United Arab Emirates

الهيئة العامة للطيران المدني
GENERAL CIVIL AVIATION AUTHORITY

Air Accident Investigation Sector

Incident

- Summary Report -

AAIS Case Nº: AIFN/0009/2011

Fumes in Passenger Cabin

Operator: Emirates
Type: Boeing 777-300ER,
Registration: A6-ECE
Place of Occurrence: Near Stockholm
State of Occurrence: Sweden
Date of Occurrence: 14 February 2011

Air Accident Investigation Sector
General Civil Aviation Authority
The United Arab Emirates

Investigation Objective

This investigation was performed pursuant to the UAE Federal Act No 20 (1991), promulgating the Civil Aviation Law, Chapter VII, Aircraft Accidents, Article 48, CAR Part VI Chapter 3, in conformity with Annex 13 to the Convention on International Civil Aviation and in adherence to the Air Accidents and Incidents Investigation Manual.

The objective of this safety investigation is to prevent aircraft accidents and incidents by identifying and reducing safety-related risk. The GCAA AAIS investigations determine and communicate the safety factors related to the transport safety matter being investigated.

All GCAA AAIS reports are publicly available from:

http://www.gcaa.gov.ae/en/epublication/pages/investigationreport.aspx

It is not a function of the GCAA AAIS to apportion blame or determine liability.

The information contained in this Summary Report is derived from the factual information gathered during the investigation of the occurrence. The exclusive objective of this work is to recommend the study and the adoption of provisions of preventative nature, and the decision as to whether they should be applied belongs to the Accountable Manager, President, Director, Chief or the one corresponding to the highest level in the hierarchy of the organization to which they are being forwarded.

This Summary Report does not resort to any proof production procedure for the determination of civil or criminal liability, and is in accordance with item 3.1, Annex 13 to the Convention on International Civil Aviation, which was incorporated in the UAE legal system.

The use of this Summary Report for any purpose other than that of preventing future accidents, may induce to erroneous interpretations and conclusions.

Investigation Process

The Air Accident Investigation Sector (AAIS) of the GCAA became aware of the event on receiving notification from the Operator, on the day of the event. AAIS notified the State of Occurrence (Sweden). On the 15th February 2011 [1] the Swedish Accident Investigation Authority (SHK)[2] offered to delegate the investigation to the GCAA AAIS, which was accepted.

[1] Communication Reference L-10/11- 15/02/2011

[2] The Swedish Accident Investigation Authority (Statens haverikommission - SHK) is a Swedish State Authority with the task of investigating accidents and incidents with the aim of improving safety (http://www.havkom.se/default.asp).

The Investigation Team coordinated with all stakeholders by initiating the investigation process according to prepared and previously exercised plans.

The occurrence involved a Boeing 777-300ER passenger flight from Dubai to New York. During cruise the cabin crew reported a smell of burning rubber and sulphur in the aft cabin area, and the flight diverted to Stockholm, Arlanda Airport.

The Aircraft landed uneventfully at the maximum landing weight.

Following maintenance action, the flight departed. However, on the subsequent sector, shortly after level off at FL300, the cabin crew again reported the odor. The flight crew consulted MCC and the right pack was turned off, in order to isolate the ozone system. After a few minutes, the smell subsided and the flight continued normally.

In accordance with the requirements of Annex 13 to the Convention on International Civil Aviation, the following authorities were notified; the NTSB [3] and the SHK. Both organizations appointed accredited representatives, who furnished the Investigation Team with all requested information, and facilitated the flow of information from Sweden.

The occurrence was initially classified as a Serious Incident. Following a review of the event the occurrence was reclassified as an Incident, in accordance with ICAO Annex 13, and the United Arab Emirates CAR-PART VI, Chapter 3. The reclassification of the occurrence as an Incident reflects the fact that there was a low probability of an accident resulting from the event.

The subsequent investigation did not reveal the reason for the odor, and this Summary Final report does not contain any Safety Recommendations.

