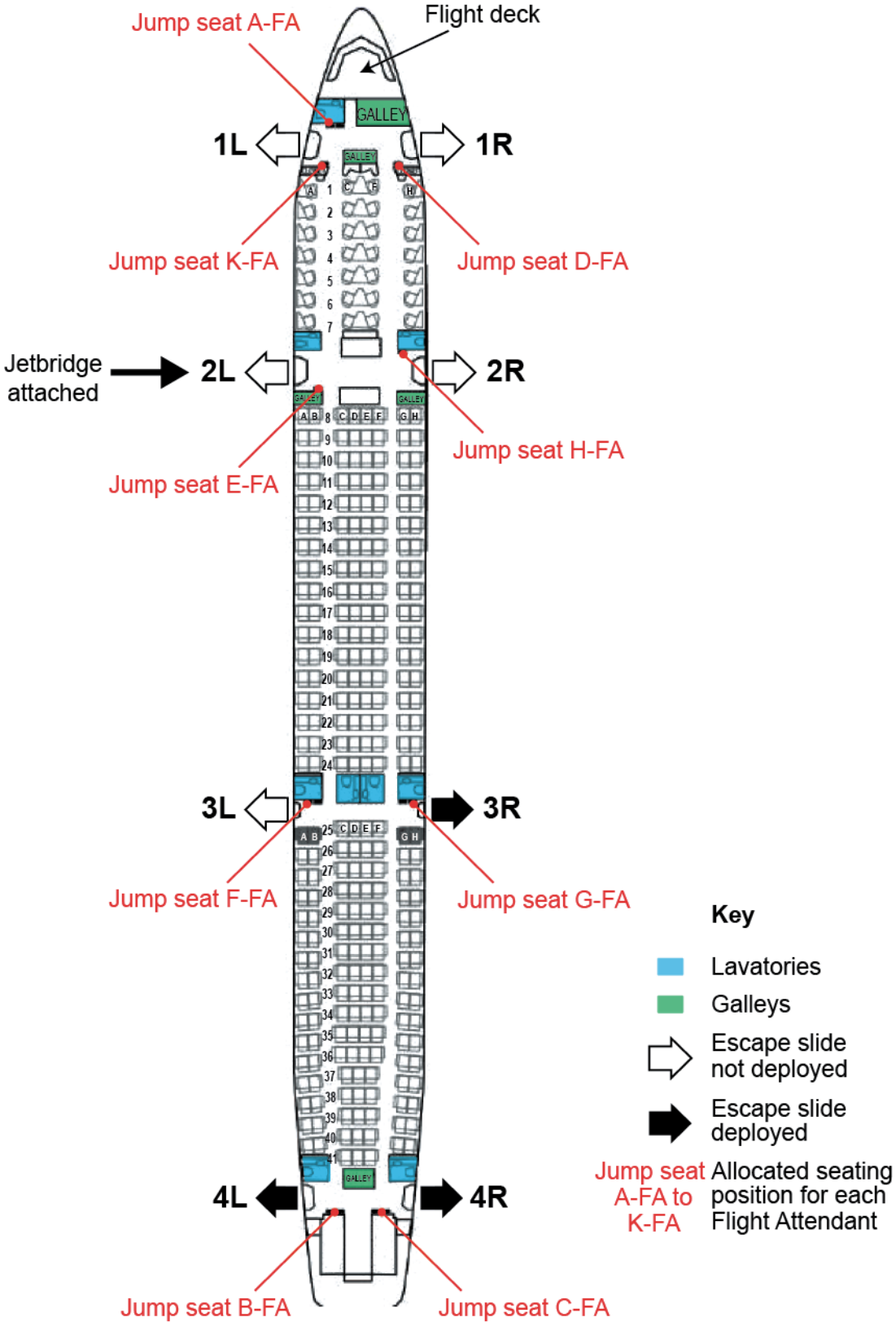


Figure 1

Cabin layout of N276AY showing numbered exits and FA jump seat locations

The engineer was on the flight deck and was talking to the pilots when the commander thought he smelt burning. Assuming it was associated with the engineering activity, the commander asked the engineer what was causing the smell, but the engineer did not know.

The commander recalled that, a few seconds later, smoke appeared behind his seat and the SMOKE LAVATORY SMOKE warning[4] illuminated on the upper display of the Electronic Centralised Aircraft Monitor (ECAM) in the centre of the main instrument panel, accompanied by an aural chime. Over the sound of this, he believed he heard the words "smoke in the cabin" and possibly "evacuate" spoken. He saw the cabin full of smoke and smoke coming from the windshield vents. Aware that the APU was providing conditioned air, he assumed it was causing the smoke and pressed the APU bleed switch to close off the APU air supply.

From the jump seat at the rear of the flight deck, the International Relief Officer (IRO) saw smoke issuing from ventilation ducts. He recalled that the commander and co-pilot actioned the checklist for a SMOKE LAVATORY SMOKE warning, and the co-pilot began to action the '*Smoke/ Avionics Vent Smoke/Fumes'* checklist, with assistance from the IRO. The co-pilot recalled that the SMOKE LAVATORY SMOKE warning illuminated after they had begun to action the '*Smoke/ Avionics Vent Smoke/Fumes'* checklist. Both pilots commented that various chimes, alarms and warnings were operating together and were distracting.

The IRO remembered one of the FAs coming to the flight deck and reporting that an evacuation was underway. At approximately the same time the commander saw, in a reflection from the terminal building, that a rear escape slide had been deployed, and noticed the APU AUTO SHUTDOWN message displayed. He assumed the APU had caused the smoke and that the situation was under control because the APU had shut down so, while the other two pilots actioned the Quick Reference Handbook (QRH), he made a Passenger Announcement (PA) to stop the evacuation in order to prevent unnecessary injuries. He expected this would stop the use of the slides and that disembarkation would continue via the jetbridge.

The commander noticed the interphone light was on, indicating a call from an FA in the cabin, but he had not heard any associated aural alert call. He assumed the sound of the smoke warning had prevented him from hearing the interphone call alert, and cancelled the master warning before trying to return the interphone call. When there was no response, he made a radio call to the aircraft operator to announce the presence of passengers on the ramp. Later he saw the Rescue and Fire Fighting Service (RFFS) arrive, and assumed there was no need for him to notify ATC himself.

Standing towards the back of the flight deck, the GOC heard the evacuation PA and observed the cabin fill with white smoke. She heard the commander first make a PA telling passengers to stop evacuating, then another telling them to continue. She used her portable radio to inform the operator's ground team that an evacuation was underway, then moved through the cabin and onto the jetbridge, helping to usher passengers off as she did so. Initially she directed them to the nearest lounge area but when smoke drifted along the jetbridge into this area they were re-directed to another lounge further from the

Footnote

[4] See *Smoke in the cabin.*

aircraft. The GOC later stated that all passengers and FAs were clear of the aircraft by 1125 hrs and she then went down to the ramp to meet the passengers who had escaped via the rear slides.

The IRO and the co-pilot actioned the evacuation checklist in the QRH because they wanted to "ensure nothing was missed", but the evacuation alarm[5] was not turned on because it was believed passengers were no longer using the slides. They then walked through the cabin as the last passengers were leaving, and with some RFFS personnel already on-board. All the FAs then disembarked and, after the RFFS had checked the aircraft, the pilots remained on-board until approximately 1200 hrs. During this period they liaised with the aircraft operator but did not ensure that power for the Cockpit Voice Recorder (CVR) was disconnected.

Cabin evacuation

Mid-cabin

The door at exit 2L remained open and the jetbridge was attached throughout the incident. The E-FA was in the galley between exits 2L and 2R, near to the F and H-FAs, when the latter drew their attention to smoke at ceiling level. The E-FA looked down the aisle and observed "smoke fill the cabin in less than three seconds". She immediately tried to call the commander using the CAPT button on the interphone[6] but received no answer. She smelt what she thought was an electrical fire and made a PA telling passengers to evacuate. Passengers attempting to retrieve belongings from the overhead bins were instructed to leave them behind. The E-FA reported that she had considered arming exit door 2R to assist the evacuation but decided this might create confusion and break the flow.

As passengers exited, the E-FA heard the commander make a PA to stop the evacuation. She believed he could not perceive the smoke and fumes as she could, so shouted to the passengers to keep moving. She then heard a further PA from the commander to continue the evacuation. Although the commander's instructions caused a short interruption, passengers responded to shouts from the FAs and continued exiting onto the jetbridge.

Aft cabin

There were four FAs in the aft galley area; the G and K-FAs who were collecting demonstration pouches, the B-FA (whose station is at exit 4L) and the C-FA (whose station is at exit 4R). The B-FA heard an "explosive noise", which seemed to come from above the left side of the galley, before smoke appeared suddenly in the cabin, obscuring her view of the other FAs. Her colleagues did not hear the sound but they were all aware of the sudden appearance of dense white smoke, which some described as having a chemical or electrical smell. The K-FA checked the ovens and looked down the left aisle of the economy cabin to establish the source of the smoke. Passengers were becoming agitated and some were standing up.

Footnote

[5] See *Evacuation signalling system.*
[6] See *Interphone calls to flight deck*.

The G-FA was forward of the aft galley, on the right side, when she saw the smoke. She shouted a warning and tried to contact the commander using the interphone CAPT button; but heard an engaged/busy tone. The B and C-FAs also stated that they tried to call the commander but their calls were not answered. By now an alarm was sounding and, while the B-FA identified this as a smoke alarm, the C-FA believed it was the secondary evacuation signal[7]. The B-FA grabbed a fire extinguisher and her Portable Breathing Equipment (PBE), and heard a PA commanding an evacuation.

The other three FAs nearby could not hear PAs due to the noise from the alarm and from passengers shouting, but had each decided independently that an evacuation was essential and said afterwards that they responded as trained. The G-FA commanded them to re-arm the doors and the K and C-FAs held back passengers while the B and G-FAs armed and then opened exits 4L and 4R. They confirmed slide deployment and checked it was safe outside before working in pairs to instruct passengers to evacuate, using the command "jump and slide".

The first passengers to evacuate were instructed to help at the bottom of the slide. All but two passengers were prevented from taking cabin bags with them.

The B-FA then heard the commander's PA to stop the evacuation and shouted this instruction to her colleagues at exits 4L and 4R. The B-FA said she spoke to the A-FA, who was the senior cabin crew member (SCCM), on the interphone and received confirmation of this instruction[8].