Notes:

Whenever the following words are mentioned in this Report with first Capital letter, they shall mean the following:

- Aircraft- the aircraft involved in this Incident;
- Investigation- the investigation into the circumstances of this Incident;
- Incident- this Incident referred to on the title page of this report;
- Report- this Incident final report;
- Investigation Team- the GCAA AAIS Investigation Team;
- Pilot- the Incident Helicopter handling pilot.

Unless otherwise mentioned, all times in the report are UTC (Local time in UAE was UTC+ 4h)

Photos and figures used in this Report are taken from different sources and are adjusted from the original for the sole purpose to improve the clarity of the Report. Modifications to images used in this Report are limited to cropping, magnification, file compression, or enhancement of color, brightness, contrast, or addition of text boxes, arrows or lines.

[3] The National Transportation Safety Board is an independent Federal agency charged by Congress with investigating every civil aviation accident the United States and significant accidents in other modes of transportation – railroad, highway, marine and pipeline (http://www.ntsb.gov/about/index.html).

Abbreviations

A/C	Aircraft
AAIS	UAE GCAA Air Accident Investigation Sector
A&C	Airframe and Engines
AFM	Aircraft Flight Manual
AGL	Airfield Ground Light
AMC	Acceptable means of compliance
AMM	Aircraft Maintenance Manual
AMO	Approved Maintenance Organization
AMS	Approved Maintenance Schedule
amsl	above mean sea level
ATC	Air Traffic Control
ATPL	Air Transport Pilot License
AWOPS	All Weather Operations
AWS	Additional Work Sheets
CAAP	Civil Aviation Advisory Publication
CAR	UAE Civil Aviation Regulation
CAR-OPS	UAE Civil Aviation Regulation – UAE Certified Operators
CAT	Category
CAVOK	Cloud and Visibility OK
CG	Centre of Gravity
C of A	Certificate of Airworthiness
COM	Communication
CVR	Cockpit Voice Recorder
Cm	centimeter
CMR	Certificate of Maintenance Review
CPL	Commercial Pilot License
DAU	Digital Acquisition Unit
Degs	Degrees
E	East
ELP	English Language Proficiency
FAA	Federal Aviation Administration
FAS	Falcon Aviation Services
FCV	Flow Control Valve
FDR	Flight Data Recorder
FL	Flight Level
GCAA	UAE General Civil Aviation Authority
Hrs	hours
ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IIC	Investigator in Charge
JFK	John Fitzgerald Kennedy International Airport, New York City
Kg	kilogram
KIAS	Knots Indicated Air Speed
Km	kilometres
Ldg	Landing
LH	Left Hand
LT	Local Time
M	meters
Mb	Millibars

MHz	Mega Hertz
Mins	minutes
MPM	Maintenance Program Manual
MSI	Major Structural Inspection
MSN	Manufacturer Serial Number
N	North
NTSB	National Transportation Safety Board
OHM	Operating Helicopter Manual
OK	all correct
PW	Pratt & Whitney
QNH	barometric pressure adjusted to sea level
RH	Right Hand
RWY	Runway
ROSI	UAE's Mandatory Reporting System (Reporting of Safety Incident)
SARPS	Standard and Recommended Practices (of ICAO)
Secs	seconds
SHK	Swedish Accident Investigation Authority (Statenshaverikommission)
SN	Serial Number
SOP	Standard Operating Procedures
p/n	Part Number
Tach	Tachometer
TM	Training Manual
TO	Take Off
TSB	Transportation Safety Board of Canada
TSO	Time Since Overhaul
TSN	Time Since New
UAE	United Arab Emirates
UTC	Co-ordinated Universal Time
VHF	Very High Frequency

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1. Factual Information

1.1 History of the flight

On 14 February 2011, during cruise of the Emirates Airline Boeing 777-300ER, registration A6-ECE, which was operating a scheduled passenger flight EK203, from Dubai International Airport, UAE, to John Fitzgerald Kennedy International Airport (JFK), New York City, USA, the cabin crew reported a smell of burning rubber and sulphur in the aft cabin area. Other crewmembers identified the odor as being like a rotten egg smell. The smell subsided and then returned from cabin air vents near the overwing area.