Twenty five passengers (including one baby) used the two aft slides. Remaining passengers were directed forward, with no further PAs heard by any of the FAs in the aft cabin. Some of them said later that there was still a lot of smoke in the aft cabin and, because they were unsure of its source, they believed continuing evacuation using emergency escape slides would have been appropriate.

Forward cabin

The SCCM was in the forward left lavatory (aft of the flight deck) when smoke appeared. She reported that the compartment filled with smoke in approximately four seconds and, as she opened the door, she thought she heard the words "smoke in the cockpit" several times, followed by the sound of "smoke bells". She grabbed a fire extinguisher and a PBE from under her crew seat and, thinking the source of the smoke was in the flight deck, she tried to pass her extinguisher to the pilots. Nobody took it from her and she realised there was smoke throughout the cabin. She then heard a PA from the E-FA saying "Evacuate, come this way".

In response to the PA, the SCCM and D-FA moved aft through the business cabin ushering passengers towards exit 2L. Approaching this exit, the SCCM heard a PA from the commander telling passengers to stop evacuating. Looking around she saw the commander standing

Footnote

[7] See *Evacuation signalling system.*
[8] The A-FA did not recall this exchange.

in the flight deck looking towards her. Realising the cabin still contained thick smoke she told the nearby E and F-FAs to continue evacuating passengers and went forward to tell the commander they should continue the evacuation. He acknowledged this and she heard a further PA to continue evacuating. She estimated that 50 passengers had vacated through exit 2L by this stage and, with some light visible at the aft end of the cabin, believed the doors there were open.

The SCCM moved aft, encouraging passengers to leave their belongings and get off. She noticed that exit 3L was open but its slide was not deployed. A passenger with two children was looking out of the door, so she instructed them to go to exit 2L and placed a safety strap across the open doorway. She saw that exit 3R was also open, with its slide deployed. The G-FA was there speaking to a passenger who said he had been seated a few rows aft of the exit and saw passengers seated there having difficulty trying to open it. He knew the slide would be needed and managed to help arm the door and open it, although nobody evacuated through the exit.

As the last passengers were leaving, personnel from the RFFS arrived and instructed the FAs to evacuate. Once on the jetbridge one FA, who had a pre-existing respiratory issue, was given portable oxygen. Several of the FAs experienced a burning sensation in their nose, throat and eyes after leaving the aircraft.

Aerodrome response

The ATC Ground Controller, who had a direct view of the aft section of the aircraft[9], spotted some smoke and the start of a passenger evacuation. An Aircraft Ground Incident (AGI) was declared at 1116 hrs and the emergency services were alerted while other aircraft were kept clear. No radio transmissions were made from the evacuating aircraft and ATC tried unsuccessfully to make contact on the Delivery frequency.

The first RFFS vehicle reached the scene between 1118 and 1119 hrs and found two evacuation slides deployed on the right side of the aircraft and one on the left. Firefighters reported smoke on the jetbridge and in the aircraft, which they boarded at approximately 1122 hrs, but there were no signs of fire. They were informed by the commander the smoke had come from the APU, and heat detectors were used to ensure there were no residual hot spots. The RFFS log recorded that all passengers and crew, except the pilots, were clear of the aircraft by 1126 hrs.

Airport police reached the stand at 1120 hrs, and attended to the 25 passengers who had evacuated onto the ramp, supervising their subsequent transfer to the terminal building.

Medical information

Crews from the London Ambulance Service responded to the AGI and provided first aid to passengers and crew in the terminal building. Three passengers and several FAs were treated for symptoms of '*minor smoke inhalation*'. One passenger grazed a leg using a

Footnote

[9] ATC at Heathrow has a direct view of certain stands but many others are not in line of sight.

slide. All crew members and one passenger were taken to a hospital and, following medical checks, were released later that afternoon.

The FAs were exposed to the thickest smoke for the longest time and some reported minor discomfort, such as headaches and ongoing irritation of their eyes and nasal passages, for 24 hours or more.

Passenger reports

The airport authority distributed AAIB questionnaires inviting passengers to provide details of the incident. Only 26 forms were returned to the AAIB, most handed to the operator by passengers once they reached the USA the following day.

It was evident from the responses that some passengers seated near the aft end of the cabin did not hear any PA instructions, but that they considered the shouted instructions given to them by the FAs nearby were clear. However, 65% of the respondents (mostly seated between row 2 and row 34) indicated the instructions they heard were unclear and 46% referred to conflicting, confusing or contradictory instructions. One respondent seated near exits 3L and R, where no FAs were positioned, stated they heard no announcements and that this caused "panic". Around 23% of the received reports suggested the commands were clear and did not refer to conflicting instructions, but indicated that the commander's intervention caused a few seconds delay.

Passengers in all sections of the cabin reported thick smoke suddenly pouring out of the air vents. The smoke was generally assessed as having a "bad" chemical smell which created a burning sensation in eyes, mouths and throats. Those near the front of the cabin indicated the effect was irritating rather than choking, while those positioned further aft reported the smoke was thicker there but that they were able to see through it.

A respondent seated in row 23 (slightly forward of exits 3L and R), commented that it was possible to see through the smoke but believed that passengers adjacent to these exits felt the smoke was so thick they needed to get air into the cabin. A passenger in row 27 watched someone else open the door at 3L and then discover the escape slide had not deployed. On the other side of the cabin, passengers in the exit row were unable to open exit door 3R but a passenger seated a few rows back assisted. He armed the door before opening it but then a PA was heard which instructed everyone to leave via the main door, and exit 3R was not used.

Recorded data

Flight recorders

No data from the event was recorded by the Flight Data Recorder (FDR) because neither of the main engines had been started. The supply of external electrical power to the aircraft meant that the CVR was operating during the event but overwritten because it remained powered for several hours after the event.

CCTV

On CCTV footage recorded by the airport operator a cloud of white smoke appeared immediately behind the aircraft while it was stationary (Figure 2). This smoke began to dissipate after approximately 30 seconds, at which point the door at exit 3R opened, followed five seconds later by the door at exit 4R. Slides deployed at both exits and the first passenger jumped onto the aft slide one minute after the first smoke appeared. The CCTV footage showed 12 more passengers using this slide over a period of 33 seconds but nobody was seen to evacuate via the slide at exit 3R. The first RFFS vehicle shown on the CCTV footage arrived on the stand 3 minutes 20 seconds after smoke appeared, 2 minutes 20 seconds after slide evacuation commenced. Numerous other response vehicles were visible attending the aircraft over the following few minutes.

Figure 2

Image from CCTV showing white smoke immediately behind the aircraft

Description of Auxiliary Power Unit

The aircraft was fitted with a self-contained APU to supply bleed air for starting engines and for the air conditioning system, and to provide electrical power. The APU generator was inoperative and the aircraft was operating under the provisions of the MMEL.

The APU consists of a gas generator which is used to power the load compressor for bleed air, and the APU generator for electrical power (Figure 3). The APU bleed valve is used to isolate the air supplied by the load compressor from the aircraft pneumatic system. When the APU is running and the bleed valve is closed, the unused air supply from the load compressor is vented into the gas generator exhaust.

The APU is electronically controlled and can be operated from the flight deck. It has several automatic shutdown modes, including low oil pressure, high oil temperature or metallic chips detected in the oil system.

The APU has a single oil system that provides lubrication and cooling to relevant components of the APU and its constituent parts, including the load compressor and the generator. This system includes pressure and scavenge pumps and two oil filters, both of which are fitted with a bypass feature to allow oil circulation to continue should the filter become blocked. Activation of the bypass causes a mechanical tell-tale indicator to extend. A magnetic chip detector is also fitted which sends a signal to the electronic control system should a conductive chip be detected.