The flight crew, in consultation with the Operator's Maintenance Control Centre (MCC), isolated the recirculation fans, galley equipment and the In Flight Entertainment (IFE) system. However, the smell continued to progress and intensified towards the forward cabin and flight deck. The flight crew elected to divert the flight to Stockholm, Arlanda Airport. The 'Smoke Fire Fumes' checklist was completed and 43 tons of fuel was jettisoned. During descent an IFE 'Cooling Fan' status message activated. The aircraft landed uneventfully at maximum landing weight. Following investigation engineering isolated the IFE cooling fan, and the aircraft was released for flight.

During the subsequent sector, from Stockholm (Arlanda) to New York (John F. Kennedy International Airport), shortly after level off at FL300, the cabin crew again reported the smell. After consultation with MCC, the right pack was turned off in order to isolate the ozone system. After a few minutes the smell subsided and the flight continued uneventfully.

During the unexpected events that occurred on the flights from Dubai, to Stockholm and onwards to New York, the crewmembers reported that cooperation was good, with leadership providing and receiving information at an optimum rate.

After landing at JFK, the right hand pack lower flow control valve was deactivated in the closed position in order to isolate the ozone converter. Both air-conditioning packs were operated on the ground and no further anomalies were noted.

On the third sector, the smell of fumes returned once again. After consultation with the Operator's MCC, the crew turned off the right air-conditioning pack and the flight continued then continued normally. Subsequent flights were all odor free.

1.2 Injuries to Persons

There were no injuries.

Injuries	Crew	Passengers	Others
Fatal	0	0	0
Serious	0	0	0
Minor / None	20	341	

Table 1. Injuries to Persons

1.3 Damage to Aircraft

The aircraft was undamaged.

1.4 Other Damage

There was no other damage as a result of the occurrence.

1.5 Personnel Information

The crewmembers were current and rested at the time of the occurrence.

For the operation of the Flight the Aircraft had two crews, the Operating Crew and the Augmenting Crew. The Operating Crew and the Augmenting Crew details are listed below:

Licence Category	GCAA ATPL
GCAA Medical Class Category	ONE
Medical Limitations	none
Date of last medical	18 July 2010
Date of last current check	16 October 2010
Total Flying hours	17000
Total hours B777	1500
Flight hours preceding 28 days	65
Flight hours preceding 7 days	28

Table 2. Operating Commander's Details

Licence Category	GCAA ATPL
GCAA Medical Class Category	ONE
Medical Limitations	none
Date of last medical	13 April 2010
Date of last current check	29 December 2010
Total Flying hours	8441:21
Total hours B777	2305:53
Flight hours preceding 28 days	77:29
Flight hours preceding 7 days	27:55

Table 3. Operating First Officer's Details

Licence Category	GCAA ATPL
GCAA Medical Class Category	ONE
Medical Limitations	none
Date of last medical	27 December 2010
Date of last current check	06 October 2010
Total Flying hours	12299
Total hours B777	2302
Flight hours preceding 28 days	56:50
Flight hours preceding 7 days	0

Table 4. Augmenting Commander's Details

Licence Category	GCAA ATPL
GCAA Medical Class Category	ONE
Medical Limitations	none
Date of last medical	11 April 2010
Date of last current check	16 January 2011
Total Flying hours	15437
Total hours B777	1157
Flight hours preceding 28 days	58.48
Flight hours preceding 7 days	6

Table 3. Augmenting First Officer's Details

1.6 Aircraft Information

1.6.1 The Boeing 777

The Boeing 777 is long-range wide-body twin-engine jet airliner developed and manufactured by Boeing Commercial Airplanes.

Aircraft type	**B777-300ER**
Serial Number	35575
Airplane Number	305
Year of Manufacture	2007
Nationality	UAE
Registration	A6-ECE
Cabin Configuration	3 CLASS
Engine Type	GE90-115B
Certificate of Registration	Issued 20 December 2007
Certification of Airworthiness	Issued 20 December 2010 Expired 19 December 2011
Last 'A' Maintenance Check	1A Check dated 12 February 2011
Last 'C' Maintenance Check	1C Check dated 13 February 2010

Table 4. Incident Aircraft Information

1.6.2 Air Conditioning Temperature Control

The diagram below illustrates the air conditioning and temperature control functional description of the Boeing 777, involved in the event.