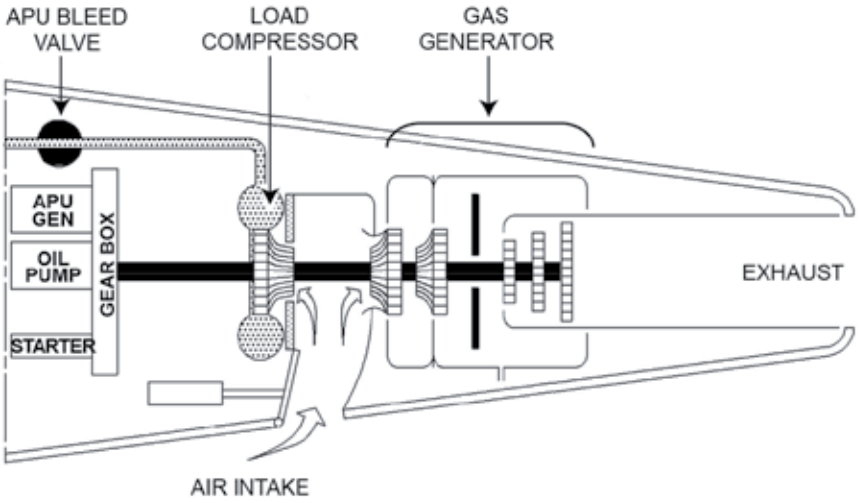


Figure 3

Schematic diagram of APU

Dispatch with APU generator inoperative

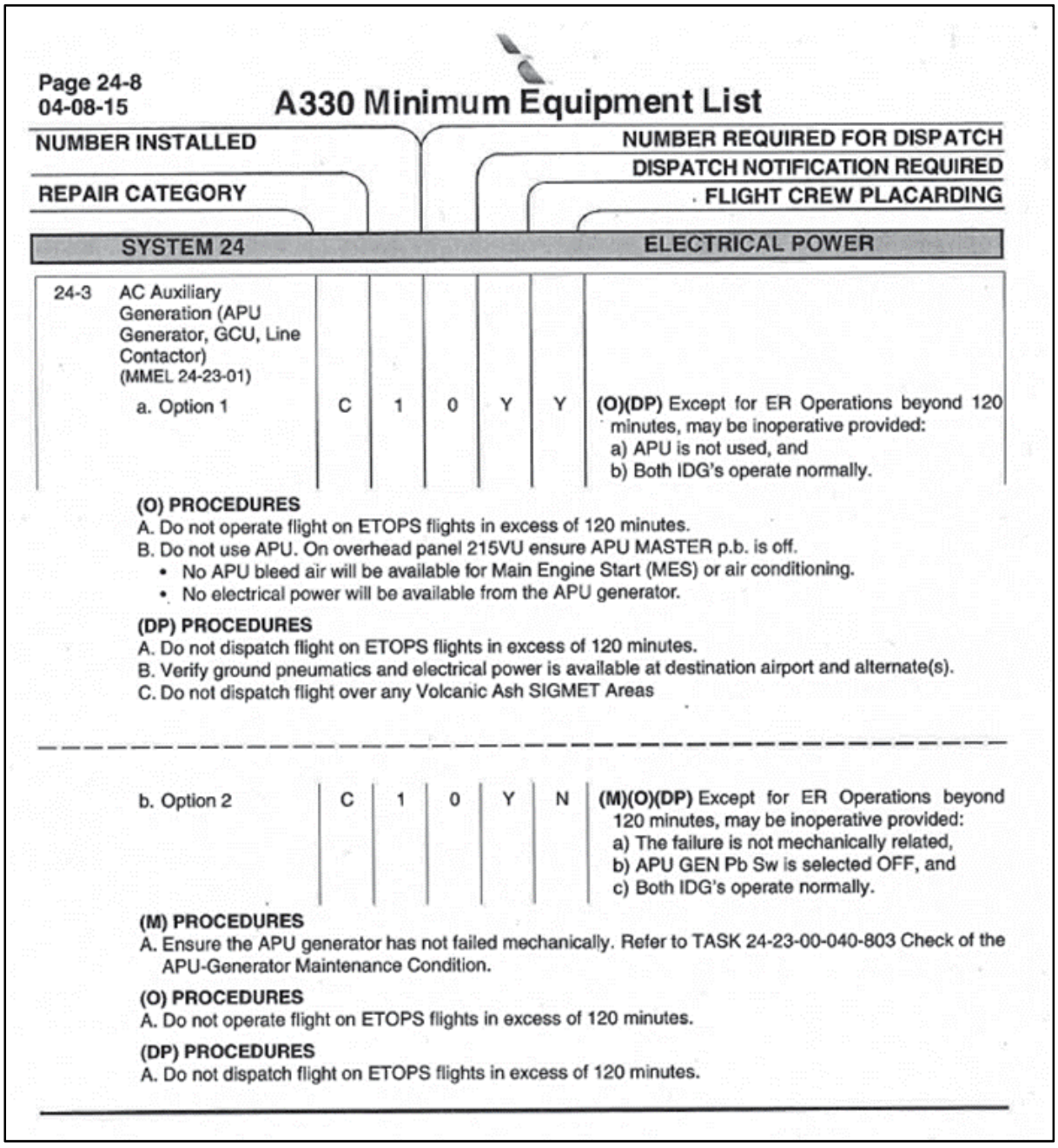
The MMEL allows an aircraft to be dispatched with certain defects if other provisions are met to assure safe flight. In this case, Section 24-3 option 2 of the A330 MEL (Figure 4) was being used. The task (24-23-00-040-803) to check the APU generator maintenance condition involved interrogating the aircraft's maintenance computer. This was completed appropriately. Relevant procedures had been carried out and recorded in the aircraft technical records.

Examination of the APU

An examination of the APU immediately after the event showed signs of oil wetting around the bleed air outlet and from the APU air inlet. The magnetic chip detector in the oil system had collected significant quantities of fine particles of ferrous material but the detector had not been triggered. The mechanical visual differential pressure indicators of both oil filters had activated, indicating the filters had blocked and as a result were bypassing unfiltered oil. Interrogation of the aircraft's maintenance computer showed the APU had shut down automatically due to high oil temperature.

The APU was deactivated and the aircraft was flown back to its maintenance base where the APU was replaced.

The APU was sent to its manufacturer in the USA where it was disassembled under supervision of the United States Federal Aviation Administration (FAA) as directed by the National Transportation Safety Board (NTSB). The load compressor and generator were removed and shipped to their original manufacturers in the Netherlands and the UK, where they were inspected under supervision of the Dutch Safety Board and AAIB respectively.



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A330 Minimum Equipment List

		NUMBER INSTALLED	REPAIR CATEGORY	NUMBER REQUIRED FOR DISPATCH	DISPATCH NOTIFICATION REQUIRED	FLIGHT CREW PLACARDING	
SYSTEM 24							ELECTRICAL POWER
24-3	AC Auxiliary Generation (APU Generator, GCU, Line Contactor) (MMEL 24-23-01)						
	a. Option 1	C	1	0	Y	Y	**(O)(DP)** Except for ER Operations beyond 120 minutes, may be inoperative provided: a) APU is not used, and b) Both IDG's operate normally.

(O) PROCEDURES
A. Do not operate flight on ETOPS flights in excess of 120 minutes.
B. Do not use APU. On overhead panel 215VU ensure APU MASTER p.b. is off.
- No APU bleed air will be available for Main Engine Start (MES) or air conditioning.
- No electrical power will be available from the APU generator.

(DP) PROCEDURES
A. Do not dispatch flight on ETOPS flights in excess of 120 minutes.
B. Verify ground pneumatics and electrical power is available at destination airport and alternate(s).
C. Do not dispatch flight over any Volcanic Ash SIGMET Areas

b. Option 2	C	1	0	Y	N	**(M)(O)(DP)** Except for ER Operations beyond 120 minutes, may be inoperative provided: a) The failure is not mechanically related, b) APU GEN Pb Sw is selected OFF, and c) Both IDG's operate normally.

(M) PROCEDURES
A. Ensure the APU generator has not failed mechanically. Refer to TASK 24-23-00-040-803 Check of the APU-Generator Maintenance Condition.

(O) PROCEDURES
A. Do not operate flight on ETOPS flights in excess of 120 minutes.

(DP) PROCEDURES
A. Do not dispatch flight on ETOPS flights in excess of 120 minutes.

Figure 4
Master Minimum Equipment List extract

The examination of the APU revealed considerable metallic debris in the shared oil system. The quantity of debris overwhelmed the filtering capacity of the system, causing the bypass to operate and allow debris to move into other areas of the oil system such as other bearings and seals. This debris eventually caused a failure of the load compressor carbon seal, allowing hot oil to enter the bleed air supply to the cabin and causing smoke in the cabin. The initiating source of the debris could not be identified positively due to the distribution of debris throughout the whole oil system.

The APU control system had initiated an auto-shutdown due to high oil temperature. This caused the bleed air valve to close, shutting-off the air supply to the cabin. Excess air was directed overboard via the gas generator exhaust, causing the plume of smoke seen by ATC.

Safety actions

APU Manufacturer

The APU manufacturer had experience of similar events where a failure occurred and oil then entered the bleed air system via the load compressor carbon seal. It had already implemented changes and features intended to prevent them.

In July 2003, the APU manufacturer issued Service Bulletin (SB) GTCP331-49-7704 which modified the design of the APU to include a "shoulder" on the load compressor-to-power section quill shaft, to prevent unseating of the carbon seal due to a failure of the load compressor bearing that could allow smoke into the cabin. In addition, software changes were made to perform an auto-shutdown of the APU in the event of a chip detection. This was done in order to allow more time for the detection of chips and activation of an auto-shutdown before an unseating or failure of the load compressor carbon seal. In addition, logic was added to the Electronic Control Box (ECB) to initiate an auto-shutdown in the event of a chip detection under certain conditions. This SB had been implemented on this APU. Based on the evidence gathered during the inspection of the APU, the manufacturer believed that this SB could not have prevented the carbon seal fracturing as found in this case.

In November 2007, the APU manufacturer issued SB GTCP331-49-7936[10] to add an optional APU auto-shutdown system for lubricating oil contamination. The system detects lubrication system contamination by sensing differential pressure across each of the two oil filters. If an impending filter bypass is detected an auto-shutdown of the APU is initiated, preventing further damage and reducing the likelihood of smoke entering the cabin. This optional system was not installed on this aircraft.

Generator manufacturer

The generator manufacturer employs a proactive FRACAS (Failure Reporting and Corrective Action System) process in which a monthly reliability trend review examines product reliability and the associated primary and secondary failure modes. If a trend is detected, internal actions are taken to investigate and resolve the issue. No adverse trends have been identified with the bearings within the generator.

Footnote

[10] Service Bulletin GTCP331-49-7704 is for the -5 APU and GTCP331-49-7738 is for the -4 APU and the ECB is modified by either GTCP331-49-7701 or GTCP331-49-7705 according to model.

Crew stations

The operator is regulated by the FAA and Federal Aviation Regulation (FAR) 121.391 states at paragraph (d):

> *'During takeoff and landing, flight attendants required by this section shall be located as near as practicable to required floor level exits and shall be uniformly distributed throughout the airplane in order to provide the most effective egress of passengers in event of an emergency evacuation. During taxi, flight attendants required by this section must remain at their duty stations with safety belts and shoulder harnesses fastened except to perform duties related to the safety of the airplane and its occupants.'*

FAR 121.394 states at paragraph (c):

> *'If more than one flight attendant is on the airplane during passenger boarding or deplaning, the flight attendants must be evenly distributed throughout the airplane cabin, in the vicinity of the floor-level exits, to provide the most effective assistance in the event of an emergency.'*

It does not specify where FAs should be positioned when the aircraft is stationary on the ground with passengers on-board who are not in the process of boarding or deplaning.

Exit seats

FAR 121.585 designates '*exit seats'* as seats from which passengers '*can proceed directly to the exit without entering an aisle or passing around an obstruction*'. The Regulation requires that passenger information cards include details of who may occupy these seats and what they are required to do in an emergency should no crew member be available to assist. The card must instruct exit seat passengers to identify themselves for reseating if they believe they cannot or do not wish to perform the functions which may be required to operate the exit. Before the aircraft is pushed back or taxis, a crew member is to determine that the passengers in the exit seats appear capable of performing such functions.

In 2003 the FAA issued Advisory Circular (AC) 121-24C regarding oral briefings given by FAs. This guidance material '*strongly encourages air carriers to require crewmembers to provide a preflight personal briefing to each person seated in an exit seat*'. The object of the briefing is to explain clearly what the person should do if the exit has to be used and to refer them to the relevant information provided on an information card.

Operator's procedures

In December 2013 the previous operator of this aircraft, with approximately 30,000 employees, had merged with another operator with approximately 70,000 employees. Over the next 16 months the new organisation's processes and manuals were inspected by the FAA prior to issue of a '*Single Operating Certificate*'. Unification was still underway at the time of this occurrence and a single flight operations system for the entire fleet, which includes 14 different aircraft types and variants, was not adopted until four months later.