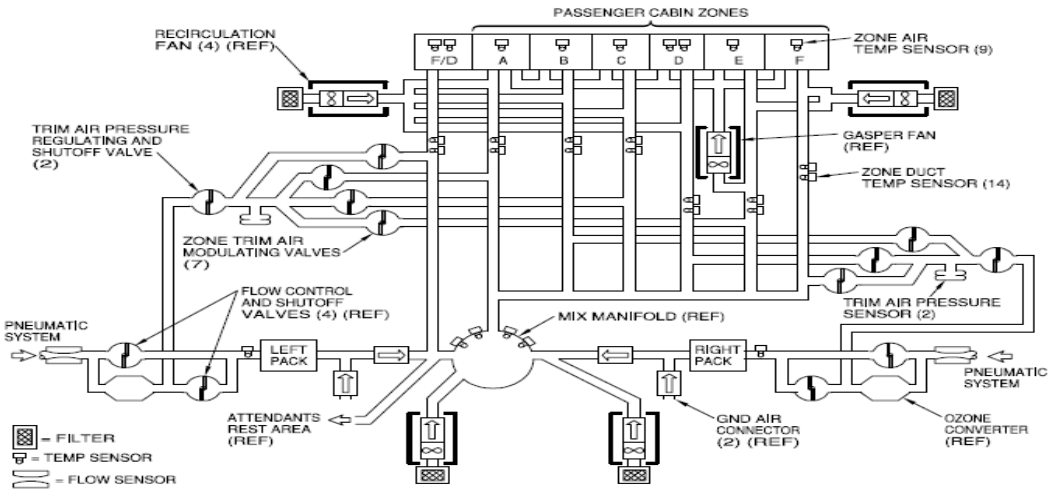

Figure 1. Boeing 777 Air Conditioning and Temperature Control

1.7 Meteorological Information

The weather conditions at the time of the event were; wind calm, cloud ceiling more than five thousand feet, visibility more than ten kilometers, temperature minus 17 on the

Celsius scale and pressure 1030 hectopascals[4], with no significant change expected to the reported conditions within the next 2 hours. In addition the runways at Arlanda were less than 10%, covered in ice of 1 millimeter depth, and braking action was good.

1.8 Aids to Navigation

Navigational aids were used for the performance of the Flight, without any problems.

1.9 Communications

Communications were recorded and were made available to the Investigation Team.

1.10 Aerodrome Information

Stockholm Arlanda Airport (IATA: ARN, ICAO: ESSA), is an international airport located in the Sigtuna Municipality of Sweden, near the town of Märsta, 37 km north of Stockholm, and nearly 40 km south-east of Uppsala.

The airport is the largest in Sweden, the third largest airport in the Nordic countries, and was used by close to 21 million passengers in 2013, with 16 million international passengers and 5 million domestic.

Arlanda has three runways: Runway 01L/19R (3,301 m long), Runway 08/26 (2,500 m long) and Runway 01R/19L (2,500 m long). Runways 01L/19R and 01R/19L are equipped with CAT III for instrument landing systems and simultaneous take offs and landings can be handled.

1.11 Flight Recorders

The Aircraft was equipped with flight recorders as per the relevant UAE Regulations. Both recorders were made available to the Investigation Team and were downloaded. In addition Quick Access Recorder[5] data was made available to the Investigation Team.

1.12 Wreckage and Impact Information

There was no wreckage

1.13 Medical and Pathological Information

There were no injuries reported.

1.14 Fire

There was no fire.

1.15 Survival Aspects

The occurrence was survivable.

[4] The pascal (symbol: Pa) is a unit of pressure, internal pressure. Pressure is a measure of force per unit area. It is named after the French mathematician, physicist, inventor, writer, and philosopher Blaise Pascal. Hectopascal (1 hPa ≡ 100 Pa) is a multiple unit of the pascal.

[5] Quick Access Recorder (QAR). A recording unit onboard the aircraft that stores flight-recorded data. These units are designed to provide quick and easy access to a removable medium on which flight information is recorded. QARs may also store data in solid-state memory that is accessed through a download reader. QARs have now been developed to record an expanded data frame, sometimes supporting over 2,000 parameters at much higher sample rates than the FDR. The expanded data frame greatly increases the resolution and accuracy of the ground analysis programs(source : FAA Advisory Circular 120-82 dated 12 April 2004).