The philosophy during the merger was to integrate, stabilise and improve any apparent issues, and the operator considered it was in the improvement phase by the time of the occurrence. The aircraft operator stated that this improvement phase "was part of senior management's long-term effort to capitalize on the synergies associated with the merger, to yield a better overall product." It did not involve changes to safety-related issues but it "was a complicated and lengthy part of the [merger] process, and safe and effective change management was emphasized throughout." It noted that the crew had extensive experience operating this aircraft type, and all were familiar with the on-board equipment.

Exit seats

There were four seats on this A330-323 designated as exit seats, as defined in FAR 121.585; seats 25A and B adjacent to exit 3L, and seats 25G and H adjacent to exit 3R. Figure 5 shows exit 3L and adjacent seats. For a fully laden aircraft the door sill height is a minimum of 5.2 metre above ground level at exits 3L and 3R.

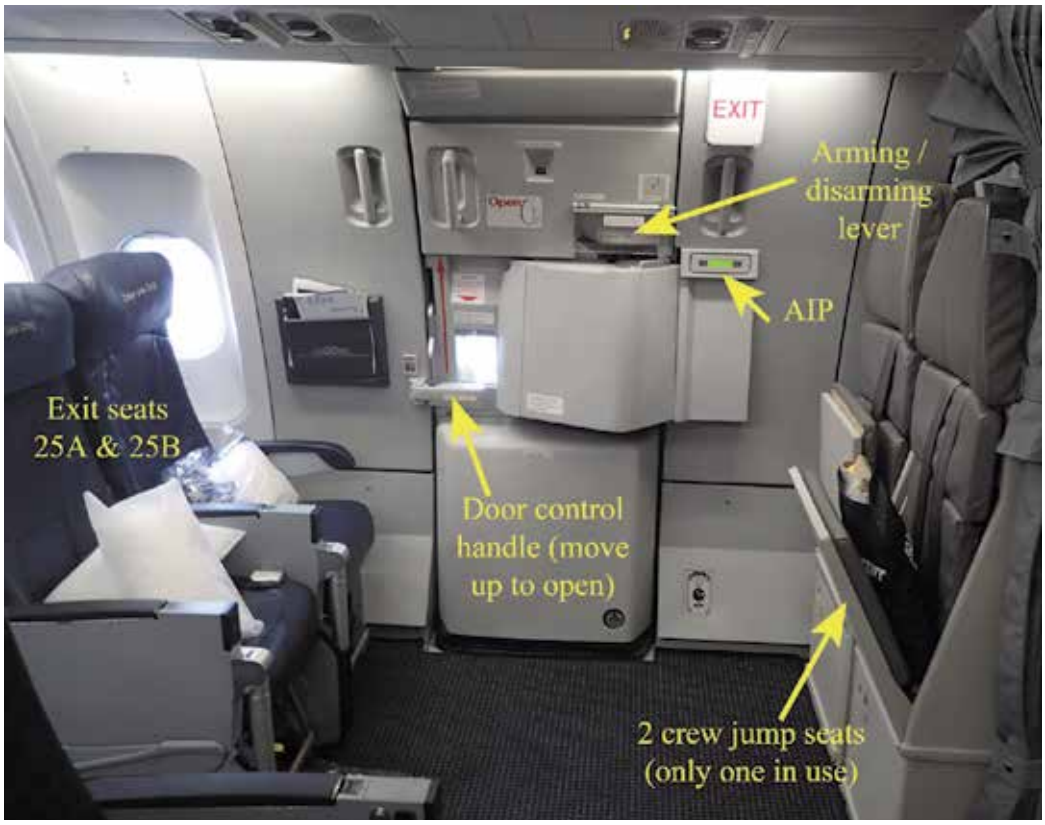

Figure 5

Photograph of Exit 3L and surrounds; the Attendant Indication Panel (AIP) is described in *Crew stations*

In accordance with AC 121-24C the aircraft operator's Flight Service In-flight Manual (FSIM) required that, prior to door closing, the F-FA give individual briefings to the passengers in 25A and B and the G-FA briefs those in 25G and H. Passengers not responding positively that they were willing and able to perform the required functions and obtain a verbal response were to be re-seated before the doors were closed.

Crew stations

A station assignment chart in the FSIM assigned work stations to each FA for various activities. During passenger boarding, the A and D-FAs work stations were at exits 1 L/R, the E and H-FAs at 2 L/R, the F and G-FAs at 3 L/R, the B and C-FAs at 4 L/R and the K-FA at 2L. There was no requirement for FAs to remain at or near their work station when the aircraft was stationary on the ground, with passengers on-board. For taxi, takeoff and landing each FA was allocated a jump seat (Figure 1). They were permitted to leave this seat to perform specific safety-related duties while the aircraft was taxiing.

An Attendant Indication Panel (AIP) (Figure 5 and Figure 6) is installed in the vicinity of each FA jump seat. The AIP displays messages relating to passenger or interphone calls as well as certain warning messages (e.g. SMOKE LAV A, EVACUATION ALERT or EMERGENCY CALL). Each AIP has a two line alphanumeric display screen. A steady green light accompanies a communication message and a flashing red light highlights the display of a warning message.

Figure 6

Example of an AIP, indicating a normal interphone call from the commander

Adjacent to exit 1L there is a Flight Attendant Panel (FAP) which provides the A-FA with detailed information and controls relating to cabin services. There is a switch on the FAP to allow the A-FA to turn on emergency lighting, which provides illumination to aid cabin evacuation, as well as indications and controls for an evacuation signalling system and for lavatory smoke alarms. Smaller versions of the FAP, known as the Additional Attendant Panels (AAP), are located by exits 2L and 4L, and have controls for the evacuation signalling system and lavatory smoke alarms.

Evacuation signalling system

The evacuation signalling system can be switched on from the flight deck or from the FAP or the AAPs, to initiate a continuous and rapidly repeated series of short, high-pitched tones throughout the cabin. When the system is activated an EVACUATION ALERT message and a flashing red light show on each AIP and a red EVAC light flashes on the EVAC control panel situated on the left overhead console in the flight deck. A horn will also sound in the flight deck for three seconds when one of the three cabin switches is used to switch the system on. The flight deck horn can be cancelled using a HORN SHUT OFF push button.

The aircraft operator's A330 Operating Manual (OM) Volume II stated that two signals were used to initiate an evacuation: the primary method being a PA by the commander, the secondary being use of the EVAC COMMAND switch. The FSIM referred to the '*emergency signalling system'* and informed FAs they could activate it from the FAP or from certain AAPs by pressing the EVAC command switch once.

Smoke in the cabin

The nine lavatory compartments on the aircraft were each equipped with a smoke detector. When smoke is detected, an aural smoke alarm sounds through all cabin loudspeakers, creating a Hi/Hi/Lo/Lo chime series which repeats continuously. Simultaneously a red light flashes at each AIP, alongside a message indicating smoke in a specific lavatory. There are also indications on the FAP and the AAPs while reset pushbuttons on these panels allow the alarm to be silenced. If detectors in more than one lavatory activate, the same aural alarm sounds and all activated detectors can be reset together from the FAP and/or from an AAP.

When any of the detectors are activated, the ECAM presents a SMOKE LAVATORY SMOKE message on the upper of two display units in the centre of the main instrument panel in the flight deck. To assist flight crew awareness, the warning is highlighted by flashing red master warning lights on either side of the main instrument panel, accompanied by continuous repetitive chimes from the flight deck loudspeakers. Both the master warning and the chimes can be cancelled by pressing either of the master warning push buttons, thus acknowledging the warning.

The procedures to be followed by the flight crew in response to the SMOKE LAVATORY SMOKE message are also shown on the upper central display panel and appear as 'CKPT/CAB COM.... ESTABLISH'. This is an abbreviated instruction for the flight crew to establish communications between the cockpit (flight deck) and the cabin.

Guidance concerning the FAs response to various emergency scenarios was provided in the FSIM. Some drills were detailed in a section of the manual that was not specific to this type of aircraft. In the event of signs of fire or smoke in the cabin, or '*If an odor is present, but cannot be identified or localized*', it instructed FAs to '*notify flight deck crew immediately using four chimes*'. Elsewhere in the FSIM it was stated that, '*On all aircraft, four chimes is an Emergency Call*', whereas a routine call was announced by '*two chimes*'. This system had been developed for the internal communication equipment on other aircraft types in which there were no priority or emergency call switches.

Interphone calls to the flight deck

There is no common standard concerning the keypad layout on interphone handsets for passenger aircraft, therefore neither the equipment manufacturer nor the aircraft operator have any obligation to consider keypad standardisation between aircraft types. On the Airbus A330-300 each FA station has an interphone handset with a number of buttons (Figure 7). When a handset is lifted from its base station and the button marked CAPT is pressed, a single long buzzer[11] sounds through the flight deck loudspeakers and small push buttons, marked ATT, flash amber on the pilots' Audio Control Panels (ACPs). When a pilot responds by depressing his ATT push button, the interphone system connects to the calling station and the light in the push button changes to green. If no pilot responds to the call within 60 seconds, the lights in the ATT push buttons extinguish. Replacing the handset in its cradle or pressing the reset button returns the handset to its original status.

Footnote

[11] The aircraft manufacturer advises each buzzer tone lasts for approximately one second.

Figure 7
Interphone communication handset showing keypad

If the handset button marked EMER CALL is pressed, the ATT push buttons on the flight deck ACPs flash amber, three long buzzer tones sound from the flight deck loudspeakers and an amber EMER CALL light flashes on a Cabin Call System Panel (CCSP), situated on the left side of the flight deck ceiling. The aircraft manufacturer states that if a pilot does not respond by depressing an ATT push button within 60 seconds, the lights in the ATT push buttons extinguish but the light on the ceiling panel continues to flash until the call is cancelled.

In a section specific to the aircraft type the FSIM stated that when the EMER CALL button is pressed the flight deck will be alerted by '*four buzzers*'. The FSIM gave dialling instructions in a tabulated format. For a normal call the CAPT button was to be pressed twice and for an emergency call the EMER CALL button was to be pressed four times.

Interphone calls from flight deck

The OM Volume II stated that a routine call from the flight deck to an FA position was announced by a single Hi/Lo chime sounding in the cabin and by a green light and a message on the relevant AIP. An EMER CALL from the flight deck to the cabin was initiated by depressing a guarded pushbutton on the CCSP. This sounded a series of three Hi/Lo chimes on all cabin loudspeakers while all AIPs showed an EMERGENCY CALL message and a flashing red light. After depressing the guarded pushbutton pilots could speak on the interphone to any FA who picked up a handset by depressing the ATT push button on their ACP.

Flight deck door indications

The lower of two central display panels on the main instrument panel is termed the System Display (SD). When the aircraft is parked and electrical power is switched on, the SD will, by default, present the DOOR/OXY[12] page which depicts the status of each door and its

Footnote

[12] Doors and oxygen page.

associated slide on a diagrammatic representation of the aircraft. A locked and armed door is depicted by a green symbol with the message SLIDE next to it in white letters. An open door is depicted by an amber symbol plus an amber caution message, CABIN. If a door is not armed the message SLIDE is displayed in amber instead of white.

Evacuation procedures

The aircraft operator's OM Volume I stated that the commander normally initiates an evacuation and that pre-planned and unplanned evacuations were to be executed in the same manner. This guidance was reflected in the Flight Manual (FM) Part 1, which stated:

> *'In an emergency evacuation, it is likely that certain passengers and crewmembers will suffer injury. The Captain should consider the relative risks of remaining aboard the aircraft against the risks of evacuation.'*

However, both these manuals and the FSIM indicated that, when an aircraft is stationary and FAs determine that a life-threatening situation exists, they may initiate an evacuation if they are unable to communicate with the commander. The FSIM noted that fire or smoke may indicate a life-threatening situation, and stated that 'if contact with the flightdeck is not possible FAs will make an independent decision regarding evacuation and operate all usable exits'. In the event that one FA initiates an evacuation, all FAs were to initiate evacuation procedures immediately by shouting evacuation commands. The FSIM did not differentiate between pre-planned and unplanned evacuations but stated that the commander had the authority to override their decisions.

The FSIM contained a list of FA '*Evacuation Procedures*'. FAs were trained to follow these procedures without reference to notes. It offered no guidance regarding the PA which an FA should make to initiate an evacuation.

The OM Volume I stated:

> *'Depending on the Emergency, A DOORS ECAM may indicate that the evacuation has started. If an evacuation has commenced, it is usually best not to attempt to stop the evacuation already in progress. If an evacuation has not commenced and it is determined that an evacuation is not needed, make an immediate PA commanding, "This is the captain. Remain seated, remain seated, remain seated".'*

The FSIM indicated that the aircraft commander might make additional PAs in an evacuation situation, including '*Remain seated, remain seated*' to advise that circumstances had changed. It stated that FAs hearing this were to safely stop the evacuation but that:

> *'It is critical for FAs to update the captain if cabin conditions warrant an evacuation. The flightdeck may be unaware of life-threatening situation(s) -e.g., excessive smoke, fire.'*

The flight deck evacuation checklist was presented on the back page of the QRH. It included shutting down the engines and APU and using fire extinguishing agent, if appropriate, instructing the commander to make an evacuation PA and to operate the EVAC COMMAND switch. The OM Volume I stated that when the commander and co-pilot had completed their flight deck duties they should proceed to the cabin, assess the conditions and assist with the evacuation.

Emergency deplaning

The FSIM included a further procedure entitled '*Emergency Deplaning / Evacuation at the Gate*'. It stated that if only a jetbridge was used, the event was considered an '*Emergency Deplaning*' rather than an evacuation. The first step in this procedure was for FAs to advise the flight deck immediately, if possible, of any emergency. The second step was:

> *'Use PA (if possible) to direct passengers to a door equipped with a jetbridge… If PA is used, add the following introduction: "Your attention please, this is your flight attendant, everyone must quickly leave the aircraft"'*

Step three instructed all FAs to remain near their assigned exits, if possible, and to direct passengers by repeating the same instructions. It warned that disarmed doors should not be left unattended while passengers were deplaning. Step four stated:

> *'If, at any time, an evacuation signal is given (e.g., "This is the captain. Evacuate. Evacuate. Evacuate." followed by the signalling system), immediately initiate an evacuation using all useable exits and appropriate evacuation commands. Be prepared to arm and open all usable exits, if necessary.'*

The Emergency Deplaning procedure was not mentioned in the aircraft operator's A330 QRH, the FM Part 1 or in the OM Volume I. However, it is a procedure recognised by the International Air Transport Association (IATA) which refers to '*Rapid Deplaning*' in its Cabin Operations Safety Best Practices Guide, stating:

> *'There are situations when passengers and crew need to deplane immediately and quickly (e.g., in serious situations such a fuelling emergency). A rapid deplaning is when passengers and/or crew rapidly exit the aircraft via the boarding doors and via the jetbridge or stairs, for precautionary measure. A rapid deplaning may be initiated by the pilots or, in their absence, the SCCM.'*

Some UK aircraft operators refer to such a procedure as '*Precautionary Rapid Disembarkation*'.

CVR procedures

The aircraft operator's Safety Policies & Procedures Manual stated that for accidents or incidents that occur outside the United States the Investigator in Charge from the State of Occurrence will have authority over the disposition of the FDR and CVR, and that an '*NTSB or Foreign Government Investigator may request the DFDR or CVR*'.

The FM, which was not specific to this aircraft type, listed the occasions on which commanders must report immediately to the operator's '*Dispatch*' department. Some, including '*Evacuation of an aircraft in which an emergency egress system is used*', required the circuit breaker for the CVR to be pulled after flight.

On this aircraft the CVR circuit breaker was situated in the avionics compartment below the flight deck, and the operator's A330-300 OM Volume I ('*Non-Normal Operations*') stated that for various occurrences, such as after an evacuation, pilots were to contact '*maintenance*' to ensure the CVR circuit breaker was pulled.

EU requirements

Exit seats

The term "exit seats" is not used in EU regulations. European aircraft operators are required to ensure that passengers in seats '*that permit direct access to emergency exits appear to be reasonably fit, strong and able to assist the rapid evacuation of the aircraft in an emergency*.'

EU regulations also specify that passengers with direct access to emergency exits that are not staffed by cabin crew members receive a pre-flight briefing on the operation and use of the exit. According to EASA "Such briefing is not a training; the aim is to provide the necessary basic instructions for a fast egress from the aircraft if a situation dictates so". This briefing is additional to the safety briefing given to all passengers; informing them of the location of emergency exits, where safety briefing cards are stowed and what they contain.

Crew stations

Commission Regulation (EU) No 965/2012 contains the EU requirements for cabin crew to be at their stations. Its Annexe IV, Commercial Air Transport Operations, paragraph CAT. OP.MPA.210 (b) states:

> *'During critical phases of flight, each cabin crew member shall be seated at the assigned station and shall not perform any activities other than those required for the safe operation of the aircraft.'*

The phrase '*critical phases of flight'* is defined as '*the take-off run, the take-off flight path, the final approach, the missed approach, the landing, including the landing roll, and any other phases of flight as determined by the pilot-in-command or commander*'. Further guidance regarding crew stations is offered in the Acceptable Means of Compliance (AMC) to the Regulation, as follows:

> *'CABIN CREW SEATING POSITIONS*
>
> *(a) When determining cabin crew seating positions, the operator should ensure that they are:*
>
> *(1) close to a floor level door/exit;*
>
> *(2) provided with a good view of the area(s) of the passenger cabin for which the cabin crew member is responsible; and*
>
> *(3) evenly distributed throughout the cabin, in the above order of priority.'*

Thus, EU regulations do not require cabin crew to be evenly distributed throughout the cabin or at specific stations while passengers are boarding or deplaning or when passengers are aboard a parked aircraft.

Annexe III to EU 965/2012 concerns Organisation Requirements for Air Operations. Paragraph ORO.CC.100 details factors that commercial operators should consider when determining the number of cabin crew required on an aircraft. These include the number and type of aircraft doors or exits, their location relative to cabin crew stations and cabin layout, additional actions to be performed by cabin crew with responsibility for a pair of doors or exits and, in the AMC:

> *'The location of cabin crew stations taking into account direct view requirements and cabin crew duties in an emergency evacuation including:*
>
> *(i) opening floor level doors/exits and initiating stair or slide deployment;*
>
> *(ii) assisting passengers to pass through doors/exits; and*
>
> *(iii) directing passengers away from inoperative doors/exits, crowd control and passenger flow management;'*

UK operators' procedures

Some UK aircraft operators provide guidance regarding cabin crew presence at doors or exits on a parked aircraft. One Airbus 330 operator stated that at each pair of doors (including the floor-level exits at 3L and 3R), the left door must be manned by cabin crew at all times when passengers are aboard.

Another operator, with a large fleet of both narrow-bodied and wide-bodied aircraft, indicated that on some types it would be impossible for cabin crew to assist passengers to board or disembark if a cabin crew member always remained next to each pair of floor-level exits. This operator required at least one cabin crew member to '*remain in the vicinity of each pair of floor-level exits*' during boarding. The operator stated that the definition of '*in the vicinity*' was provided because the concept was trained thoroughly. As crew moved further away from an exit they were expected to keep the cabin situation under ever-closer scrutiny and always to be ready to return to the exit area without delay should an emergency arise.

IATA guidance

The IATA Cabin Operations Safety Best Practices Guide (3rd edition) states at paragraph 11.7 that:

> *'During passenger boarding, cabin crew should be evenly distributed throughout the cabin, as close to the exits as practicable to help ensure that they are ready to carry out an evacuation if necessary without warning.'*

Personnel

The crew had rested for more than 24 hours after operating a flight to London the previous day. All the FAs had more than three years' experience on the A330-300 and five had operated this aircraft type for more than 10 years. Each had completed annual recurrent training for this type within the preceding eight months.

This recurrent training required the FAs to prove their knowledge of emergency equipment and procedures using an on-line module before participating in a practical element. This involved type-specific cabin mock-ups in which they had to demonstrate correct operation of the doors while giving appropriate verbal commands to passengers. Sometimes the FAs had simulated calling the flight deck by interphone but each year they were required to demonstrate they could perform an unplanned evacuation of the A330-300 using the cabin mock-up. Their training was intended to ensure they could evacuate aircraft safely in various scenarios, although practise for evacuating a parked aircraft was not required and had not been specifically addressed. There was no evidence of joint evacuation training being undertaken by the FAs and flight deck crew.