1.16 Test and Research

1.16.1 The GCAA Incident Database

The AAIS researched fumes related events recorded in the GCAA Incident Database. This revealed that there were 172 fumes related occurrences between January 2010, and February 2014. The sources of the fumes were identified, with the majority being related to the electrical and air-conditioning systems. For each incident the source of the fumes had been positively identified.

1.16.2 Tests Performed at Destination

At JFK, the IFE Cooling Fan was replaced and the IFE System was checked by an engineer for full functionality. The system was found to function correctly.

In the process of fault isolation, the RH Air Conditioning Pack upper Flow Control Valve (FCV) was deactivated in the closed position in order to force the ozone converter to be in the operational loop with the lower FCV. Under this condition, a strong smell reappeared in the cockpit and there was also an odor in the passenger cabin.

In order to further identify the source the RH Pack Lower FCV was deactivated, and the Pack was selected to full heat and left running for ten minutes. Then the system was selected to normal zone temperature, and no odor was sensed. Four different persons confirmed the lack of smell, along with the out-bound cockpit crew.

The Aircraft was dispatched with the RH Pack Lower FCV Deactivated in the Closed position (MEL 21-51-02-02 Cat-C) and consequently the Right Pack Ozone Converter was INOP (MEL 21-73-01 Cat-C);

1.16.3 Heat Exchanger & Condenser/Reheater Inspection

The Heat Exchanger (HX) (S/N 200307170) and the Condenser/Reheater (S/N2005060940) were both sent for inspection at the manufacturer's, Hamilton Sundstrand, laboratory and both were found to be internally contaminated with fluid.

According to the maintenance records, the Heat Exchanger (HX) was last cleaned in June/July 2010, and remained in stores until fitted to the subject aircraft two days before the incident.

1.16.3.1 External Inspection

No unusual conditions were noted on the exterior of the HX or the Condenser/Reheater. There was no obvious smell coming from either the HX or the Condenser/Reheater.

1.16.3.2 Internal Inspection

The HX exhibited what appeared to be a wet spot of evaporating liquid in the secondary inlet (see figure 2). An attempt was made to pour any residual liquid out for analysis but nothing could be collected. The wet spot was examined and was determined to be water.

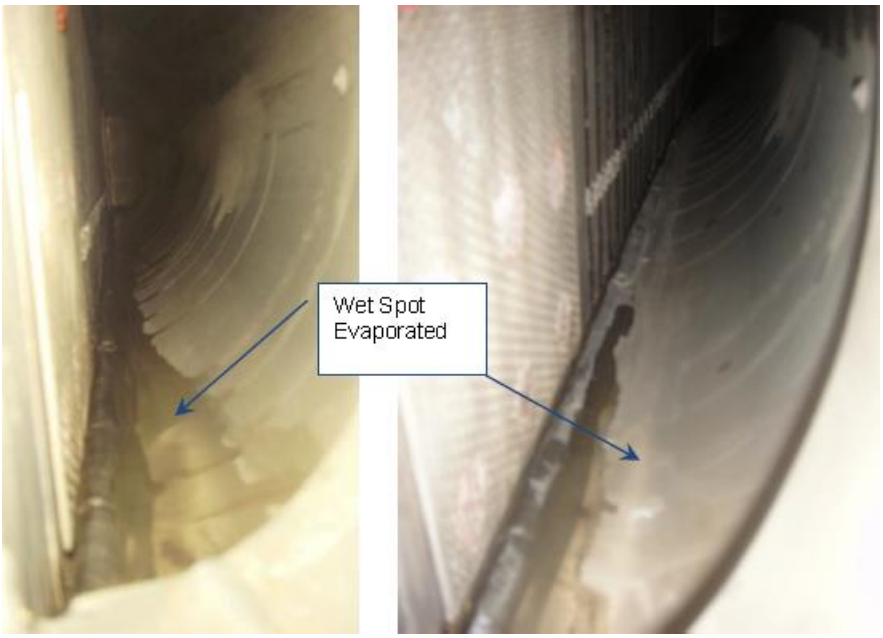

Figure 2. HX Secondary Inlet Photo Taken at the Operator's Facilities (left) and at the Inspection Facilities (right).