The IRO had 11,725 hours experience on this type of aircraft. The commander had 1,912 hours on type (31,635 hours total time) and the co-pilot had 305 hours on type (12,700 hours total time). They had all completed licence proficiency training in the preceding 10 months, in addition to the recurrent human factors training required every 9 months. Their training for evacuation procedures had focussed on rejected takeoffs with fires, leading to a cabin evacuation initiated by the commander. The pilots had practised this in a flight simulator but had not experienced evacuation scenarios involving a parked aircraft because there was no requirement for them to do so.

The operator stated that it aimed to integrate some aspects of flight crew and FA recurrent training but had not provided joint practice of emergency procedures such as cabin evacuation. It acknowledged that when an aircraft is parked at the gate, certain circumstances might warrant an evacuation using only the jetbridge (emergency deplaning), while others might justify the use of all available exits. The operator stated that "its training program emphasized proper assessment of any evacuation situation and the exercise of sound judgment by the cabin crew in accomplishing safe and orderly evacuation".

Crew Resource Management (CRM) training requirements

FAA requirements

The FAA's AC 120-51E concerning CRM training states, '*Communication and coordination problems between cockpit crewmembers and flight attendants continue to challenge air carriers and the FAA.*' It notes that while CRM training is required to be included in recurrent training programmes, '*Joint CRM training for pilots and flight attendants is not required by FAA regulations, but it is encouraged and has been practiced effectively at some air carriers for years*'. The AC recommends that recurrent training includes CRM exercises in which entire crews participate.

The FAA's *Flight Standards Information Management System*[13] document states that its pilot operations inspectors and cabin safety inspectors:

> *'…should ensure that their assigned certificate holders are aware of the desirability of flightcrew and F/As performing emergency evacuation and ditching drills together. Furthermore, they should ensure that when this is not possible, air carriers are aware of the desirability of training programs that include information addressing the roles of other crewmembers during emergency evacuations and ditchings.'*

EU requirements

Annexe III to EU 965/2012 requires flight and cabin crew to undertake certain combined recurrent CRM training. This is specified by AMC1 to ORO.FC.115 paragraph (a) (6) (ii) (A), which states that the combined training should address at least, '*effective communication, co-ordination of tasks and functions of flight crew, cabin crew and technical crew*.' This is repeated in the AMC to ORO.CC.115. Operators are also required by ORO.CC.140 to include evacuation procedures in annual recurrent training for cabin crew (only).

There is no EU requirement for flight crew and cabin crew to receive joint training specifically relating to evacuation procedures. However, some UK operators do routinely include this because, under previous UK regulations which are no longer extant, the Civil Aviation Authority (CAA) had stated (in Civil Aviation Publication 789):

> *'Particular emphasis should be placed on the provision of joint practice in aircraft evacuations and other emergencies so that all who are involved learn of the duties other crew members should perform before, during and after evacuation, thereby appreciating the necessity for effective two-way communications in such emergencies.'*

Footnote

[13] FAA Order 8900.1, Volume 3, paragraph 3-1167 and 3-1792 refer.

Canadian requirements

The Transportation Safety Board (TSB) of Canada studied evacuations of 21 large passenger-carrying aircraft which occurred between 1978 and 1991. Its report[14] found that in three evacuations ineffective crew communications exposed passengers and crew to unnecessary risks. It recommended, among other things, that, '*The Department of Transport require that air carriers implement an approved joint crew emergency training program with emergency simulations for all air crew operating large passenger-carrying aircraft.*' In 1995 Transport Canada introduced new joint CRM training requirements for pilots and FAs, specified in Canadian Aviation Regulations Standard 725.124 paragraph (39), which states that air operators are to provide CRM training that includes:

> *'(b) Annual training in safety and emergency procedures. It shall include, as applicable, joint participation of pilots and flight attendants and cover the following items:*
>
> *(i) relationship of crew members;*
>
> *(ii) review of accidents/incidents of air operators;*
>
> *(iii) presentation and discussion of selected coordinated emergency procedures (practice of CRM skills); and*
>
> *(iv) crew member evacuation drills, including debriefing.'*

IATA training guidance

The IATA Operational Safety Audit (IOSA) Standards Manual sets out standards and recommended practices against which operators are audited by IOSA[15]. Paragraphs FLT 2.2.9 and CAB 2.2.10 state:

> *'If the Operator conducts passenger flights with cabin crew, the Operator should ensure flight crew members participate in joint training activities or exercises with cabin crew members for the purpose of enhancing onboard coordination and mutual understanding of the human factors involved in addressing emergency situations and security threats.'*

IATA acknowledges such joint training may be difficult to organise, especially when cabin crew outnumber flight crew, so joint training in emergency procedures is not mandated but its inclusion in recurrent training is recommended, at least once every 36 months.

Previous incidents

Evacuation of Boeing 747-436, G-CIVB at Phoenix, Arizona, 11 July 2009

Acrid fumes were noticed when the aircraft was pushed back and the engines started. The engines were shutdown, the doors were disarmed and as the aircraft was towed back on stand several passengers left their seats. Before the door was opened, cabin crew at exits

Footnote

[14] TSB Aviation Safety Study SA9501.
[15] All IATA member airlines are IOSA registered and must remain registered to maintain IATA membership.

3L and 4L, in the worst affected part of the cabin, observed smoke coming from a sidewall and left their stations to use fire extinguishers.

Some passengers became distressed and one person opened the unmanned and un-armed exit 3L. The slide did not deploy and nobody used the exit, although the evacuation alarm was activated. Shortly afterwards the commander instructed that the other doors be re-armed and he then ordered an evacuation using exits on the right side of the aircraft (the terminal was in close proximity on the left side). No slide-related injuries were reported.

After the event the CVR was not preserved because electrical power was applied during maintenance activity. The AAIB made relevant Safety Recommendations to both the operator and the CAA. These were accepted and action was taken to ensure timely preservation of CVR recordings in the event of future reportable occurrences, in accordance with ICAO Annex 6 Part I, 11.6 and EU-OPS 1.160. The AAIB report was published in Bulletin 6/2010.

Evacuation of Boeing 757-28A, G-FCLA at Glasgow Airport, 11 October 2012

Smoke appeared in the cabin and flight deck while passengers were disembarking onto a jetbridge from door 2L. The commander ordered an evacuation, shut down the APU (which he believed was causing the smoke), and alerted ATC. The aft doors 4L and 4R were re-armed and opened by cabin crew, and passengers escaped down slides from these exits and from 3R.

On this aircraft type the exits at 3L and 3R have permanently armed slides and one cabin crew member is stationed adjacent to 3R. The operator of this aircraft requires crew to '*remain in the vicinity*' of exits when passengers are on-board, even when the doors are permanently armed. Door 3L was not opened due to the close proximity to the jetbridge. The crew observed that all the lavatory smoke alarms were activated and this increased the noise level in the cabin. The AAIB report of this occurrence was published in Bulletin 3/2013.

Evacuation of Boeing MD-88, N909DL, at LaGuardia Airport, New York, 5 March 2015

The aircraft was substantially damaged when it departed the runway with five crew members and 127 passengers on-board. The NTSB report of this accident and the subsequent evacuation (NTSB/AAR-16/02) made several Safety Recommendations to the FAA including:

> *'A-16-025 - Require 14 Code of Federal Regulations Part 121 operators to provide (1) guidance that instructs flight attendants to remain at their assigned exits and actively monitor exit availability in all non-normal situations in case an evacuation is necessary and (2) flight attendant training programs that include scenarios requiring crew coordination regarding active monitoring of exit availability and evacuating after a significant event that involves a loss of communications.*

> *A-16-026 - Develop best practices related to evacuation communication, coordination, and decision-making during emergencies through the establishment of an industry working group and then issue guidance for 14 Code of Federal Regulations Part 121 air carriers to use to improve flight and cabin crew performance during evacuations.'*

Regarding Recommendation A-16-025, the FAA is considering revising AC 120-48, which provides guidance on communication between flight crew and FAs. In response to Recommendation A-16-026, the FAA is considering establishing an industry-wide working group *'to examine the issue and make recommendations on additional ways of enhancing communication, coordination and decision-making during emergencies'.*

Previous occurrence involving Airbus A320-214, G-EZWX

During a flight on *28 November 2016*, the crew of G-EZWX had difficulty establishing internal emergency communications due to an undocumented feature of the interphone emergency call function. This confused crew members and delayed the flight deck crew in establishing two-way communications with the cabin crew. Following an AAIB investigation[16], the aircraft manufacturer advised that it would provide additional information to operators on the operation of the emergency interphone system. The aircraft operator intends to provide its crews with appropriate guidance and training once this information is made available.

NTSB Recommendations

A NTSB study of 46 aircraft evacuations which occurred between September 1997 and June 1999[17], found that communication and co-ordination issues continued to exist between flight crew and FAs during evacuations. It noted that joint evacuation exercises had proved effective at resolving these problems and made Recommendation A-00-85 that the FAA should require air carriers to conduct periodic joint evacuation exercises involving flight crews and flight attendants. This Recommendation was rejected by the FAA on the basis that it considered the recommendations in AC-120-51 and in the Air Transportation Operations Inspectors' Handbook[18] to be sufficient.

Following the evacuation of an MD-88 at LaGuardia Airport in March 2015 the NTSB made further recommendations concerning flight and cabin crew performance during evacuations (see *Previous incidents*).

CVR overruns

CVR overruns are well documented in accident and serious incident reports and have prompted a corresponding number of recommendations for the duration of CVRs to be increased. Initially this resulted in the requirement to fit commercial air transport aircraft with a Maximum Certificated Takeoff Mass (MCTOM) greater than 5,700 kg, issued with

Footnote

[16] The report of this investigation was published in AAIB Bulletin 9/2017.
[17] Safety Study NTSB/SS-00/01 Emergency Evacuation of Commercial Airplanes.
[18] Since superseded by the Flight Standards Information Management System document.

an individual C of A (Certificate of Airworthiness) on or after 1 April 1998, with CVRs with a minimum duration of 2 hours. Further changes have now been adopted by the European Commission (Commission Regulation (EU) 2015/2338 amending Regulation (EU) No 965/2012) requiring commercial air transport aircraft with an MCTOM greater than 27,000 kg and first issued with an individual CofA on or after 1 January 2021 to carry a CVR with a minimum duration of 25 hours.

Analysis

The aircraft was operating with an APU generator inoperative and had been dispatched in accordance with the MEL, which included a check of the APU generator condition using the aircraft's maintenance computer. This check did not reveal any anomalies.