The Condenser/Reheater exhibited a wet spot in the Reheater hot inlet. An attempt was made to gather any residual fluid by pouring it out but nothing was collected. The wet spot appeared to be a water spot. In an effort to gather any foreign material that may have been present in the core, water was poured through the core and a sample collected for analysis.

The reddish/brown compound witnessed on the interior walls of the Condenser/Reheater was actually a Rockhard Stoving Enamel that is applied as a corrosion preventative. This coating is applied both during original production, and as required at subsequent shop visits. After maintenance, and cleaning and baking in an oven to drive off residual moisture, this compound is sprayed into the unit and dripping and running occurs normally prior to oven curing of the material, following the application step.

Even though several areas were found where some Rockhard material had been eroded from the core inlet, most of the material was found to be intact. Erosion of this material would not lead to a sulphurous smell. See figure 3. It is likely that liquid water, present on the interior walls of the Condenser/Reheater, was mistaken for liquid Rockhard, when in fact the water only coated the Rockhard, which was intact.

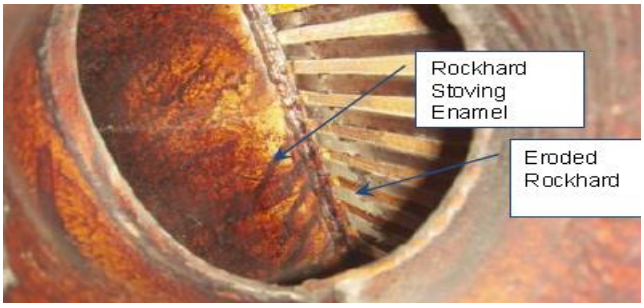

Figure 3. Condenser/Reheater Internal View

1.16.4 Test Results

The HX was cleaned as per CMM 21-52-02.

The Condenser/Reheater was tested per CMM 21-72-02 before any cleaning and it passed all tests with a greater pressure drop margin than many other units after cleaning.

1.16.5 Conclusion

Because there was no foreign contamination found inside the HX or the Condenser/Reheater, it is concluded that neither unit contributed to the odor encountered in flight, and later on the ground during troubleshooting.

Further, since the smell was strong in the overwing cabin area, with the ozone converter in the flow circuit, and that the smell lessened when the ozone converter was bypassed, the most likely source of the smell was the ozone converter. The same HX and Condenser/Reheater were in the pack when both of these tests were run, including when there was no smell in the cabin.

Catalytic type converters are known to produce sulphur dioxide gas under certain conditions in the presence of exhaust fumes from burning hydrocarbon fuels. An aircraft that is in line for takeoff on a taxiway behind other aircraft with their engines running could conceivably ingest exhaust fumes into the bleed air supply system, and subsequently into the ozone converter. It is noted that trim air to the flight deck and cabin distribution system always passes through the ozone converter.

1.16.6 Corrective Action

Since no foreign material was found in the HX or Condenser/Reheater no corrective action for these parts is required. The examination and inspection facility suggested that the ozone converter, which was reported as being removed from the aircraft at the same time as the HX and Condenser/Reheater, also be investigated.

1.16.7 Ozone Converter Examination

1.16.7.1 Visual Examination

The unit was sent to the manufacturer, Honeywell LORI, in the as-removed condition. The unit was lightly fouled with carbon black. Honeywell LORI Engineering employees examined the unit and, while there was a faint odor, the smell was not especially unusual. Other PN 2341590 units were in the same facility, which had the same faint odor as detected on the subject unit. The brownish tinge reported by the Operator is the normal color of the core matrix.

1.16.7.2 Laboratory Analysis

The unit was submitted to Honeywell's Torrance Material and Process Laboratory. A solvent mixture was poured into the top of the ozone converter and the effluent was captured. A portion of the effluent was concentrated and submitted for Fourier Transform Infrared (FTIR) Spectroscopy[6]. FTIR analysis identified the extracted material as silicone.