Examination of the APU after the event revealed considerable metallic debris in the shared oil system. This debris eventually caused the load compressor carbon seal to fail, allowing hot oil to enter the bleed air supply to the cabin and causing smoke in the cabin. The initiating source of the debris could not be identified positively due to the distribution of debris throughout the oil system.

A feature was available to detect and shut down the APU automatically in the event of lubrication system contamination causing impending oil filter bypass, but was not installed on this aircraft. Had this feature been fitted, it is likely the APU would have shut down automatically prior to the filter bypass condition, thereby preventing the conditions that led to pyrolysed oil entering the cabin. Accordingly**,** to prevent a similar occurrence, the following Safety Recommendations are made.

Safety Recommendation 2017-022

It is recommended that the Federal Aviation Administration mandate Service Bulletin GTCP331-49-7936 to add a system that shuts down the APU automatically if there is contamination of the lubricating oil.

Safety Recommendation 2017-023

It is recommended that the European Aviation Safety Agency mandate Service Bulletin GTCP331-49-7936 to add a system that shuts down the APU automatically if there is contamination of the lubricating oil.

This event surprised the crew and developed quickly. The pilots were pre-occupied with resolving an unrelated system defect and the flight deck environment was complicated by the presence of an engineer and the GOC. In the cabin, some FAs had found passenger boarding more pressured than normal and preparations were being made for a manual safety briefing when the smoke appeared.

First appearance of smoke

Several FAs attempted to contact the commander, in accordance with the operator's guidance but using the normal interphone call function. None of the pilots noticed the small amber lights on the ACPs or the single buzzer tone which announced a cabin interphone

call. The commander suggested afterwards that this might have been due to the noise of the master warning. Aural chimes were not cancelled immediately the SMOKE LAVATORY SMOKE warning was noticed. It is possible the interphone call was not noticed because simultaneously the pilots were asking the engineer about the smoke.

Flight deck reaction to smoke

It took the flight crew a few moments to appreciate that the smoke was not associated with the engineer's work. The commander then assumed it was being emitted by the air conditioning system, fed by the APU, so he pressed the switch to shut off the APU bleed.

The commander's prompt action indicates that he assimilated the problem quickly, but was accomplished without reference to a checklist. His recollection that the SMOKE LAVATORY SMOKE warning was present before he took this action accorded with the IRO's report which stated the commander and the co-pilot then actioned the checklist for SMOKE LAVATORY SMOKE. However, the only action on this checklist was to establish communications with the cabin, and none of the flight crew tried to contact the FAs using the interphone at this stage. Although the A-FA apparently tried to pass an extinguisher into the flight deck, her presence only appears to have been acknowledged by the IRO and no discussion concerning the situation in the cabin appears to have ensued.

Absence of recorded data

The absence of recorded data prevented a more precise understanding of the sequence of events. The co-pilot may have referred to the QRH immediately smoke was seen and, while he was doing this, the commander turned off the APU bleed. If so, the co-pilot and IRO were conducting the '*Smoke/Avionics Vent Smoke/Fumes'* procedure when the SMOKE LAVATORY SMOKE warning illuminated, accompanied by the chimes of the master warning. With the door to the flight deck open the sound of the lavatory alarm from the cabin speakers would have added to the noise level. The flight crew indicated that they were presented with several simultaneous visual and aural inputs, which might account for conflicting recollections of the event sequence.

Emergency call option

The aircraft operator's instructions to FAs for communication with the flight deck in the event of smoke in the cabin was not consistent. Contrary to this guidance, it is necessary to press the EMER CALL button on this aircraft only once to initiate an emergency call.

An emergency call may have been more noticeable to the pilots than a normal call, and prompted them to respond to the FAs. No such guidance was provided by the operator. The FAs were trained to operate on several types of aircraft. Handset keypad layouts are not standardised, such that emergency calls are initiated in different ways on different types. This lack of standardisation may have been a factor in the FAs being unable to initiate an emergency call. Therefore the following Safety Recommendations are made:

Safety Recommendation 2017-024

It is recommended that the Federal Aviation Administration regulate the operation of interphone handsets, including during emergency communications, so that it is standardised irrespective of aircraft type.

And:

Safety Recommendation 2017-025

It is recommended that the European Aviation Safety Agency regulate the operation of interphone handsets, including during emergency communications, so that it is standardised irrespective of aircraft type.

When smoke became apparent in the flight deck, the flight crew responded quickly by taking action they considered appropriate but they did not call the FAs to establish the situation in the cabin. The SMOKE LAVATORY SMOKE checklist requires this to be done and, although an emergency interphone call is not specified, this offers the best means of conferring with all the FAs. The lack of such immediate liaison with the FAs indicates that training to respond to smoke events while on the ground could be improved. The aircraft operator has reported the action it intends to take to address this (see *Aircraft operator's response* in the Safety action section).

Initiation of evacuation

When the E-FA received no response to her interphone call, she decided the situation was life-threatening and made a PA to initiate an evacuation. The alternative '*Emergency Deplaning*' procedure was not mentioned in guidance to flight crew. An appropriate drill has now been introduced (see *Aircraft operator's response* in the Safety action section). The inconsistency might have become apparent to the aircraft operator earlier if the two groups had received regular joint training for evacuation scenarios.

The FA's decision to initiate evacuation was consistent with the aircraft operator's policy that FAs may initiate an evacuation if: the aircraft is stopped, they are unable to communicate with the commander and a threat to life is identified. Having made a PA commanding an evacuation the E-FA did not turn on the evacuation signal, though this is an action the operator expects its FAs to accomplish without reference to notes.

Once an evacuation was commanded, all available exits should have been used, but the exits at 1L, 1R and 2R were not opened and the FAs in the forward portion of the cabin executed an '*Emergency Deplaning*' using only the jetbridge at 2L. Following this event, the aircraft operator's task force has identified the need to prepare new guidance and improve crew training for '*Emergency Deplaning / Evacuation at the Gate*' (see *Aircraft operator's response* in the Safety action section).

Exit seat passengers

The two FAs who might have been in the vicinity of exit 3L or 3R when the evacuation PA was made had both moved away to obtain demonstration pouches. If pouches had been located close to these exits, or if only one of the FAs had gone to obtain one, then a crew member trained to operate the exits would have remained nearby. However, there was no requirement for an FA to remain in the vicinity of these floor-level emergency exits or for the FAs to be evenly distributed throughout the cabin when boarding or deplaning is not taking place and an aircraft is parked.

Passengers in the adjacent seats had received an '*exit seats*' briefing, which effectively placed responsibility on them to operate the exit in an emergency if no crew member was nearby. The safety information card to which they had been referred provided detailed instructions on '*Exit Seat Responsibilities*' as well as diagrams indicating how the exit should be operated.

After hearing the evacuation PA and perceiving the smoke, passengers in the seats adjacent to 3L and 3R opened both exits. Apparently those at 3R decided they needed to do something more than lift the door operating handle and sought help from a passenger seated further aft, who was able to arm the slide before opening the door. CCTV imagery showed that door 3R began to open approximately 30 seconds after smoke was emitted by the APU, and before door 4R opened. It is not known if the passengers checked outside for dangers or hazards before opening door 3R and deploying the slide.

The door at exit 3L was apparently opened in accordance with the safety information card, without the slide being armed. However, the guidance on the card which then shows the manual slide deployment handle being pulled, was not followed and the slide did not deploy. The fall of 5.2m metres from the sill of this door to the ramp below represented a significant hazard to anyone using it.

It is possible that by verbally agreeing to adopt the role of '*exit seat*' passenger, and by accepting detailed instructions, they felt responsible for opening the exits because no FAs were present. Under EU regulations, passengers seated adjacent to unsupervised exits do not receive detailed instructions on '*Exit Seat Responsibilities*' but are given a more basic briefing aimed at allowing them to make a fast egress from the aircraft if necessary. Therefore the following Safety Recommendation is made:

Safety Recommendation 2017-026

It is recommended that the Federal Aviation Administration reconsider the requirements for briefings given to passengers seated at exits, to ensure they offer appropriate guidance on exiting the aircraft rapidly in an emergency without implying undue responsibility for opening the exits.

A review of previous similar events suggests that this scenario is not unique and indicates it is desirable for trained crew members to be available to operate floor-level emergency exits whenever an aircraft is on the ground with passengers on-board. The practice of

some UK operators to do so has proved effective, for example during the evacuation of a Boeing 757 at Glasgow in 2012.

IATA advocates cabin crew being evenly distributed throughout the cabin during passenger boarding. This is reflected in FAA regulations which require, when an aircraft has more than one FA, that the FAs be evenly distributed throughout the cabin and in the vicinity of floor-level exits during both boarding and deplaning, to provide the most effective assistance in the event of an emergency. However, the FARs do not require the FAs to be evenly distributed at other times when passengers are on-board a parked aircraft and the EU regulations do not include such a provision. Therefore the following Safety Recommendations are made:

Safety Recommendation 2017-027

It is recommended that the Federal Aviation Administration require cabin crew on aircraft that are parked, and with passengers on-board who are neither boarding nor deplaning, to be evenly distributed throughout the cabin and in the vicinity of floor-level exits in order to provide the most effective assistance in the event of an emergency.

And:

Safety Recommendation 2017-028

It is recommended that the European Aviation Safety Agency require cabin crew on aircraft that are parked and with passengers on-board to be evenly distributed throughout the cabin and in the vicinity of floor-level exits, in order to provide the most effective assistance in the event of an emergency.

Evacuation from 4L and 4R

Having been unsuccessful contacting the flight crew by interphone, the four FAs in the aft galley area assessed that the situation merited an emergency evacuation. The lavatory smoke alarm was sounding in the cabin but the C-FA misidentified this as the secondary evacuation signal. The sounds of the two alarms are different and AIP provides a further indication, so this misinterpretation suggests inadequate training or knowledge of the systems. However, even if the alarm had been correctly identified, it is likely that the dense and noxious smoke was sufficient for the FAs in the aft galley to initiate evacuation, with or without a PA instruction being heard.

The FAs reported that they worked in a well-coordinated manner to arm the doors and begin an orderly evacuation, with the first passengers seen using the 4R slide one minute after smoke was first emitted from the APU exhaust.

Commander's instruction to cease evacuation

The occupants of the flight deck did not report noticing amber door indicators presented on the flight deck SD. The pilots' attention may have been focussed on the smoke warning on the display above. Consequently the commander only realised that a slide evacuation was

underway when he saw a reflection of the deployed slide from the terminal building. He thought the source of the smoke had been removed, because he had taken action to close off the APU air supply. He knew the APU had shut down, so did not seek assistance from outside the aircraft. He was concerned passengers might be put at more risk by using the slides than by staying on-board.

Had the commander initiated an EMER CALL to speak to the FAs it would have been in accordance with the actions required for the SMOKE LAVATORY SMOKE warning displayed at the time. This would have enabled the commander to agree a course of action with the FAs. Instead he made a PA to stop the evacuation, despite the OM's guidance that it is '*usually best*' not to attempt to halt an evacuation that is underway.

The commander's PA briefly caused confusion in the cabin and although he subsequently reversed this instruction, passenger egress was delayed by a few seconds. However, the commander reported that as soon as he realised slides had been deployed he made his PA to prevent injury; this stopped passengers from using the slide at 3R and ended the controlled slide evacuation from 4L and 4R.

Aerodrome assistance

The rapid response of the emergency services was due to ATC noticing an evacuation was underway and declaring an AGI. A delay could have occurred if the aircraft had been on a stand out of ATC's line of sight, because no appropriate radio call was made. The only radio call the commander made was to alert the aircraft operator to the presence of passengers on the ramp. He did not call ATC because he assessed they already knew what was happening when he saw the RFFS arrive. Almost two minutes elapsed between the commander's PA to end the evacuation and the arrival of the first RFFS vehicle.

Subsequent flight deck actions

The evacuation commenced without the flight crew's knowledge and the evacuation checklist was not actioned immediately. Following the commander's intervention and the subsequent decision to continue evacuating passengers via the jetbridge, the co-pilot and the IRO actioned the evacuation checklist to ensure "nothing was missed". However, the second checklist item, to call ATC, was not carried out. ATC had tried to call the aircraft without response and a direct line of communication between the two parties might have enabled important information to be exchanged.

The evacuation checklist also instructs the evacuation signalling system to be switched on but this was not deemed necessary with passengers now leaving by the jetbridge. A flight crew drill for '*Emergency Deplaning*' might have been more appropriate but did not exist at the time (see *Aircraft operator's response* in Safety action).

The pilots remained aboard after the passengers and FAs had deplaned and the RFFS had declared the aircraft to be safe. The commander and the operator's '*Dispatch*' department communicated but no action was taken to remove power from the CVR in accordance with the FM.

Crew training

The aircraft operator's guidance lacked clarity in places and there were differences between that provided to the flight crew and to the FAs. For example, the OM Volume 1, referred to by the flight crew, divided evacuations into planned and pre-planned events but no such differentiation was made in the FSIM, to which the FAs referred. The crew experienced communication and co-ordination difficulties, and some recommended procedures were not followed. This suggests that training for this scenario could be improved and reflects findings in Safety Study NTSB/SS-00/01 and also in Canada's TSB Aviation Safety Study SA9501.

The EU requires joint recurrent training that must address '*effective communication and co-ordination of tasks and functions*'. IATA recommends that flight and cabin crew participate in joint training to enhance their co-ordination and a mutual understanding of human factors when dealing with emergencies. Whilst the operator involved in this occurrence has proposed action to improve its processes, improvements more generally may require action by the regulator. Accordingly, the following Safety Recommendation is made:

Safety Recommendation 2017-029

It is recommended that the Federal Aviation Administration require that flight and cabin crew participate in joint training to enhance their co-ordination when dealing with emergencies.

Safety action

Aircraft operator's response

The aircraft operator recognised several aspects of this evacuation which it considered well handled by its personnel, allowing the aircraft occupants to move to a place of safety with minimal injury. However, the operator also found its guidance and training for cabin evacuations was orientated towards incidents during takeoff or landing, and its internal Safety Management System (SMS) dictated that certain processes be changed.

Rather than delaying any changes while a detailed internal report was prepared, the operator immediately established an Emergency Deplaning and Evacuation Task Force. Its role was to improve co-ordination and communication between the workforce in the flight deck, the cabin and on the ramp, to mitigate risks to passengers and employees during emergencies. This resulted in several internal safety actions:

- All pilots were informed that an evacuation should only be halted by the commander if he '*has clear information that continuation of the evacuation would cause greater injury*'.
- Studies of the interphone equipment on different aircraft types confirmed a need to refine the communication process on certain types. On the Airbus A319, A320, A321 or A330-300, FAs should now press the EMER CALL button once to contact the flight deck in an emergency. On the Airbus

A330-200 they should press the PRIO CAPT button and on the Embraer E190 the EMER PILOT button.

- A video was produced with the co-operation of the crew involved in this occurrence, to highlight the issues they experienced. This video is being used as an educational tool for all pilots during their recurrent Human Factors (HF) training, for the nine month cycle commencing 1 February 2017. It may also become possible to use this video during FA training.
- A type-specific '*Emergency Deplaning*' drill has been developed for use by pilots on each of the operator's aircraft types and incorporated into the OM and the appropriate QRH. This drill is relevant to parked aircraft that are using a jetbridge or steps. Details were promulgated to all crews and pilots received relevant simulator training.
- As there is no commonality between the cabin interphone handsets on different aircraft types, a physical training aid is being developed for use during initial and recurrent FA training. This is intended to give FAs a better understanding of the differences they will encounter and to help them adapt to any of the 14 aircraft types or variants on which they can be qualified.
- Recurrent HF training for the aircraft operator's 12,000 pilots takes place on a 9 month cycle. The 27,000 FAs are on a 12 month cycle. This makes it difficult to conduct joint evacuation training with entire crews, so the operator is considering having pilot representatives participate in FA training and vice-versa. Future recurrent training for both pilots and FAs will focus on unplanned cabin evacuations when the aircraft is not on the runway.
- The Continuing Qualification training given to all FAs between April 2017 and March 2018 includes a review of an '*Emergency Deplaning*' and it is likely attendees will hear the specific aural alert signals for each aircraft type.
- The operator expects a company safety investigator to contact the commander by telephone as soon as its '*Dispatch*' department has been advised of a serious incident or accident. The safety investigator is now required to remind the commander during this contact that action be taken to ensure the circuit breaker for the CVR is pulled without delay.
- Training procedures were developed for the aircraft operator's ramp personnel, to ensure they know how best to react if a slide evacuation occurs while an aircraft is parked.

Twice a year, US operators, along with some foreign airlines that operate to the US, share experiences at a safety forum. The operator intends to discuss issues raised by this event at such a forum; to raise the industry's awareness of the challenges that can be created by a cabin evacuation from a parked aircraft.

Aircraft manufacturer

The aircraft manufacturer has reviewed and amended the MMEL section 24-23-01, for the dispatch of an aircraft with APU AC auxiliary generation unserviceable and a summary of these changes is as follows:

MMEL item 24-23-01A 'APU not used':

No change, as not relevant to the event.

MMEL item 24-23-01B 'Electrical failure':

To insure a more robust detection of a mechanical failure, a review has been conducted with the APU Generator supplier and the following 4 failure messages will be added to the list from the AMM task 24-23-00-040-803.

GEN APU (8XS)
GEN APU (8XS) EX FLD / GAPCU (40XG)
GAPCU (40XG) EX FLD / GEN APU (8XS)
GEN APU (8XS) EX FLD / GAPCU (40XG)

If any of these messages is present in the PFR when doing the interactive APU test, then the MMEL 24-23-01C must be applied.

MMEL item 24-23-01C 'AC auxiliary generation deactivated or removed (mechanical failure)':

An update of the related AMM tasks (e.g. 24-23-00-040-801 and -802) has been decided, to prevent oil cross-contamination from the APU Gen to the APU. The AMM TASK 49-91-41-210-802-A "Check of the APU Oil System for APU Generator Debris" has been added at the end of those tasks, and must be carried out prior to aircraft dispatch. This AMM task includes a physical check of the APU oil system (inlet screens of the scavenge-oil, inspection of the magnetic chip detectors and the mechanical differential pressure indicator, check of the lubrication oil supply and generator scavenge filters).

Conclusion

Smoke entered the cabin after the APU load compressor oil seal became compromised, allowing hot oil to enter and pyrolyse in the bleed air supply to the cabin. Examination of the APU after the event revealed considerable metallic debris in its shared oil system. This debris eventually caused the load compressor carbon seal to fail, allowing hot oil to enter the bleed air supply to the cabin and causing smoke in the cabin. The initiating source of the debris could not be identified positively due to the distribution of debris throughout the oil system.

Modifications exist to mitigate these conditions and two Safety Recommendations have been made that an optional SB, to add enhanced APU automatic shut-down protection for lubrication system contamination, be mandated.

The aircraft manufacturer has reviewed and amended the MMEL to provide enhanced mitigation when operating with unserviceable APU AC auxiliary electrical generation.

This emergency situation, involving an evacuation from an aircraft parked at the gate with the jetbridge in place, was unusual for the FAs, who had not practised it as part of the aircraft operator's training programme. Prompt and effective communication between the cabin and the flight deck might have avoided an evacuation, but the pilots and the IRO were distracted by the presence of an engineer, who was attending to a defect. The normal interphone call function used by the cabin crew did not attract their attention. The EMERGENCY call function may have been more conspicuous but guidance provided by the aircraft operator concerning its use may have been confusing.

An evacuation was initiated because FAs did not receive specific instructions from the flight crew and the FAs perceived that the situation was life-threatening. Exits at the front of the aircraft were not used, indicating that the FAs in this part of the aircraft were trying to achieve an '*Emergency Deplaning*' via the jetbridge, even though an evacuation was commanded. This may have been the most appropriate procedure in this situation but it was not a drill familiar to the flight crew and better crew communication was required before using it.

Passengers near exits 3L and 3R had accepted responsibility for exit operation and, with no FAs in the vicinity when the emergency began, opened the doors but did not deploy one of the slides. This created the hazard of an unprotected five metre drop from the doorway to the ground and, even though an FA subsequently placed a security strap across the opening, it was fortunate that nobody used the affected door.

Once the commander had realised an evacuation was underway he instructed it to cease because he believed he had removed the source of the smoke and wanted to prevent injury, but he did not discuss the cabin situation with the FAs before making his PA. This indicated a breakdown in communication and co-operation between flight crew and cabin crew members; an issue which is being addressed by the operator through enhanced guidance and training. Other operators may be susceptible to similar shortcomings in these circumstances until regulations for cabin evacuation training are amended to minimise them.