[6] Fourier Transform-Infrared Spectroscopy (FTIR) is an analytical technique used to identify organic (and in some cases inorganic) materials. The method has been used for the field identification of unknown substances for many years. Information downloaded from : http://www.mee-inc.com/hamm/fourier-transform-infrared-spectroscopy-ftir/
http://onlinelibrary.wiley.com/doi/10.1002/9780470015902.a0003112.pub2/full
http://www.thermoscientific.com/content/tfs/en/products/fourier-transform-infrared-spectroscopy-ftir.html?ca=ftir
http://www.smithsdetection.com/index.php/technologies/fourier-transform-infrared-spectroscopy.html

1.16.7.3 Summary

The extracted substance identified through the FTIR analysis was consistent with silicone oil. Silicone lubricants are a known installation aid used during installation of Environmental Control Systems and are not odor causing materials.

1.17 Organizational and Management Information

The Operator is an airline based in Dubai, United Arab Emirates. It is certified (AOC) to perform worldwide passenger and cargo flights by the GCAA, the Competent Authority, which also provides oversight functions. The airline operates approximately 2500 flights per week, from its hub at Dubai International Airport, with a fleet of B-777s, A-330s, A-340s and A-380s.

1.18 Additional Information

Not applicable for this investigation

1.19 Useful or Effective Investigation Techniques

Normal investigation procedures were used.

2. Analysis

This section of the report contains the analysis of the information documented in “Section 1.Factual Information” and which is relevant to the determination of the conclusions and causes.

2.1 Commander’s Decision to Divert

During the flight the odor, as described by the crew, was strong, and it was becoming more unpleasant and uncomfortable. Therefore, the crew had to decide whether it was safe to continue. The Commander, with all the available information that he had at the time, decided that it was unsafe for the aircraft and passengers to cross the Atlantic Ocean. His decision was based on the prevailing circumstances which were not clear as no one on-board could identify the source of the odor.

2.2 Component Inspections

All relevant components were examined and there was no solid evidence to confirm the source of the smell in the passenger cabin.

2.3 Crew Management

Throughout the flight from Dubai to New York the flight and cabin crewmembers had to utilize all available resources in order for information to flow efficiently from the cabin, where the odor was initially observed. All crewmembers had to maintain the team concept, based on their non-technical skills in order to establish and maintain their situational awareness. More importantly, the diagnosis of the problem had to support their decision making, whilst the workload was managed without creating any conflicts, and ambiguities had to be communicated and resolved. Therefore, the crew managed the situation well, in line with the Operator’s CRM policies and the crew resource management was effective and efficient

3. Conclusions

3.1 Findings

3.1.1 The Aircraft had a valid Certificate of Airworthiness was certified, insured, equipped and maintained in accordance with existing regulations and approved procedures.
3.1.2 The Aircraft was airworthy when dispatched for the flight.
3.1.3 The mass and the center of gravity of the Aircraft were within the prescribed limits.
3.1.4 There was no evidence of any defect or malfunction in the Aircraft that could have contributed to the Incident.
3.1.5 There was no evidence of system malfunction prior to the Incident.
3.1.6 The flight deck lighting and other electrical services were operating normally.
3.1.7 The flight and cabin crewmembers were properly licensed, medically fit, qualified, and adequately rested to operate the flight, in accordance with existing regulations.
3.1.8 The flight and cabin crewmembers were in compliance with the flight and duty time regulations.
3.1.9 There was no evidence that incapacitation or physiological factors affected the crewmembers' performance.
3.1.10 There were no injuries.
3.1.11 The Aircraft was equipped with a flight data recorder (FDR) and cockpit voice recorder (CVR) as per the relevant regulations.
3.1.12 A disturbing odor was generated during the flight.
3.1.13 The operating crew decided to divert the aircraft, for safety reasons, to Stockholm.
3.1.14 Following maintenance action at JFK, the flight dispatched to its destination.

3.2 Cause

This investigation was unable to determine the cause of the disturbing odor in the passenger cabin.

4. Safety Recommendations

There are no Safety Recommendations resulting from this Investigation.

END